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Environmental Protection or Economic Prosperity? Testing the Inevitability of Trade-offs in India

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ABSTRACT

India is one of the fastest-growing economies. However, it is also one of the countries that exhibit the highest level of environmental concerns. While India's national income has multiplied over the last 23 years (2000-2023), carbon dioxide emissions, deforestation, and air pollution remain alarming concerns. Thus, this paper raises an old economic query in a new context: Can a country foster economic growth and protect its environment at the same time? In this paper, this question is explored in the Indian context based on economic theories such as the Environmental Kuznets Curve, the Porter Hypothesis, and through the concept of decoupling, as well as a dataset compiled from the World Development Indicators (WDI) and the Central Electricity Authority (CEA), Government of India spanning 2000 to 2023.

The analysis reveals a pattern of relative decoupling in India: its GDP's carbon intensity has declined by about two-thirds and the proportion of clean power in installed generation capacity has increased from about one-quarter to more than two-fifths of the total, since 2000. However, absolute emissions, forest pressure, and air pollution remain significant issues, as gains are unevenly distributed across sectors and regions. The paper concludes that the trade-off is not a given outcome, but is shaped, and can be reshaped by pricing, institutions, and political choice.

Keywords: Decoupling, environmental kuznets curve, Environmental policy, India, Sustainable development

1. Introduction

Since the early 2000s, the Indian economy has witnessed remarkable growth. Its GDP has grown manifold, extreme poverty has decreased significantly, and millions have gained access to electricity, sanitation, and digital services over time. At the same time, India has emerged as one of the most environmentally stressed countries. Delhi and dozens of other Indian cities routinely rank among the cities with the poorest air quality, globally. Moreover, with forests being

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rampantly stripped off for developing mines, roads, and factories, India is now the third-largest emitter of carbon dioxide.

Rapid growth and the resultant significant adverse environmental impact have reignited the age old debate: can a country economically prosper while safeguarding its environment, or does it have to sacrifice one goal for the other? In the wake of the 1970s oil shocks, researchers were more likely to adopt the latter view (Feiock & Stream, 2001). The IPAT identity (population x affluence x technology) suggested that as output increased, more resources would be used and naturally, more waste would be generated (Ehrlich & Holdren, 1971). Subsequent research brought forth a more nuanced view. Referred to as the 'Environmental Kuznets Curve,' Grossman and Krueger (1995) proposed that some pollutants initially increase and then decrease as national income grows. Simultaneously, Porter and Van Der Linde (1995) suggested smart regulation can stimulate innovation rather than merely increase costs. This perspective does not assume that the trade-off is necessarily inevitable, rather it argues that it is dependent on policy and market-structure.

This paper investigates this conditional, policy-dependent perspective in light of the Indian experience. Section 2 discusses core theories put-forth by economists to consider the growth and environment nexus. Section 3 outlines the ways in which the two clash or reinforce each other. Section 4 views India's growth-environment trajectory from 2000 to 2023 based on the dataset compiled from sources like the World Bank, Global Carbon Project, and Government of India. Section 5 examines three areas where the tension is most acute: coal and power, urban air pollution, and forests. In Section 6, the policy instruments that India has employed to manage the relationship are reviewed, and in Section 7, the counterarguments and constraints that any optimistic account must address are considered. Section 8 states the conclusion.

The main thrust of this paper is that in the short run, there is a trade-off between environmental protection and economic prosperity in India, but in the long run, the story unfolds differently. India's own data indicates a relative decoupling as the economy grows faster than the rate of environmental damage. However, it is important to note that absolute damage has increased in certain areas. This trend can either continue or be effectively addressed depending on institutional and policy factors.

2. Theoretical Framework

The following three economic concepts are particularly germane to the analysis of the relationship between environmental protection and economic growth: the Environmental Kuznets Curve, the Porter Hypothesis, and decoupling. Each offers a different explanation for why this relationship is not fixed.

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2.1 The Environmental Kuznets Curve

The Environmental Kuznets Curve (EKC) is an inverted U-shaped curve that represents the increase in pollution with income growth in the early stages of development and the eventual decline as income continues to rise in later stages of development (Grossman and Krueger 1995). This pattern was observed by Grossman and Krueger for some local pollutants, including sulfur dioxide in the context of signatories to the North American Free Trade Agreement. The idea is simple: at low-income levels, there is focus on employment and nutrition, however, once basic needs are met, the focus shifts to better environmental quality and cleaner technology.

