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Fields of Concentration:
Primary Field: Spatial Economics, Environmental and Energy Economics
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Qualifying Examinations Completed:
2022 (Oral): Spatial Economics, Macroeconomics
2021 (Written): Microeconomics, Macroeconomics

Dissertation Title: *Essays on Spatial and Environmental and Energy Economics*

Committee:
Professor Costas Arkolakis (Chair)
Professor Kenneth Gillingham
Professor Amit Khandelwal
Professor Samuel Kortum

Education:
Ph.D., Economics, Yale University, 2026 (expected)
M.Phil., Economics, Yale University, 2023
M.A., Economics, Yale University, 2023
M.A., Economics, Seoul National University, 2020
B.A., Economics, Seoul National University, 2018

Fellowships, Honors, and Awards:
Ryoichi Sasakawa Young Leaders Fellowship (SYLFF), Yale University, 2024
Doctoral Fellowship, Cowles Foundation Fellowship, Yale University, 2020 – 2026
Research and Lecture Scholarship, Seoul National University, 2019 – 2020
Brain Korea 21 Plus Research Scholarship, Seoul National University, 2018 – 2020

Research Grants:
Data Acquisition Grant, Economic Growth Center, Yale University, 2025
SYLFF Research Awards, Yale University, 2024
SYLFF Research Awards, Yale University, 2023

Teaching Experience:

Fall 2024, Teaching Assistant to Prof. Ana Cecilia Fieler, International Finance (Undergraduate), Yale University

Spring 2023, Teaching Assistant to Prof. Giuseppe Moscarini, Macroeconomics (PhD), Yale University

Fall 2022, Teaching Assistant to Prof. Giuseppe Moscarini and Fabrizio Zilibotti, Introductory Macroeconomics (Undergraduate), Yale University

Spring 2020, Teaching Assistant to Prof. Soyoung Kim, Recent Trends in Macroeconomics (Graduate), Seoul National University

Fall 2019, Teaching Assistant to Prof. Woong Yong Park, Advanced Macroeconomics (Graduate), Seoul National University

Spring 2019, Teaching Assistant to Prof. Soyoung Kim, Topics in International Monetary Economics (Graduate), Seoul National University

Spring/Fall 2018, Teaching Assistant to Prof. Soyoung Kim, Macroeconomics (Undergraduate), Seoul National University

Research Experience:

Research Assistant to Prof. Costas Arkolakis, Yale University, 2021-2022, 2024

Research Assistant to Prof. Lorenzo Caliendo, Yale University, 2023

Research Assistant to Prof. David Atkin and Amit Khandelwal, 2022-2023

Research Assistant to Prof. Soyoung Kim, Seoul National University, 2018-2020

Working Papers:

"The Spatial Consequences of Industrial Environmental Regulation" (October 2025), *Job Market Paper*

"Deep Industrial Decarbonization: Theory and Evidence from South Korea" with Costas Arkolakis and Emmanuel Murray Leclair, (August 2025), *Working Paper*

Work In Progress:

*"*An Anatomy of Multinational Production: Evidence from Affiliate Labor Composition" with Shoki Kusaka and Wei Xiang, (July 2025)

"From Plants to Firms: Aligning Environmental Regulation with Firm-Level Technology Choices", (July 2025)

Seminar and Conference Presentations:

2025: Southern Economic Association (upcoming),
Urban Economics Association,
Econometric Society World Congress,
Society for Economic Dynamics

Referee Service:

Journal of International Economics, Research Policy

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Dissertation Abstract

My dissertation explores topics at the intersection of spatial, environmental, and energy economics. I combine reduced-form empirical strategies with structural modeling to examine how environmental policies reshape pollution patterns and economic activity in the industrial and power generation sectors across space and over time.

The Spatial Consequences of Industrial Environmental Regulation [Job Market Paper]

Air pollution and climate change are central to debates on welfare and distributional outcomes, prompting a wave of industrial environmental regulations. A key question is how these policies reshape the distribution of emissions and output. Because most regulations target large manufacturing and power plants in polluted and populated regions, two issues arise: cross-sector and cross-region leakage—how emissions shift within and across manufacturing and power generation sectors and regions. However, due to a lack of data, policy variation, and theoretical frameworks, these questions are so far underexplored.

I study these questions in the context of the *Total Volume Control of Pollutants at Place of Business* regulation implemented in 2020 in South Korea. This policy imposed facility-level emission caps that varied by district and prior emissions volume, and allowed for trade in emissions rights. I use manufacturing and power generation data from 2016 to 2022, which has information about firm locations, emissions, inputs, and outputs. In a difference-in-differences design, I show that emissions abatement and leakage were driven by manufacturing plants. Industrial electrification emerged as a central abatement channel, shifting emissions from manufacturing to power plants. Due to leakage from manufacturing, power plants remained unchanged.

To interpret these findings and assess the equilibrium effects of the policy, I develop a unifying spatial general equilibrium model that links locations, manufacturing, and power generation. The model incorporates multiple response margins: abatement (emission control measures and fuel

substitution) and leakage (within and across sectors and regions). Production function estimates, pre-regulation data, and the difference-in-differences estimates discipline the model parameters, governing emissions and economic activity: factor and fuel substitution elasticities and emission control measure elasticity.

Three findings emerge from the estimated model. First, the regulation induced substantial reallocation: regulated manufacturers reduced emissions, while unregulated manufacturers, power plants, and even regulated power plants increased them. This result highlights spillovers within and across sectors, providing an interpretation of the reduced-form estimates. Second, welfare gains from reduced environmental damage exceeded output and consumption losses in regulated districts. Although unregulated districts experienced increased emissions, the policy improved aggregate welfare by targeting polluted and populated areas. Counterfactuals show that prioritizing large polluters in polluted and populated regions yields larger gains than uniform rules.

Overall, the paper shows that effective environmental regulation must anticipate spatial and cross-sector reallocation—critical considerations for policy design under budgetary and administrative constraints.

Deep Industrial Decarbonization: Theory and Evidence from South Korea, with Costas Arkolakis and Emmanuel Murray Leclair

We examine deep industrial decarbonization, the process of altering industrial production processes to remove fossil fuels, using new theory and empirical evidence from South Korea. South Korea has instituted a series of national and district-specific policies aimed at curbing industrial emissions, including cap-and-trade systems, various command-and-control regulations, and subsidies for the adoption of green technologies. These policies have driven substantial green technology adoption in fossil-fuel-intensive industries like cement and steel. Drawing on unique establishment-level data capturing energy use and production, we document a dramatic rise in electrification: between 2016 and 2022, the share of plants relying solely on electricity almost doubled (from 35% to 65%). We develop and estimate a dynamic spatial general equilibrium model where firms can pay fixed switching costs to adopt or drop fuels. In our model, national-, district-, and industry- specific regulations affect local fuel prices and subsidies reduce the fixed costs of adopting cleaner fuels. We find that subsidies targeting small and medium-sized enterprises drive most electrification, rather than environmental regulations. We then quantify the welfare effects of these policies across space and over time. A key finding is that, despite widespread electrification, greenhouse gas reductions remain limited because the largest polluters, who account for most emissions, are less likely to become fully electrified.