

[Energy Distinguished Lecture Series]

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Transport Infrastructure and Energy Economics: Decarbonization Effects of Railway Networks, Evidence from 25 Years of Japanese Railways

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Abstract

This lecture examines how railway infrastructure drives the energy transition, drawing on two recent studies of Japan's mature railway network. Transport accounts for roughly one-fifth of Japan's final energy consumption and CO₂ emissions and remains about 98% oil-dependent, so a car-to-rail modal shift is, in energy terms, a substitution from oil to electricity. Yet in a mature network where new openings are rare and incremental, standard binary difference-in-differences designs lack power. Both studies therefore combine a continuous Market Access (MA) framework with staggered DID and instrumental-variable strategies (historical railway networks and terrain-based least-cost-path counterfactuals) to identify network-wide effects causally. The first study, covering 5,388 Tokyo towns over 25 years (1995-2019), finds that a 1% increase in rail MA reduces suspended particulate matter by 0.285% and NO₂ by 0.046%, implying cumulative reductions of 9.6-21.7% in SPM and health benefits of \$98-162 million. The second study, covering 1,741 municipalities over 21 years (2000-2020), finds that high-speed rail expansion reduced sectoral CO₂ emissions by 98.4 Mt, a social benefit of about \$5 billion, operating primarily through improvements in manufacturing carbon intensity rather than industrial composition. Together, the two papers show that the environmental value of railways comes from network-wide connectivity rather than the number of lines, and that the MA-plus-DID toolkit provides a general framework for evaluating the environmental returns of infrastructure investment in mature networks.

Brief Bio



Sunbin Yoo is an Associate Professor in the Department of Energy at Sungkyunkwan University. She received his Ph.D. from The University of Tokyo in 2020 and served as Assistant and then Associate Professor of Civil Engineering at Kyushu University, Japan, from 2020 to 2026 before joining Sungkyunkwan University.

Her research lies at the intersection of transport economics, urban planning, and energy and environmental economics, with a focus on the causal evaluation of transport infrastructure: how railways, high-speed rail, and highways shape the environment, regional economies, and society. Her recent work quantifies the decarbonization and air-quality effects of Japan's railway networks, and his broader research covers aviation and extreme weather, micromobility, and consumer behavior in energy markets. Her work has appeared in journals including *Energy Economics*, *Sustainable Cities and Society*, *Renewable & Sustainable Energy Reviews*, and *Transportation Research Part E*.

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