However, EKC does not apply universally. Dasgupta et al. (2002) demonstrated that the shape, height, and turning point of the curve vary across pollutants and countries. In-principle, developing countries can "tunnel under" the curve by adopting cleaner technology earlier rather than pollution-intensive goods production (Munasinghe, 1999). However, Stern (2004) highlighted that statistical evidence for a clean EKC is limited and weak, and that global pollutants like carbon dioxide exhibit little evidence of an automatic turning point at any level of income. The distinction between local, visible pollutants (which societies have strong incentives to fix) and global, diffused pollutants (which no single country has full incentive to fix on its own) is critical in the Indian context, as further discussed in Section 4.

2.2 The Porter Hypothesis and Induced Innovation

The second, related idea is the Porter Hypothesis. Porter and Van Der Linde (1995) suggested that well-designed environmental regulation encourages innovation, waste reduction, and resource efficiency, sometimes making firms even more competitive than before the regulation was enacted. This does not imply that all regulations are beneficial for industries as it often also entails increased cost of compliance.

2.3 Decoupling: Relative Versus Absolute

The third concept–decoupling–is the separation of two distinct sub-claims that are often conflated in public debate. Relative decoupling occurs when the pressure on the environment per unit of economic production decreases, while the overall pressure on the environment increases as overall economic production increases (Batra, 2023). On the other hand, absolute decoupling occurs when overall environmental pressure decreases despite economic growth. After a thorough review of the economic literature, Haberl et al. (2020) determined that relative decoupling is widespread globally, while absolute decoupling of carbon emissions at a rate sufficient enough to achieve international climate goals is still limited and primarily found in a small number of high-income countries (which in many cases also import pollution-intensive goods from other countries). Hickel and Kallis (2020) are far more sceptical and suggest even the

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most successful economies are not moving fast enough towards decoupling. Continued GDP growth in prosperous countries might be incompatible with the carbon budgets required to maintain low emission levels. These two ideas of relative and absolute decoupling will serve as the primary lens for interpreting India's trajectory.

3. Mechanisms of Interaction in the Indian Context

There are several channels through which growth prospects and environmental protection interact in a particular economy such as India. Three such channels are particularly relevant: 1) a direct channel from industrial expansion to resource use and pollution, 2) an indirect channel from regulation, innovation, and rebound, and 3) a political channel from public opinion and electoral incentives.

3.1 The Direct Channel: Industrial Growth and Resource Extraction

The simplest channel is the direct one. The cement, steel, coal, and electricity production, the number of vehicles on the roads, and the rate of urbanization have all increased as the Indian economy has expanded. The negative externalities/ environmental costs of each of these activities are not necessarily borne directly by the owner of the activity. For instance, the owner of a coal-fired power plant pays for the coal, labour, and machinery, but not for the respiratory illness caused by the emissions in neighbouring villages or for the mercury that settles in local water supply (Guttikunda & Jawahar, 2014). The difference between private and social cost is the “negative externality” (Coase, 1960).

This direct channel can at times lead to a policy reaction that mitigates the damage depending on regulatory capacity. Greenstone and Hanna (2014) examined India's experience with environmental regulation, comparing the effects of air pollution regulations with those of water pollution regulations adopted by different Indian states since the 1980s. They discovered that water regulations significantly curtailed pollution and infant mortality in part because compliance was relatively easy to monitor. By contrast, the impact of air pollution regulations was not measurable, as monitoring and curtailing emissions from widely dispersed smokestacks required rigorous enforcement. This finding is significant because it implies that the direct link between growth and environmental damage is not solely economic, but also heavily dependent on how efficiently pollution can be measured and regulated.

3.2 The Indirect Channel: Regulation and Rebound

Regulation and price signals also act indirectly by influencing firm and household decisions regarding what they buy, build, and invent. One such scheme in India that has been used to reduce energy consumption through market mechanisms is the Perform, Achieve and Trade

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Scheme, 2008, which sets energy-efficiency targets for large industrial plants and allows efficient firms to sell certificates to less efficient firms (Bureau of Energy Efficiency, 2012). It is based on the logic of the Porter Hypothesis: rather than simply punishing energy consumption, it encourages companies to identify cheaper ways to save energy.

