Indian Journal of Agricultural Economics 80: 3 (2025):1068-1080
DOI:10.63040/25827510.2025.03.027

Green Trade Policies: Can the WTO Bridge the Gap Between Economic Growth And Environmental Sustainability?

Longbor Bey[1], Amod Sharma[1], and Brota Sing Bey[2]

ABSTRACT

This study investigates the key drivers of CO_2 emissions in India from 1990–91 to 2023–24, integrating trade dynamics and energy-economic indicators through the Kaya Identity framework and multiple regression analysis. Time series data on population, GDP per capita, energy intensity, and carbon intensity were sourced from IEA, EDGAR, World Development Indicators, and WTO. The analysis revealed that, although India has made substantial progress in improving energy efficiency and maintaining stable carbon intensity, emissions have continued to rise due to rapid growth in GDP per capita and steady population increases. GDP per capita emerged as the most dominant factor influencing emissions, peaking at 1.99, while energy intensity consistently declined, indicating improved efficiency. A comparative analysis between actual and expected CO_2 emissions using the Kaya Identity shows that from 1990 to 2000, actual emissions closely followed projections. However, since the early 2000s, actual emissions have exceeded expectations, primarily driven by intensified industrial output and economic growth. By 2022–23, normalised emissions reached 8.55, exceeding the projected value of 7.71. A slight decline in emissions in 2023–24, coupled with improved energy intensity, suggests the potential influence of cleaner energy adoption and policy measures. The regression analysis further indicates that exports significantly contribute to GHG emissions due to energy-intensive production. At the same time, imports are associated with lower domestic emissions, likely substituting emission-heavy local manufacturing. Tariff rates showed no significant effect. The overall regression model is statistically valid, as confirmed by ANOVA results. These findings underscore the crucial need for green trade policies and sustainable industrial practices to strike a balance between economic growth and environmental sustainability.

Keywords: WTO, Kaya identity, GHG emissions, environment, sustainable

JEL Code: O13, Q12, Q15, Q18, R20

I

INTRODUCTION

The historic Paris Agreement marked a turning point in global climate governance, bringing together 195 nations in a shared commitment to combat climate change. Under this agreement, countries must submit Nationally Determined Contributions (NDCs), which outline their individual strategies for reducing greenhouse gas (GHG) emissions and enhancing adaptive capacity. To ensure transparency and accountability, the Agreement introduced an enhanced transparency framework and a Global Stocktake mechanism that occurs every five years, starting in 2023. Before the Paris Conference, 186 countries were responsible for over 90 per cent of global emissions and submitted their Intended Nationally Determined Contributions (INDCs). These documents outlined emission reduction plans up to 2025 or 2030, including economy-wide carbon targets and commitments to preserve carbon sinks (IPCC, 2018). India, despite its relatively small share in historical emissions, has taken ambitious climate actions, tailored to its development priorities

[1]Department of Agricultural Economics, Nagaland University, Medziphema Campus, Nagaland-797106
[2]ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi-110012

and national circumstances. In line with the principle of Common but Differentiated Responsibilities and Respective Capabilities (CBDR–RC), India became the first G20 nation to achieve its 2015 NDC target of reducing emissions intensity 11 years ahead of schedule. It also surpassed its non-fossil fuel electricity capacity target nine years ahead of schedule (MoEFCC, 2024). In its updated NDCs, India committed to increasing forest-based carbon sequestration. According to the India State of Forest Report (ISFR, 2023), the country's carbon stock reached 30.43 billion tonnes of CO_2 equivalent, reflecting an increase of 2.29 billion tonnes since 2005 and a significant step toward the 2030 target of 2.5–3.0 billion tonnes of CO_2 equivalent. Indian energy transition is particularly impressive. The Solar power capacity increased from 2.63 GW in 2014 to 92.12 GW in 2024, a 35-fold rise. This supports India's goal of sourcing 50 per cent of its cumulative electricity capacity from non-fossil sources by 2030. However, even as India progresses toward its climate goals, it remains highly vulnerable to the impacts of climate change. In 2023, India experienced its hottest February since 1901, highlighting the increasing frequency and severity of extreme weather events (MoEFCC, 2024). In this broader climate-development landscape, international trade plays a critical role. The Rio Declaration on Environment and Development (1992) emphasised the integration of economic growth with environmental sustainability. It highlighted the role of trade in poverty reduction (Principle 5), sustainable consumption (Principle 8), and global cooperation on environmental issues (Principle 12). Despite this, post-Rio trade policies often focused more on environmental safeguards than on development equity.

