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Environment

Construction sector and air pollution: Evidence from India

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Articles

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The construction sector has emerged as a significant yet often overlooked contributor to worsening air quality in India. Exploring the link between construction activities and air pollution, this article shows that heavy-duty diesel equipment used on construction sites lead to NO_2 emissions. This highlights the need to incorporate NO_2 reduction targets into national policies, which currently mainly focus on particulate matter.

In India, a country experiencing rapid industrialisation and urbanisation, the sources of air pollution are diverse and complex. Among these, the construction sector has emerged as a significant yet often overlooked contributor to worsening air quality. Large infrastructure projects like the Golden Quadrilateral (GQ) highway network and the *Pradhan Mantri Gram Sadak Yojana* (PMGSY) have fueled a substantial increase in construction activities between 2000 and 2012, resulting in a marked rise in construction employment (Mahajan and Nagaraj 2017).

In recent research (Farooqui 2024), I explore the link between construction activities and air pollution. My study specifically focuses on the environmental impact of construction, examining its contribution to pollutants such as NO_2 (nitrogen dioxide), SO_2 (sulphur dioxide), PM2.5 (particulate matter 2.5 microns or less in diameter), and PM10 (particulate matter 10 microns or less in diameter). Using the share of employment in the construction sector as a proxy for construction activities, the analysis relies on district-level data from multiple sources. Pollution outcomes are measured for the year 2013, while the main explanatory variable, construction sector employment, is derived from the years 2009 and 2011. Data sources include air quality measurements from the Central Pollution Control Board (CPCB), industrial statistics from the Annual Survey of Industries (ASI), and employment data from the Employment and Unemployment Surveys of the National Sample Survey Organisation (NSSO). Additional data sources include toll revenue data as a proxy for vehicular movement, satellite-derived metrics such as night lights and forest cover, and climate data from the Indian Meteorological Department (IMD).

Methodological challenges and empirical approach

Identifying the causal impact of construction on air pollution presents several methodological challenges. One issue is reverse causality: high pollution levels might discourage construction activities in certain areas, or local pollution control policies could indirectly influence construction practices. Another challenge is that factors such as industrial density, economic growth, or urbanisation could influence both construction levels and pollution concentrations independently, complicating efforts to isolate the construction sector's specific impact on air quality.

To address these challenges, I employ an instrumental variable (IV) approach, using the distance of a district headquarters to the nearest point on the GQ highway as an instrument for construction employment.[1] This instrument leverages the fact that areas closer to the GQ highway are likely to experience greater construction activity due to improved connectivity, while remaining unaffected by local pollution levels. By using this instrument, I reduce the influence of confounding factors, enabling a more precise estimation of construction's causal effect on air pollution.

Key findings

When examining the relationship between construction activities and air pollution directly, this study identifies a significant impact on NO_2 emissions. Incorporating 'fixed effects', the coefficient on NO_2 emissions is 1.6, statistically significant at the 5% level[2]. This implies that one percentage point increase in construction sector employment leads to an average rise of 56 micrograms per cubic meter ($\mu g/m^3$) in NO_2 emissions.

Using IV regression, which addresses the methodological concerns described above, the effect is amplified, with one percentage point increase in construction employment resulting in an average increase in NO_2 levels ranging between 106 $\mu g/m^3$ and 121 $\mu g/m^3$ (statistically significant at 1%). These figures significantly exceed the CPCB's proposed annual average limit of 40 $\mu g/m^3$ for NO_2.

Mechanisms

A primary driver behind significant NO_2 emissions in the construction sector is the machinery itself. Heavy-duty diesel equipment commonly used on construction sites, such as excavators, bulldozers, and cranes, emit substantial amounts of NO_2 as a byproduct of fuel combustion. These machines operate at high intensities, which amplifies the emission of NOx gases, including NO_2, as compared to other pollutants (Frey *et al.* 2010). Research by Ahn *et al.* (2010) shows that the NOx emission factors for construction equipment are considerably higher than those for particulate matter (PM), underscoring the outsized role that construction machinery plays in NO_2 pollution.

Supporting this, Giunta *et al.* (2019) conducted a case study of a highway project in Italy, revealing that emission factors for construction equipment were significantly higher for NOx than for PM. This finding aligns with the observed stronger association between construction activities and NO_2 emissions compared to PM and SO_2 in this study. The specific emission profile of construction machinery helps to explain why the construction sector disproportionately contributes to NO_2 levels, indicating the need for targeted interventions to regulate and reduce emissions from this heavy-duty equipment.

Policy implications

This study establishes a positive causal link between construction activities and NO_2 emissions in India, with no observed association with SO_2 or PM emissions. The results are robust across different specifications of the empirical model, and align with findings from similar studies internationally.

These results underscore the critical need to address construction's environmental impact, especially as India continues to expand its urban infrastructure. In recent years, India has launched additional measures to combat air pollution, such as the National Clean Air Programme (NCAP), which aims to reduce PM2.5 and PM10 concentrations by 20%-30% by 2024 relative to 2017 levels (Ministry of Environment, Forest and Climate Change (MoEFCC), 2019). Yet, these policies do not specifically target NO_2 emissions from construction, leaving a gap in the regulatory framework. Further, enforcement of environmental regulations remains weak due to challenges like corruption and limited institutional capacity (Duflo *et al.* 2013, 2018). Strengthening these regulatory mechanisms is essential for effective policy implementation.

Given the construction sector's impact on NO_2 emissions, policymakers should consider targeted measures. These could include stricter emissions standards for construction equipment, incentives for cleaner technology, and rigorous monitoring of construction activities. Additionally, incorporating NO_2 reduction targets into national policies could create a more comprehensive approach to air quality management.

Notes:

1. In social science research, isolating cause and effect can be challenging because of confounding factors – variables that influence both the cause and the effect. An instrumental variable is a tool researchers use to solve this problem. It works by identifying a variable (the 'instrument' – in this case, proximity to the GQ) that is strongly correlated with the cause but not directly with the outcome.

2. When studying data across regions, time, or groups, unobserved characteristics – like historical, cultural, or geographic differences – can bias results. Fixed effects account for these unchanging characteristics by effectively "subtracting them out," allowing researchers to focus on the relationship between variables of interest.

Further Reading

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