However, the efficiency of this indirect channel is complicated by two factors. The first is the rebound effect: efficiency gains do not translate one-for-one into lower total resource use, since the cost savings they generate can themselves drive higher consumption. Gillingham et al. (2016) estimate direct rebound effects of 10-30 percent for household energy use in high-income economies, with larger economy-wide rebounds when cheaper energy fuels broader growth. This effect is likely to matter even more in India, where a rapidly growing, aspirational middle class means efficiency gains in individual appliances will be offset by a surge in the sheer number of appliances being bought for the first time (International Energy Agency, 2021). The second complication is leakage across borders: if India imposes strict standards on a polluting industry, production can simply relocate to a country with less stringent rules, shifting rather than actually reducing the pollution (Copeland & Taylor, 2004).

3.3 The Political Channel: Public Opinion and Electoral Incentives

The third channel is politics. A policy that lowers overall cost but imposes high individual costs and low individual benefits is more likely to be resisted (Olson, 1971). For instance, the impact on household budgets was the focus of public discussion when fuel prices increased in India, irrespective of whether this was attributable to tax hikes, global oil price shocks, or even the intent to reduce vehicular pollution that contributes to Delhi's smog. The same dynamic is visible in stubble burning: bans imposed on farmers without affordable alternatives are poorly enforced and quietly reversed (Cusworth et al., 2018). This channel demonstrates that even technically sound policies may fail in practice unless they are designed to balance who bears the short-term cost and who receives the long-term benefit.

4. Empirical Evidence: India's Growth-Environment Trajectory, 2000-2023

To test these theoretical channels in the Indian context, this paper analyses a dataset prepared from 2000 to 2023. A summarised version of this dataset is set out as Table 1 below:

Table 1. Selected indicators of India's growth-environment trajectory, selected years (2000-2023)

Year	GDP growth	CO2 per capita (t)	CO2 intensity of GDP	Forest area (% land)	PM2.5 (μg/m3)	Non-fossil capacity (%)

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	(%)		(Mt/US$bn)			
2000	3.8	1.00	2.26	21.5	77	26.0
2005	9.3	1.20	1.69	22.6	84	25.6
2010	10.3	1.49	1.10	23.0	90	25.9
2015	8.0	1.71	1.06	23.8	90	31.4
2019	3.9	1.89	0.90	24.2	87	36.0
2020	-5.8	1.71	0.90	24.3	79	38.0
2023	8.2	2.01	0.80	24.3	78	43.0

Source: World Development Indicators (WDI) and Central Electricity Authority (CEA), Government of India.

Figure 1 below depicts the growth rate of India's GDP and the carbon dioxide emissions per capita, over the years. The overall upward trend of both series, especially before 2015, is in line with the conventional negative relationship between growth and the environment: more output has generally led to more per capita emissions. Both series witnessed the largest drop in 2020, when COVID-19 caused a 5.8 per cent contraction in the economy, and per-person emissions dropped in tandem. Both series recovered in 2021.

Figure 1. India's GDP growth and CO_2 emissions per capita, 2000-2023 (WDI Data).