1.1 Indian Trade Policy: Balancing Liberalisation and Protection

The ASEAN-India Free Trade Agreement (AIFTA), implemented in 2010, liberalised over 90 per cent of traded goods, including key agricultural commodities like palm oil, pepper, and black tea. However, India retained protective tariffs for many sensitive products to safeguard its domestic sectors. For instance, India maintains a 70 per cent import tariff on pepper, but offers ASEAN countries a reduced 50 per cent rate under AIFTA, balancing trade commitments with domestic producer protection (GoI, 2024). While Vietnam leads global pepper exports, the value of Indian pepper exports declined in 2023, despite steady volumes. The tariffs on palm oil imports from ASEAN nations were reduced from 100 per cent to 37.5 per cent, enhancing the competitiveness of Indonesian and Malaysian imports. Notably, Indonesia overtook Malaysia as India's top palm oil supplier in 2023. Yet, the import value of crude palm oil fell, likely due to declining global prices. Conversely, rice, a politically and economically sensitive crop, remains outside preferential tariff agreements. India continues to apply a 70 per cent import duty, underscoring its commitment to protect domestic farmers. Despite this, India retained its position as the world’s leading rice exporter, with export values rising in 2023, even though export volumes declined slightly (GoI, 2024). These developments highlight the need for a balanced policy approach, one that harmonises environmental goals, trade liberalisation, and agricultural sustainability. As countries aim to make trade a driver of sustainable development, India must carefully balance its development goals with climate action, food security, and fair trade practices. Achieving this balance will require innovative policy instruments and adaptive strategies that support green growth while ensuring the livelihoods of millions who depend on agriculture are not compromised.

II
MATERIALS AND METHODS

2.1 Database

The present study relies entirely on secondary data sources. Data on population, GDP per capita, energy intensity, and carbon emissions for India from 1990–91 to 2023–24 were obtained from the International Energy Agency (IEA), Emissions Database for Global Atmospheric Research (EDGAR), World Development Indicators (WDI), and the World Trade Organisation (WTO). Additionally, data on tariff rates, imports, exports, and greenhouse gas (GHG) emissions for the period 1999–2000 to 2022–23 were collected from Macrotrends and the IEA. This comprehensive dataset was used to analyse India's current environmental and economic status, to assist researchers, policymakers, and government agencies in balancing sustainable environmental practices with economic growth objectives.

2.2 Analytical Framework

In this study, CO_2 emissions were estimated using the original Kaya Identity, as described in Equation (1). The model is applied without the use of additional coefficients or special transformations. The analysis spans 33 years from 1990 to 2023, and the estimated emissions were compared with actual historical data to assess the predictive accuracy of the Kaya Identity. The Kaya Identity is a widely used analytical model for conducting quantitative assessments of CO_2 or GHG emissions. Professor Yoichi Kaya first introduced it during an IPCC seminar in 1989 and later formalised it in academic literature (Kaya and Yokobori, 1997; Yoichi, 1989). This identity presents a simple mathematical framework that connects demographic, economic, and technological factors to estimate global CO_2 or GHG emissions resulting from human activities. The Kaya Identity expresses total emissions as the product of four key drivers using equation (1):

$$CO_2 = P \, x \, \frac{GDP}{P} \, x \, \frac{E}{GDP} \, x \, \frac{CO_2}{E} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

P = Total population in India

GDP/ P = GDP per capita; measures economic activity per person ($/person-yr)

E/ GDP = Energy intensity; represents energy efficiency in production and (kWh/$)

CO2/ E = Carbon intensity; carbon emissions per unit of energy utilised (kg/kWh)

Equation (1) provides a structured framework for identifying and assessing the core drivers influencing carbon emissions from fossil fuel combustion. The amount of GHG emissions, measured in CO_2 equivalents (CO_2eq), is dependent on both the volume of fossil fuel consumed and the type of fuel used. Multiple factors, including population size, economic development, standard of living, industrial energy dependency, and climatic conditions, further shape fuel consumption.

2.2.1 Population Growth and Emissions

Among all emission drivers, population growth is a major contributor to increasing CO_2 levels, particularly in developing nations. The global population increased from 5.3 billion in 1990 to 8.2 billion in 2024, representing a net rise of 2.9 billion people. The Indian population is estimated to be 1.46 billion, according to Worldometer's analysis of United Nations data. This represents 17.78 per cent of the world's population, making India the most populous country globally.

