Title: Rails, Risks, and Resilience: A Dynamic Spatial Equilibrium Analysis with Natural Disaster Risk

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Abstract:

High-speed railway (HSR) networks are crucial for promoting economic linkages between regions, yet they are vulnerable to catastrophic natural disasters. We develop a dynamic stochastic spatial equilibrium model in which catastrophic disasters temporarily reduce regional productivity and disrupt the transportation network, and apply it to Japan's Tokai Trough Earthquake (TTE) risk and the Chuo Shinkansen (CS) maglev railway project. The newly added network can therefore provide not only fast connectivity between regions but also a redundancy value against the disaster risk. Productivity-recovery and network-disruption parameters are calibrated on the 2011 Tohoku Earthquake, and the model qualitatively reproduces the observed slow population decline and wage overshoot in the affected regions. Quantitatively, we find that the population-weighted welfare cost of TTE risk is 7.43\% of permanent consumption, of which 98\% is explained by the migration option-value channel, representing a spatial-spillover mechanism where even far-epicenter zones lose welfare. The CS delivers welfare gains of 3.43\% under TTE risk versus 2.49\% in the risk-free benchmark, resulting in a 0.94 percentage-point redundancy value.