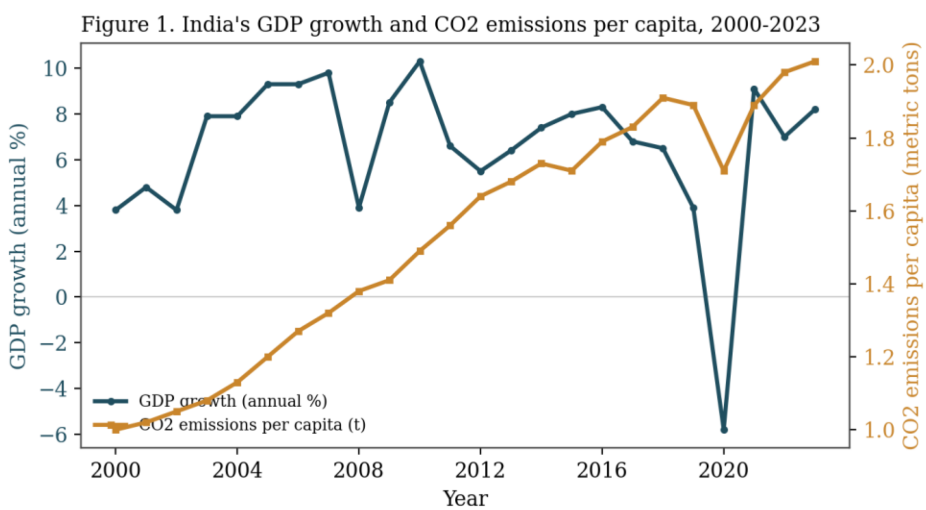

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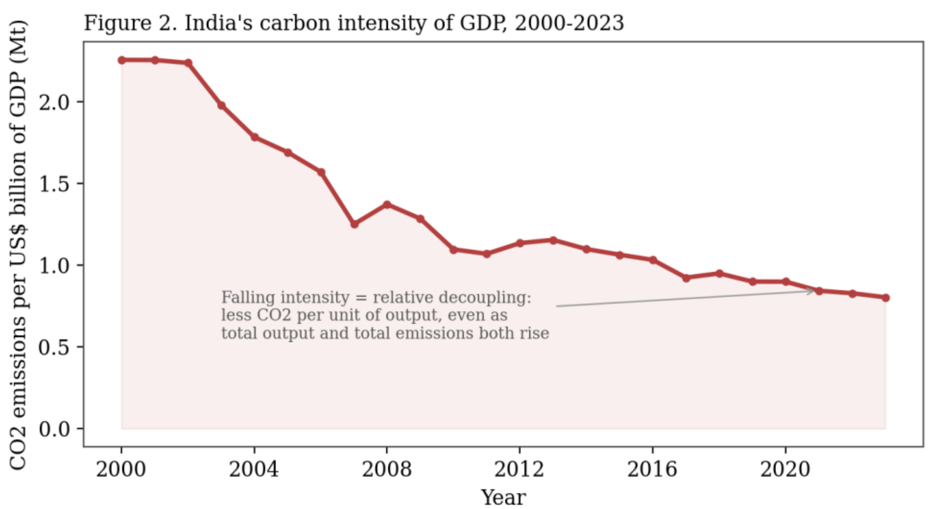
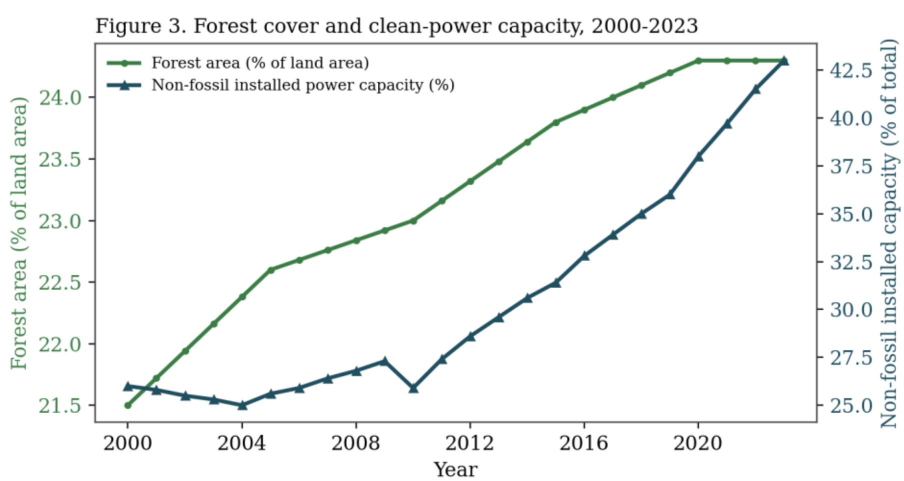
Figure 2. India's carbon intensity of GDP, 2000-2023 (Calculated from WDI Data)



A more evident picture is provided by carbon intensity i.e. carbon dioxide emissions per unit of GDP, as illustrated in Figure 2 above. Between 2000 and 2023, this measure declined by approximately two-thirds, from 2.3 mega-tonnes of CO_2 per billion US dollars of output to 0.8. The improvement reflects both a shift toward less carbon-intensive industries and the growing share of non-fossil power in the generation mix. This is a textbook example of relative decoupling; the pollution caused for every rupee of output has been declining over the past 20 years, while the total pollution continued to increase as the amount of output increased even faster.