India's rapid industrialisation and economic expansion have significantly increased its carbon emissions. In 2023, the countries fossil CO_2 emissions rose by nearly 8 per cent, reaching an all-time high of 3 billion metric tons (GtCO_2). Since the early 2000s, India's emissions from fossil fuel use and industrial activity have nearly tripled, positioning it as the third-largest CO_2 emitter globally (Statista, 2025).

2.2.2 Economic Output: GDP per Capita

A nation's economic condition is typically represented by its GDP per capita, which is calculated as the total GDP divided by the population. This is a key indicator of the standard of living and is often used in cross-country comparisons. Countries with low GDP per capita typically face challenges in meeting basic needs such as food**,** healthcare**,** education, and housing (Tucker, 2012). Since higher economic output generally correlates with increased energy use, GDP per capita is also an indirect indicator of GHG emissions.

2.2.3 Energy Intensity

Energy intensity measures how much energy is consumed to generate one unit of economic output (e.g., one dollar of GDP). It is a core indicator of a country's energy efficiency. This metric is influenced by the degree of industrialisation, economic structure (manufacturing vs. services and the policy emphasis on energy-saving technologies (Wang et al., 2005; Wang et al., 2015). Similarly, the countries with lower energy intensity produce more economic value per unit of energy consumed, indicating higher efficiency.

2.2.4 Carbon Intensity

Carbon intensity reflects the amount of CO_2 emitted per unit of energy consumed. It measures the degree to which an economy relies on carbon-intensive fuels, such as coal, oil, and natural gas. Countries that transition to renewable energy sources tend to reduce their carbon intensity. For instance, between 1990 and 2002, China cut its carbon intensity by approximately 51 per cent, demonstrating significant progress. In contrast, countries such as Saudi Arabia, Indonesia, Iran, and Brazil saw a notable rise in carbon intensity during the same period (Baumert et al., 2005).

2.2.5 Global Trends and Implications

While population growth and economic development are the primary contributors to rising emissions, global progress in improving energy efficiency and carbon intensity can mitigate some of the negative effects. The interplay of these four factors determines the trajectory of national and global emissions.

To assess year-over-year changes in emissions, the study applies logarithmic differentiation to the Kaya Identity. This technique allows us to approximate the annual percentage change in CO_2 emissions (ΔCO_2) as the sum of the log-differences (or growth rates) of each of the Kaya components using equation (2):

$$\Delta \ln CO_2 = \Delta \ln P + \Delta \ln\left(\frac{GDP}{P}\right) + \Delta \ln\left(\frac{E}{GDP}\right) + \Delta \ln\left(\frac{CO_2}{E}\right) \ldots\ldots\ldots\ldots (2)$$

Where,

ΔP = Contribution of population growth to CO_2 emissions

$\Delta(GDP/P)$ = Contribution of economic growth (per capita GDP) to CO_2 emissions

$\Delta(E/GDP)$ = Contribution of energy efficiency improvements (lower values mean better efficiency)

$\Delta(CO_2/E)$ = Contribution of decarbonization of energy (e.g., transition to renewable sources)

Additionally, to examine the impact of different variables on GHG emissions in India, we applied a multiple regression analysis. This statistical approach enables us to evaluate the individual effect of several independent variables on GHG emissions, and is represented in the following general form:

$$Y = A + \beta_1.X_1 + \beta_2.X_2 + \beta_3 .X_3 + e \qquad \ldots\ldots\ldots\ldots\ldots... \quad (3)$$

Whereas,

Y = GHG emission in India
X1 = Tariff rate (weighted mean applied tariff)
X2 = Import (US $)
X3 = Export (US $)
e = Random disturbance term
A = Intercept.

β_1, β_2, and β_3 are the partial regression coefficients of the respective explanatory variables. The result was estimated from the regression equation (3) and compiled in Table 3.

