Railway Expansion Reduces Carbon Emissions: 30 Years of Evidence

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Transportation significantly contributes to global carbon emissions, accounting for about 22% of total emissions from 2000 to 2022, primarily due to fossil fuels (Davis et al. (2010)). The International Energy Agency (IEA) reports that 96% of the sector's energy comes from oil-based sources, emphasizing the need for emission reductions. Global initiatives, aligned with Sustainable Development Goals 11 and 13, target a 5% annual decrease in CO_2 emissions from private vehicles by 2050 (Rogelj et al. (2018)). Consequently, the IEA supports expanding railway systems to decarbonize urban mobility, leveraging railways' greater energy efficiency over road transport (Lin et al. (2021)).

This study explores whether 30 years of railway expansion contribute to carbon emission reductions. Our research stands out in three key ways. First, while railways are known for their potential to reduce emissions, significant gaps remain in understanding their efficacy. Railways could reduce emissions by alleviating congestion and promoting a shift to rail transport (Mohring (1972)). However, improved traffic conditions might increase private vehicle usage, worsening pollution (Duranton and Turner (2011)). High-speed rail (HSR) may reduce pollution through specific mechanisms like technical, allocation, and substitution effects (Yang et al. (2019)).

Second, unlike existing studies that use Difference-in-Differences (DID) methods to highlight the direct environmental benefits of new railway stations, our study broadens this scope. We examine how railway network changes affect emissions across various Japanese cities over three decades, identifying potential spillover effects. We incorporate Market Access (MA)—a continuous measure of a city's connectivity—to provide a comprehensive analysis of both direct and indirect effects of improved accessibility.

Although the DID method captures localized impacts, it may miss broader environmental dynamics. For instance, if residents of city A drive to a station to catch a train to city B and then drive from the station in city B to their final destination, this sequence might result in a net decrease in emissions. Conventional DID analyses might misinterpret this as an increase due to the initial car journeys in both cities. Thus, analytical models must encompass both local and broader impacts of new railway stations on urban emissions.

Our analysis reveals that railway expansions significantly reduce carbon emissions. The study indicates that increased railway connectivity leads to a notable decrease in urban CO_2 emissions, supporting the hypothesis that enhanced rail networks alleviate congestion and promote a shift from private vehicle use to rail transport. The data also show that cities with better Market Access experience more pronounced reductions in emissions, highlighting the broader environmental benefits of improved railway infrastructure. These findings suggest that strategic investments in railway systems can play a crucial role in achieving global emission reduction targets.

References

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