Figure 3. Forest cover and clean-power capacity, 2000-2023 (WDI and CEA, Govt. of India).



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As shown in Figure 3 above, the two indicators are trending in a positive direction: forest area as a percentage of land area and the share of non-fossil fuel sources (large hydropower, nuclear, solar, wind, and biomass) in India's installed electricity generation capacity have both risen since 2000. However, it is important to note that the forest-area series should be viewed with caution as it is reported only in five-year cycles based on forest assessments by the Food and Agriculture Organization (FAO) and is interpolated between the cycles. Despite the loss of land in certain areas for mining, roads and industry, India's forest cover as measured by international agencies has been increasing since 2000, aided by large-scale afforestation initiatives by the government. The non-fossil fuel capacity share is the most obvious policy success in the dataset, increasing from about 20% of installed capacity in 2000 to over 40% in 2023. This growth is largely due to the rapid growth of subsidised solar and wind energy since 2014.

Figure 4. India's PM 2.5 air pollution exposure against WHO guideline, 2000-2023 (WDI data)

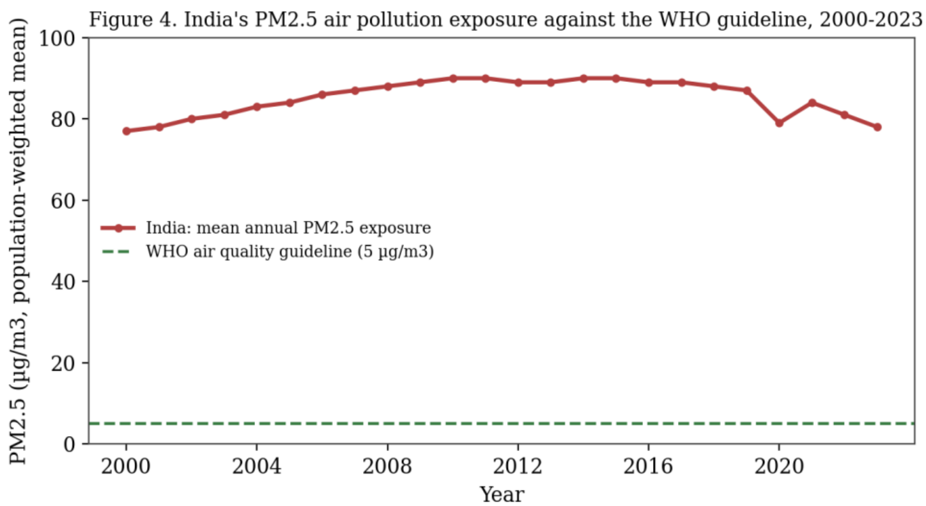

Figure 4 is a much more sobering story. The mean population-weighted exposure to fine particulate matter (PM2.5) was nearly constant at extremely high levels, between approximately 15 and 18 times the World Health Organization (WHO) Guidelines (World Health Organization, 2021). It only fell slightly during the 2020 pandemic. Air pollution has not improved as much as carbon intensity or forest cover and clean capacity have. At India's current income level, there is little sign of automatic improvement that a simple Environmental Kuznets Curve story would predict (Sinha & Shahbaz, 2018). This is in keeping with the theoretical discussion in Section 2 that indicated that pollutants that are more difficult to monitor, more diffused in their sources and more expensive to abate in the short run, are more likely to not reach the turning point that cleaner, more easily regulated pollutants have reached in other countries.

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Taken collectively, the data does not support either side of the debate. The data from India does not substantiate automatic “green growth” where prosperity and environmental quality go hand in hand without friction as demonstrated by PM2.5 pollution levels. Nor does it indicate a trade-off as an inevitable outcome in which growth has to be sacrificed for the environment as evidenced by the dramatic drop in carbon intensity and the increase in clean power capacity. The logical answer is that there is progress on certain measures with clear price and policy signals, while others areas, where enforcement is more difficult, and the political costs of action are more immediate, have lagged behind.

5. Sectoral and Regional Case Studies

To delve deeper, this section examines three areas of the Indian economy where the tension between growth and environmental protection is most visible: energy sector, urban air pollution, and forests and land use.

