Evolution of Subway Network Systems, Subway Accessibility, and Change of Urban Landscape: A Longitudinal Approach to Seoul Metropolitan Area

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ABSTRACT

The subway is one of the major passenger transport systems in Seoul, Korea. Over the last 30 years, the subway system has interacted with urban land use. This study aims to describe the subway system evolution and reveal the causal relations with land rent and population distributions in conjunction with the evolution of the subway system. Extensive and rapid expansion of subway networks have increased subway accessibility in all regional areas over time and have simultaneously strengthened the status of Central Business Districts (CBDs). These facts indirectly imply a possible strong association amongst land rent, population, and subway accessibility. To reveal these relationships, the Granger-causality test in vector auto-regression form is employed. The results confirm the hypothesis of a causal relationship, the influence of the subway accessibility to the land rent in nearby CBD areas. However, inverse causality also exists between these two variables, implying a more complex relationship. In contrast, population variables have a comparably weak causal relationship with subway accessibility in the spatial context of the subway system in Seoul.

Keywords: Granger-Causality, Land Rent, Population, Subway Accessibility, Vector Auto-Regression

1. INTRODUCTION

Transport accessibility is known to be a crucial element in determining urban land-use patterns and change. Based on accessibility, land-use affects transport accessibility over time (Cervero & Duncan, 2002; Black, 2010). In this context, understanding these interactions has long been one of the major tasks of geographers, transport researchers and even policy makers. Among
several different types of transport modes, public transit systems, including rail and subway networks, have been highlighted as major facilitators of economic development with significant interactions between their development and land-use (Badoe & Miller, 2000). In places where there is a heavy concentration of population in Seoul, a historical and economic central place in Korea, the development of public transport system has been recognized as development of critical infrastructure to support public and business needs in the face of rapidly growing economic development (Noh, 1995; Kim, 2009).

This study explores the relationships between economic development and changes in land-use in conjunction with the evolution of subway systems in the Seoul metropolitan area, Korea. Given over thirty years of economic development, the subway’s network accounts not only for a significant portion of daily passenger travel in Seoul, but also for its impact on location decisions, which has been followed by dramatic changes in land use. The construction of the Seoul subway network was a political decision in the beginning. The development and evolution of the network, however, reflects requirements of economic factors and, in turn, affects the location decisions for subway stations as well as for subway lines that are extended. In Seoul, the change in accessibility of subway stations from the gradual expansion of networks has resulted in new phases of urban land use. In a broad sense, this paper focuses on how the urban landscape of Seoul has been affected by, or has affected the evolution of, the subway network system from its initial stages to its current status.

It seems obvious that increasing transportation accessibility is a fundamental factor for a region to attract more people from other places and to create more amenities for local residents and workers. However, such an increase could induce negative externalities such as inducing more traffic, causing air pollution, increasing land value in certain area, and even providing criminals’ access to the neighbourhood (Il-lanfeldt, 2003). As such, an area with newly established subway stations is expected to affect regional amenities around an area in positive or negative ways, depending on the regional context and thus, facilitates a specific land-use change that can bring more interaction with other regions. In this context, it is valuable to understand some questions and answers with regard to the process of economic development associated with the evolution of subway systems. Specifically, four research questions are investigated in this study, as follows:

1. How has subway accessibility evolved over time?
2. What is the relationship between the subway accessibility of regions and socio-economic variables?
3. Has a change in subway accessibility led to regional economic changes, or vice versa, in Seoul?
4. What type of network expansion can be suggested that will result in improved and sustainable urban development?

To address these questions, we aim to develop a series of historic subway accessibility measures and to investigate their relationship with urban land-use. Longitudinal data showing the evolution of subway network systems was collected and structured in a GIS environment, and a series of network accessibility measurements were taken. Next, we introduce a time-series analysis where the causal directions between the subway’s accessibility and the regional economic variables over time are determined. Employment of the longitudinal measures enables us to investigate the inter-relationships among context, mechanism, and outcome to determine their possible causality and effectiveness.

The remainder of this paper is organized as follows. A brief overview of the literature is provided in the next section, focusing on studies of the impact of transit systems in metropolitan areas, related to rent and population growth. Section 3 presents analytical frameworks that are applied in the analysis. Section 4 presents
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