III

RESULTS AND DISCUSSION

3.1 Green Trade as a catalyst for Indian export diversification and growth

Figures 1 and 2 indicate that while global demand for low-carbon and environmentally sustainable goods and services has surged in recent years, India's performance in exporting environmental goods and services (EGS) remains comparatively weak. The trade balance in EGS is currently skewed in favour of imports, with India importing more environmental goods than it exports. This

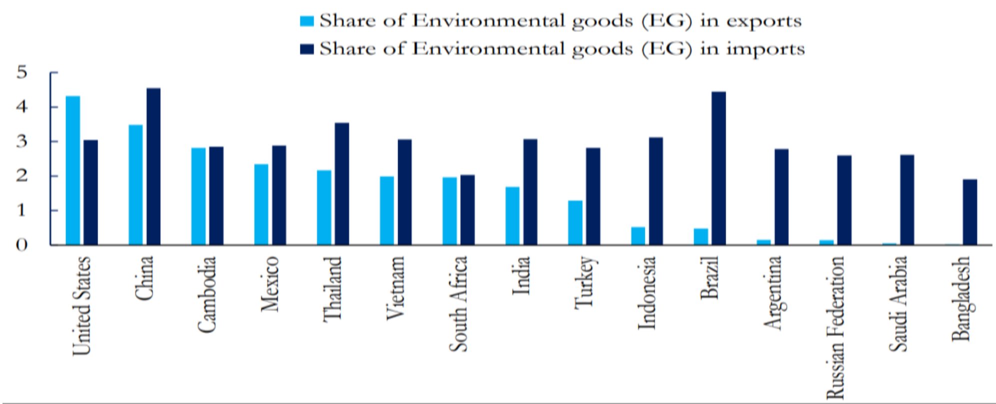

FIGURE 1. INDIA'S PARTICIPATION IN ENVIRONMENTAL GOODS

SOURCE: WORLD BANK REPORT

persistent trade gap suggests that India is yet to tap into the full potential of the expanding global market for EGS. When benchmarked against other emerging economies such as Bangladesh, Costa Rica, Indonesia, Thailand, Vietnam, and South Africa, India lags not only in the volume of EGS exports but also in the diversity and value-added nature of these exports. These countries have been able to better position themselves within global value chains (GVCs), reflecting stronger institutional support, targeted policy interventions, and strategic investments in green technology.

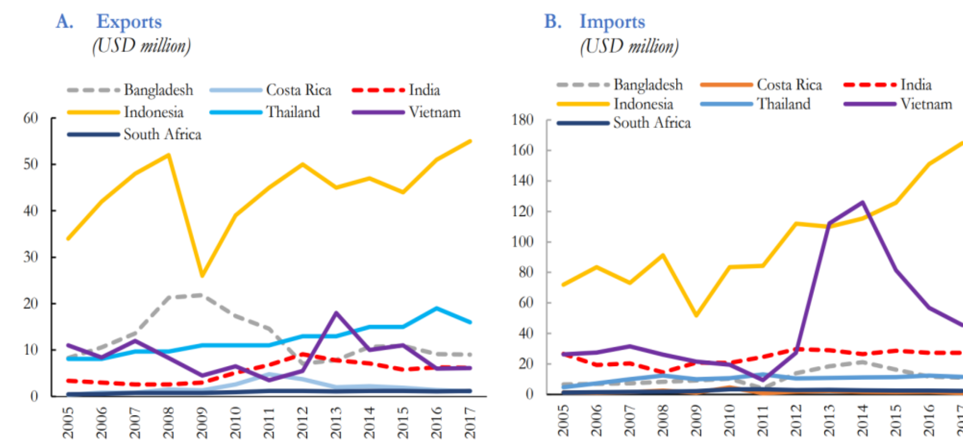

FIGURE 2. INDIA'S ENVIRONMENTAL SERVICES EXPORTS ARE LAGGING BEHIND COMPARATORS

SOURCE: WTO TIMOS

3.2 Descriptive Statistics of Key Identity Contribution

Table 1 and Figure 3 show that among the four contributing factors- population, GDP per capita, energy intensity, and carbon intensity-GDP per capita emerged as the most dominant, peaking at 1.99, reflecting the substantial impact of economic growth on emissions. As India's economy expanded rapidly over the last

TABLE 1. DESCRIPTIVE STATISTICS OF KAYA IDENTITY CONTRIBUTION

Statistic	Population (billion)	GDP per Capita ($/Person/year)	Energy Intensity (kWh/$)	Carbon Intensity (kg/kWh)	Total Contribution
Minimum	0.00	-0.20	-0.48	0.00	-0.12
1st Quartile	0.16	0.12	-0.19	0.03	0.34
Median	0.31	0.87	-0.08	0.07	1.16
Mean	0.29	0.82	-0.11	0.07	1.07
3rd Quartile	0.42	1.45	0.00	0.11	1.79
Maximum	0.51	1.99	0.05	0.14	2.14