5.1 Coal, Power, and the Energy Transition

Since Independence, coal has primarily fuelled India's economic development and continues to account for the largest share of India's electricity generation (IEA, 2023). The environmental and social burden of coal mining and coal-fired power generation has been concentrated in Jharkhand, Chhattisgarh, Odisha, and Madhya Pradesh. In these Indian states, the impact of coal mining and power generation has been associated with deforestation, water pollution, and respiratory diseases in local communities (Centre for Science and Environment, 2008). In the last decade, India has developed one of the world's largest renewable energy programs, through a combination of competitive auctions, production-linked incentives for domestic solar manufacturing, and large solar parks in states like Rajasthan and Gujarat (IEA, 2023). Although this has translated into an increasing share of non-fossil fuel capacity, absolute coal capacity has continued to grow and total electricity demand has risen rapidly, as shown in Figure 3. Thus, more focused and targeted policy interventions are required to reduce the fossil fuel share in energy demand. This is the most obvious example in the Indian dataset of relative, not absolute, decoupling: the energy mix is becoming cleaner, but the total energy use and total fossil fuel use are both also increasing. It also reflects a real equity issue: the swift transition from coal, beneficial environmentally, would also jeopardize the livelihoods of those who rely on coal for their income in states that are heavily reliant on coal revenue, highlighting the reason behind India’s emphasis on a gradual, and “just” transition (Liu et al., 2022).

5.2 Delhi and the Politics of Air Pollution

The political channel described in Section 3.3 is perhaps most prominently observed in Delhi's winter smog problem. During the months of October and November, the city's air quality is

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pushed into the hazardous AQI range for weeks on end due to a potent mix of vehicular emissions, industrial pollution, construction dust, dropping temperatures that keep pollutants close to the ground, and smoke from crop-stubble burning in neighbouring states (Central Pollution Control Board, 2017). Delhi and the National Capital Region have, in turn, implemented a Graded Response Action Plan which imposes stricter measures on construction, vehicle movement, and industrial activity as pollution levels rise, and orders from the Supreme Court of India and the National Green Tribunal have compelled state governments to take action (Divan & Rosencranz, 2022).

This case study illustrates why air pollution has proven much more difficult to address than carbon intensity. Greenstone and Hanna (2014) found that as air pollutants are widespread and scattered across millions of vehicles, small businesses, and farms, Indian regulators have been unable to effectively address them. It also demonstrates the policy challenge: stubble burning is easy to ban on paper, but unless an affordable, viable alternative is offered to the farmers to clear fields between the rice and wheat seasons, they will continue to do so, as the short-term cost of stubble burning is borne by the farmers, while the benefit of cleaner air in Delhi is felt hundreds of kilometres away.

5.3 Forests, Mining, and Infrastructure

The Indian forest-cover data (Figure 3) has indeed increased since 2000, with large compensatory afforestation programs under the Indian Compensatory Afforestation Fund Act, 2016. The Act mandates that any forest land diverted for mining, roads, or industry must be compensated by afforestation elsewhere. Critics note that a national average can conceal actual losses of old forests with biodiversity value in certain sensitive areas, like the Aravalli hills and Western Ghats, where mining, quarrying, and urbanization continue to brazenly encroach protected areas, even as new forests are planted in other parts. This tension is evident in how environmental clearances have been granted in recent years. Reforms for fast-tracking environmental clearances for infrastructure projects have been heavily criticised by environmental groups, who point out that environmental concerns will be undermined by expeditious clearances granted for projects located in ecologically sensitive areas (Kohli & Menon, 2021). This is an obvious example of a direct channel as outlined in Section 3.1. While infrastructure and mining provide tangible and immediate economic returns, the environmental costs due to loss of old forests and biodiversity are diffused, long-term, and easily deferred.

6. Policy Instruments and Institutional Response

The Indian policy chapter over the last 20 years is a testimony to the Porter Hypothesis and its limitations. On the positive side, the National Solar Mission, 2010 and successive programs have

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helped in establishing solar power as one of the cheapest sources of electricity by guaranteeing prices, competitive auctions, and import duty adjustments, thereby directly contributing to the growth in non-fossil fuel capacity. The Perform, Achieve and Trade Scheme adopted the same market principles as industrial energy efficiency (Ministry of New and Renewable Energy, 2010). At the UN Climate Change Conference 2021, India announced five targets under its *'Panchamrit'* (five-part) commitments, which include achieving 500 gigawatts of non-fossil fuel electricity capacity, 50 per cent of electricity demand from renewables, 45 per cent reduction in the carbon intensity of GDP from 2005 levels, and achieving net-zero emissions by 2070 (Feng et al., 2024).

