

Effects of Metropolitan Rail Expansion on Commuting Time and Distance

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Abstract

Achieving both improved accessibility and jobs–housing balance has long been a central objective of urban planning. While metropolitan rail expansion is widely promoted as a solution to congestion and long commuting times, its spatial consequences remain ambiguous. Improved transit accessibility reduces travel time, but it may simultaneously lower the cost of distance, enabling households to reside farther from workplaces. As a result, accessibility gains may conflict with the goal of jobs–housing proximity. In rapidly suburbanizing metropolitan regions, enhanced rail connectivity may facilitate longer-distance commuting rather than shortening it. This raises a critical question: Does metropolitan rail expansion reduce commuting burdens, or does it intensify spatial mismatch between jobs and housing? This study addresses this question in the Seoul Metropolitan Area (SMA), where extensive rail expansion has reshaped regional connectivity over the past decade. Previous studies suggest that transport infrastructure expansion can produce complex spatial effects. Rail accessibility improvements have been shown to increase property values, alter employment centers, and influence suburbanization patterns. However, evidence regarding commuting distance remains

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mixed. To identify the causal effects of metropolitan rail expansion, this study employs a difference-in-differences (DID) framework. The treatment group consists of administrative units newly served by metropolitan rail stations, while comparable non-treated areas serve as controls. Unlike prior studies relying on aggregated O–D datasets, this research utilizes anonymized transportation card transaction data. These big data records provide fine-grained spatial and temporal information on individual commuting trips, enabling precise measurement of commuting distance before and after station openings. Rather than comparing only two discrete years, this study leverages continuous observations across pre- and post-opening periods, allowing for a more robust estimation of dynamic treatment effects. Some studies argue that improved transit accessibility shortens commuting time and enhances efficiency, while others find that transport expansion encourages residential decentralization and longer commuting flows. The interaction between accessibility improvement and jobs–housing balance remains theoretically contested. This study contributes by empirically examining how rail expansion affects commuting distance using high-resolution mobility data. Preliminary results reveal that metropolitan rail expansion increased average commuting distances in treated areas. Administrative units gaining new stations experienced statistically significant increases in commuting distance relative to control areas. In contrast, areas without new stations exhibited either stable or declining commuting distances over time. These findings suggest that improved suburban accessibility may enable households to choose more distant residential and workplace locations. Furthermore, spatial heterogeneity is observed. The magnitude of commuting distance increase is larger in Incheon and Gyeonggi-do than in Seoul. This pattern implies that rail expansion may be reinforcing regional disparities within the metropolitan area. The findings indicate that accessibility improvements do not automatically translate into improved jobs–housing balance. Instead, metropolitan rail expansion may facilitate longer commuting by reducing travel costs across space. From a policy perspective,

transportation investment and spatial planning strategies must be integrated. Rail expansion alone cannot resolve commuting burdens unless accompanied by employment decentralization and balanced urban development policies. Given that commuting patterns operate at a metropolitan scale, policy interventions should account for regional heterogeneity in accessibility gains and labor market distribution.

Keywords: transit smart card data, metropolitan rail, commuting distance, commuting time, jobs-housing mismatch, difference-in-differences method