Note: GDP= Gross domestic product; Kg = kilogram; kWh= Kilo Watt-Hour and $=Dollar three decades, the increased industrial output, infrastructure development, and rising consumption patterns significantly boosted CO_2 emissions. Population growth, while steadier, has consistently contributed to rising emissions, with its highest impact recorded at 0.51, highlighting demographic pressure as another underlying factor. In contrast, energy intensity has shown a consistent downward trend, indicating improvements in energy efficiency across sectors.

The negative median value of energy intensity confirms this decline, suggesting that India is producing more economic output per unit of energy consumed. Carbon intensity, which measures emissions per unit of energy, has remained relatively stable, indicating limited progress in decarbonising the energy mix. Despite gains in energy efficiency, the combined effect of economic and population growth has outweighed these improvements, resulting in a steady increase in total emissions, which reached a maximum contribution of 2.14 by 2023.

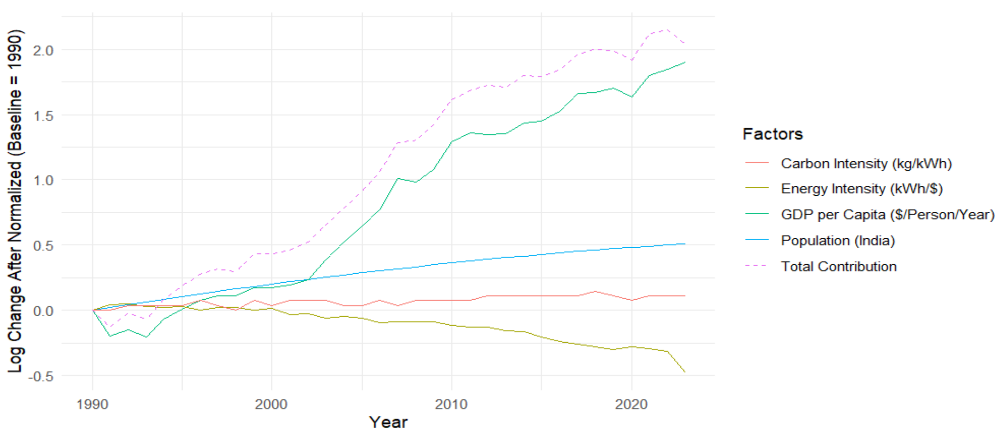

FIGURE 3. KAYA IDENTITY DECOMPOSITION OF CO_2 EMISSIONS IN INDIA (1990-2023)

3.3 Emissions Unveiled: Tracking Indian CO_2 Reality against Expectations

Table 2 and Figure 4 illustrate the comparative analysis between actual and expected CO_2 emissions, derived from the Kaya Identity, which provides valuable insights into India's emission trajectory over the past three decades.