On the negative side, the National Clean Air Programme (NCAP), introduced in 2019 to reduce particulate pollution in the nation's most polluted cities–has been plagued by the same implementation problems that Greenstone and Hanna (2014) documented for other environmental programmes. Targets are well-meaning and high, but implementation relies on hundreds of local and state authorities that have unequal capacity and, in some cases, competing incentives to focus on industrial activity rather than air quality monitoring. Land-use policy is no different. While forest cover is increasing due to compensatory aforestation, legal challenges stemming from weak enforcement in sensitive mining and infrastructure areas, remain largely unaddressed.

Overall, the pattern across these programs reiterate that regulation that is well-priced, predictable, and relatively easy to monitor, such as a solar auction or an efficiency-trading scheme, has worked. Alternatively, regulations that depend on monitoring millions of dispersed, small-scale sources have struggled to succeed.

7. Limitations in the Decoupling Narrative

There are at least three reasons why a more conservative interpretation of the evidence is required. First, India is a country with a large number of poor and near-poor households, who prioritise reliable, affordable energy and secure livelihoods, as opposed to low-emission targets which are more relevant to prosperous nations. Second, the pace of decoupling India has achieved so far is relative, not absolute. While both Haberl et al. (2020) and Hickel and Kallis (2020) acknowledge the existence of relative decoupling, they caution that this is not equivalent to the absolute reduction in overall emissions that climate protection ultimately requires. Although emissions are becoming less intensive, India's total carbon dioxide emissions (and its total energy use) continue to increase, unlike developed economies where the absolute amount of emissions is decreasing over time (Le Quéré et al., 2019).

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Third, not all conflicts can be solved by structural change and clean technology. Both Managi and Jena (2008) and Sinha and Shahbaz (2018), who focus on India, conclude that renewable energy growth reduces the carbon intensity, but the income-pollution relationship in India has not yet reached the stage of a clear downward trend that an EKC would suggest, especially for CO2. The equity issues highlighted in Sections 5.1 and 5.2 are genuine concerns. A more rapid shift from coal would exacerbate the hardship of coal-dependent states if not accompanied by targeted measures to support those affected by the transition and the enforcement of stubble-burning bans without an economically viable alternative for farmers would have the potential to resolve air quality issues in Delhi at the cost of rural livelihoods in other parts of the country. None of these constraints indicates there is an economic law of trade-offs between environmental protection and growth. They do demonstrate that it will take a sustained political effort to solve it, not only cleverer technology or a well-designed tax.

8. Conclusion

The primary purpose of this paper is to examine whether there is an inevitable trade-off between environmental protection and economic development in India using theory and economic and environmental datasets from 2000 to 2023. The evidence suggests a conditional rather than a fixed relationship. India has reduced its carbon intensity of GDP by almost 2/3, and the proportion of clean energy in the installed base has almost doubled, both of which are real measures of relative decoupling driven by clear and well-designed price and policy signals in the energy sector. Meanwhile, air pollution has improved very little over the past 21 years or more, and absolute emissions of total carbon, total energy consumption, and pressure on specific forest areas have continued to increase, all of which are more difficult to regulate politically and administratively because of the dispersion of pollution sources, their difficulty of monitoring, and the high short-term costs of controlling them.

The most obvious takeaway from the differences between these two very different outcomes is that the trade-off is not intrinsic to growth. It's a characteristic of the visibility of environmental costs, the ease of monitoring and regulating specific types of pollution, and the equitable distribution of the short-term costs of a transition between those who pay them and those who reap the benefits. Growth and environmental improvement have moved together in areas with clear, enforceable rules; however, progress has lagged wherever enforcement depends on monitoring dispersed sources, as with stubble burning and urban air pollution.

The answer to the question raised by the title of this paper is therefore not an unqualified yes, or no, but rather a trade-off in certain sectors, at certain times, and for certain groups of people. But they are not an inevitable feature of Indian economic growth in general. The evidence gathered here indicates that, if environmental costs were properly priced, institutions were more stable, and fairness was more intentional, the Indian story in the next 20 years growth cycle will be much less of a trade-off than the preceding twenty.

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