TABLE 2. KAYA IDENTITY-BASED CO_2 EMISSION ANALYSIS: REAL AND EXPECTED VALUES

Year	Population (Billion person)	GDP per Capita ($/Person/year)	Energy Intensity (kWh/$)	Carbon Intensity (kg/kWh)	Total CO_2 (MT)	Baseline CO_2 (MT)	Real CO_2	Expected CO_2
1990	0.86	371.09	1.31	0.25	105.94	105.94	1.00	-0.34
1991	0.88	305.57	1.37	0.25	93.99	105.94	0.89	-0.09
1992	0.90	319.18	1.38	0.26	102.03	105.94	0.96	0.16
1993	0.92	302.88	1.35	0.26	97.3	105.94	0.92	0.41
1994	0.94	347.73	1.34	0.26	113.72	105.94	1.07	0.66
1995	0.96	375.18	1.35	0.26	125.11	105.94	1.18	0.92
1996	0.98	401.05	1.31	0.27	137.99	105.94	1.3	1.17
1997	0.99	416.23	1.34	0.26	147.01	105.94	1.39	1.42
1998	1.01	413.63	1.34	0.25	143.71	105.94	1.36	1.67
1999	1.03	441.93	1.31	0.27	162.64	105.94	1.54	1.92
2000	1.05	442.75	1.33	0.26	164.76	105.94	1.56	2.17
2001	1.07	450.36	1.27	0.27	165.19	105.94	1.56	2.42
2002	1.09	469.15	1.28	0.27	175.67	105.94	1.66	2.68
2003	1.11	544.14	1.23	0.27	199.61	105.94	1.88	2.93
2004	1.13	624.26	1.25	0.26	230.07	105.94	2.17	3.18
2005	1.15	710.49	1.23	0.26	261.15	105.94	2.47	3.43
2006	1.17	801.67	1.19	0.27	298.58	105.94	2.82	3.68
2007	1.19	1,021.89	1.2	0.26	384.81	105.94	3.63	3.93
2008	1.20	992.52	1.2	0.27	384.08	105.94	3.63	4.18
2009	1.226	1,094.95	1.2	0.27	433.29	105.94	4.09	4.44
2010	1.24	1,347.52	1.17	0.27	524.2	105.94	4.95	4.69
2011	1.26	1,445.46	1.15	0.27	562.41	105.94	5.31	4.94
2012	1.27	1,429.32	1.15	0.28	581.44	105.94	5.49	5.19
2013	1.29	1,432.84	1.12	0.28	576.56	105.94	5.44	5.44
2014	1.31	1,553.88	1.11	0.28	637.12	105.94	6.01	5.69
2015	1.32	1,584.00	1.07	0.28	635.95	105.94	6	5.95
2016	1.344	1,707.51	1.03	0.28	670.57	105.94	6.33	6.2
2017	1.36	1,950.10	1.01	0.28	752.39	105.94	7.1	6.45
2018	1.37	1,966.25	0.99	0.29	763.97	105.94	7.21	6.7
2019	1.38	2,041.43	0.97	0.28	772.05	105.94	7.29	6.95
2020	1.40	1,907.04	0.99	0.27	724.1	105.94	6.83	7.2
2021	1.41	2,239.61	0.98	0.28	864.14	105.94	8.16	7.45
2022	1.42	2,352.61	0.96	0.28	906.19	105.94	8.55	7.71
2023	1.43	2,480.79	0.81	0.28	818.04	105.94	7.72	7.96

Note: MT= million tonne

The Kaya Identity decomposes total CO_2 emissions into four key drivers: population, GDP per capita, energy intensity, and carbon intensity. Using 1990 as the baseline, both actual and modelled emission trends were examined to assess alignment with theoretical expectations. In the early years of the study period (1990–2000), Indian real CO_2 emissions remained relatively aligned with the expected trajectory. This indicated that growth in population, moderate economic expansion, and relatively stable energy use and carbon efficiency were within predictable bounds. For instance, from 1990 to 2000, normalised CO_2 values rose from 1.00 to 1.54, while the expected values rose from -0.34 to 1.92, suggesting a close correlation. However, beginning in the early 2000s, real emissions started to grow more rapidly than anticipated. This divergence can be attributed to accelerated economic growth and industrial expansion, reflected in rising GDP per capita values.

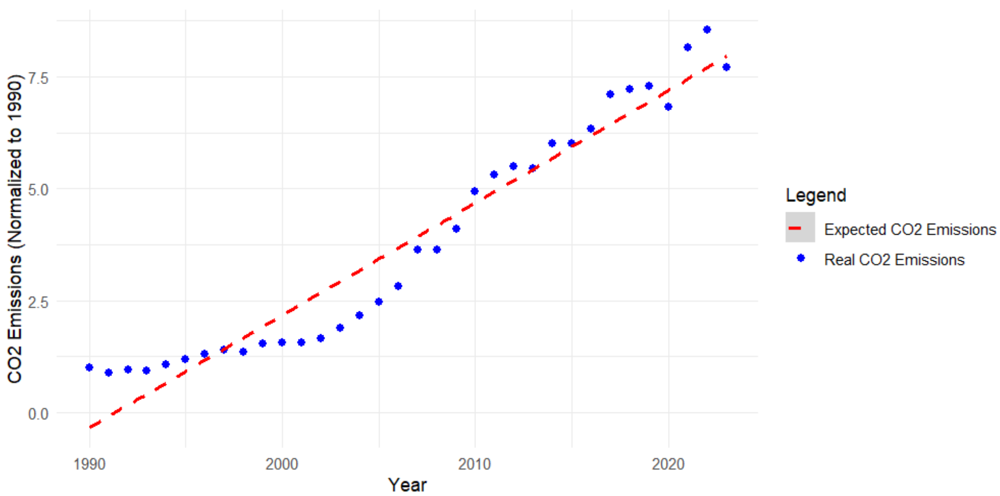

FIGURE 4. COMPARISON OF REAL VS EXPECTED CO_2 EMISSIONS USING THE KAYA IDENTITY (1990 BASELINE)
SOURCE: COMPUTED BY THE AUTHOR BASED ON THE EDGAR, 2024 DATA

While energy intensity began to improve gradually, indicating more efficient energy use, the gain was insufficient to offset the sharp rise in economic activity and energy demand. By 2010–11, normalised CO_2 emissions had reached 4.95, outpacing the expected value of 4.69. From 2011 onwards, the gap widened further. Although carbon intensity remained relatively stable and energy intensity showed gradual improvement, the surge in GDP per capita and population growth continued to drive emissions upward. By 2022–23, real emissions (normalised to 8.55) exceeded the Kaya Identity projection (7.71), highlighting a consistent trend of emissions growing faster than structural expectations. Interestingly, in 2023–24, a decline in normalised CO_2 emissions to 7.72 was observed, despite a continued rise in GDP per capita and population. This suggests a potential turning point influenced by the adoption of cleaner energy, policy interventions, or post-COVID economic adjustments. A noticeable reduction in energy intensity to 0.81 kWh per dollar in 2023–24—the lowest in the series —may have contributed to this decline, indicating improved energy efficiency.

Table 3 shows the regression analysis, which revealed that tariff rates have an insignificant impact on India's greenhouse gas (GHG) emissions, as indicated by a negligible coefficient and a high p-value. In contrast, imports show a statistically significant negative relationship with emissions, suggesting that higher imports may reduce domestic pollution by decreasing the need for emission-intensive local production. On the other hand, exports have a strong and highly significant positive association with GHG emissions, implying that increased export activity contributes to higher emissions, likely due to energy-intensive manufacturing and transportation processes. Overall, the findings highlight the environmental implications of trade patterns, with exports driving emissions upward and imports potentially helping to mitigate them.

TABLE 3. IMPACT OF IMPORTS, EXPORTS, AND TARIFFS ON INDIAN GHG EMISSION

Sl. No.	Variable Description	Coefficient	P-value
1	Tariff rate	-0.02	0.80
2	Import	-0.64	0.02*
3	Export	0.94	0.00**
4	Intercept	0.19	0.91

Note: Multiple Correlation (R) = 0.96; Coefficient of multiple determination (R2) = 0.93;
*8Significant at 5 per cent and * Significant at 1 per cent

Table 4 presents the ANOVA results, which indicate that the regression sum of squares (SS) is 1.47 with 3 degrees of freedom (df), yielding a mean square (MS) of 0.49. This indicates that the portion of total variation in emissions that can be attributed to the independent variables, viz., tariff rate, imports, and exports. The residual sum of squares was found to be 0.09 with 20 degrees of freedom, and the corresponding mean square was found to be very low, approximately 0.0045, which shows that the model leaves behind a minimal amount of unexplained variation.

TABLE 4. ANOVA FOR REGRESSION

Sl. No.	Sources of variation	df	SS	MS	F	Significance of F
1	Regression	3	1.47	0.49		2.42E-12***
2	Residual	20	0.09	0.004**	103.27	
3	Total	23	1.56	-		

Note: df= degree of freedom; SS= Sum of square; MS= Mean square
Significant at 5 per cent probability level, * Significant at 1 per cent probability level

The F-statistic was estimated to be 103.27, and the significance of F (p-value) is 0.000, which is highly significant. This means that the overall regression model is statistically valid and that at least one of the independent variables meaningfully explains variation in GHG emissions. The total sum of squares was estimated to be 1.56, representing the overall variation in the dependent variable across all observations.

IV

CONCLUSION

The World Trade Organisation (WTO) plays a pivotal role in aligning economic growth with environmental sustainability by encouraging the adoption of green trade policies. India, through its commitment to the Paris Agreement and its Nationally Determined Contributions (NDCs), has made considerable progress in expanding renewable energy, reducing emissions intensity, and enhancing carbon sinks. However, despite these efforts, the country's exports of environmental goods and services remain below those of its global peers. The Kaya Identity analysis from 1990 to 2023 reveals that the primary drivers of rising CO_2 emissions in India have been population growth and increased GDP per capita, despite improvements in energy efficiency and a relatively stable carbon intensity. Since 2010, actual emissions have exceeded projections, likely due to accelerated industrial activity and energy consumption. Although a slight decline was noted around 2020, the overall emission trend remains upward. Moreover, regression analysis reveals that exports are positively correlated with GHG emissions. At the same time, imports are associated with a reduction, suggesting that domestic production processes-particularly those linked to export sectors—need urgent evaluation and reform to mitigate their environmental impact.

The government should develop and enforce green certification standards for export-oriented industries, ensuring that products meet international environmental norms. Additionally, financial incentives such as tax credits, subsidies, or low-interest green loans should be offered to firms that adopt clean technologies, use renewable energy, and reduce GHG emissions in their production processes. Reduce tariffs and non-tariff barriers on the import of environmental goods and clean technologies, such as solar panels, wind turbines, carbon capture systems, and energy-efficient machinery. Simultaneously, India should negotiate trade agreements that include provisions for technology transfer to facilitate sustainable production and energy use.

REFERENCES

Baumert, K.A., Herzog, T., & Pershing, J. (2005). Navigating the Numbers. World Resources Institute.

Forest Survey of India. (2024). India State of Forest Report 2023. Ministry of Environment, Forest & Climate Change, Government of India.

IEA. (2021). India Energy Outlook 2021. Paris: International Energy Agency. Retrieved from https://www.iea.org/reports/india-energy-outlook-2021.

World Bank. (2025). World Development Indicators. Retrieved March 17, 2025, from https://data.worldbank.org

Enerdata. (2025). India energy information. Retrieved March 18, 2025

International Monetary Fund. (2020). Balance of Payments Statistics Yearbook and data files. Washington, D.C. Accessed on March 9, 2025

IPCC. (2018). Global warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Cambridge University Press. https://doi.org/10.1017/9781009157940

Kaya, Y., Yokobori, K. (1997). Environment, energy, and economy: strategies for sustainability. United Nations University Press Tokyo, Japan.

Makutėnienė, D., Staugaitis, A. J., Makutėnas, V., & Grīnberga-Zālīte, G. (2023). The Impact of Economic Growth and Urbanisation on Environmental Degradation in the Baltic States: An Extended Kaya Identity. Agriculture, 13(9), 1844.

Ministry of Commerce & Industry, Government of India. (2010). Agreement On Trade in Goods Under the Framework Agreement on Comprehensive Economic Cooperation Between the Association of Southeast Asian Nations and The Republic of India

MoEFCC. (2021). India: Third Biennial Update Report to the United Nations Framework Convention on Climate Change. Ministry of Environment, Forest and Climate Change, Government of India.

Ratna, R., & Kallummal, M. (2013). ASEAN-India Free Trade Agreement (FTA) and its Impact on India: A Case Study of Fisheries and Selected Agricultural Products. Foreign Trade Review, 48, 481–497.

Sharma, A. (2006). Fish Production in Nagaland - A regression approach. Journal of Dairying, Foods and Home Science. March. 25(1). March: 43-46.

Tandon, A. 2024. Amid the global green goods boom, India is yet to jump on the bandwagon. Mongabay-India.

Tavakoli, A. (2017). How precisely" kaya identity" can estimate GHG emissions: A global review. Jordan Journal of Earth and Environmental Sciences, 8(2), 91-96.

Tucker, I. (2012). Microeconomics for today. Cengage Learning.

U.S. Energy Information Administration (2023). Energy Institute - Statistical Review of World Energy (2024); Bolt and van Zanden - Maddison Project Database 2023 – with major processing by Our World in Data. “Primary energy consumption per GDP” [dataset]. U.S. Energy Information Administration, “International Energy Data”; Energy Institute, “Statistical Review of World Energy”; Bolt and van Zanden, “Maddison Project Database 2023” [original data]. Retrieved on March 18, 2025

Wang, C., Chen, J., & Zou, J. (2005). Decomposition of energy-related CO2 emission in China: 1957-2000. Energy 30(1), pp. 73-83

Wang, Z., Wang, C., & Yin, J. (2015). Strategies for addressing climate change on the industrial level: affecting factors to CO2 emissions of energy-intensive industries in China. Natural Hazards 75(2), pp. 303-317

Yoichi, K. (1989). Impact of carbon dioxide emission on GNP growth: interpretation of proposed scenarios. Paris: Presentation to the energy and industry subgroup, response strategies working group, IPCC.