Characterizing the relationship between road infrastructure and local economy using structural equation modeling

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A B S T R A C T

Road infrastructure is frequently cited as a critical catalyst for regional economic growth in transport policy research. However, it remains uncertain how the road infrastructure interacts with the local economic systems. Prior studies demonstrated that associations between the road infrastructure and local development were case-specific to some extent, and even contradictory conclusions could be generated. Simple quantitative or qualitative analysis, therefore, cannot effectively reveal complex interactions. This paper first proposes a conceptual model to theorize a transport-region economic relationship and then applies structural equation modeling (SEM) to explore the relationships between the road infrastructure and local economy, as well as the mediating factors. Using statistical data from 2005 to 2012, SEM models are established for two typical regions with different development levels in China: the Jiang-Zhe-Hu region (highly developed) and the Yun-Gui-Chuan region (less developed). This econometric approach, which emphasizes the economic mechanisms, confirms the efficiency of the SEM in this study. The results show that these two regions differ greatly in mediators for the influence of the road infrastructure on the local economy. The road infrastructure influences the local economy largely by attracting overseas investments and promoting real estate development in the Jiang-Zhe-Hu region. In the Yun-Gui-Chuan region, the road infrastructure impacts the local economy primarily by stimulating market openness. Such results confirm the hypothesis that the pathway for the influence of the road infrastructure on the local economy should vary with regions with different development levels. This paper is believed to provide new insights into transport-region research.

1. Background

Road infrastructure is frequently cited as a critical catalyst for regional social transformation and economic growth in transport research (Asomani-Boateng et al., 2015; Iacono and Levinson, 2015). A large body of empirical literature indicates that road infrastructure can generate payoffs for local development (Lakshmanan, 2011; Lakshmanan and Chatterjee, 2005; Lian and Wey, 2013; Njoh, 2012); however, it remains uncertain as to how the payoffs come into effect. As summarized in Polzin (1999), the impacts of road infrastructure can be categorized into three types: direct, indirect and secondary. The direct impacts are those related to the improved service and accessibility, including market openness, foreign investment and urban expansion (Polzin, 1999; Won et al., 2015). The indirect impacts are those related to mediating community responses and policy change, including increased attractiveness, reduced development costs and tax incentives (Polzin, 1999; Won et al., 2015). The secondary impacts are those related to social perception and individual behavioral changes, which would manifest as commercial and business agglomeration (Polzin, 1999; Won et al., 2015). In this context, it is worthwhile to examine the pathways for the influence of the road infrastructure on the local economy using quantitative measurements.

As a multivariate statistical technique, structural equation modeling (SEM) can discover the direct or indirect relationships between exploratory variables and a dependent variable and then visualize the causal influencing pathways and mediating effect (Kelloway, 1998; Ullman, 2007; You, 2017; Su et al., 2016). Previous pilot studies have indicated that SEM is suitable for social and economic studies (Deng et al., 2013; Kick and McKinney, 2014; McKinney, 2014; Wu et al., 2015). However, few studies have applied SEM to investigate the relationships between the road infrastructure and local economy, as well as the mediating factors. The primary objective of this paper is to explore the relationships between the road infrastructure and local economy using SEM. In particular, analysis is conducted in two regions with different levels of development (DLOD): the Jiang-Zhe-Hu region in eastern coastal China and the Yun-Gui-Chuan region in southwestern inland China. The Jiang-Zhe-Hu region, renowned as the Yangtze River Delta Economic Zone, constitutes three provinces (Jiangsu, Zhejiang and Shanghai) in eastern coastal China (Fig. 1). Composed of 42 cities/
counties, this region covers a total area of 212 thousand km$^2$ and has a population of 159 million (data sources: Jiansu Statistical Yearbook, Zhejiang Statistical Yearbook, and Shanghai Statistical Yearbook). The Yun-Gui-Chuan region, located in southwestern China (Fig. 1), is composed of the Yunnan, Guizhou and Sichuan provinces. Composed of 83 cities/counties, this region covers a total area of 1052 thousand km$^2$ and has a population of 162 million (data sources: Yunnan Statistical Yearbook, Guizhou Statistical Yearbook, and Sichuan Statistical Yearbook). These two regions have both experienced fast economic growth and upscaled construction of road infrastructure during recent decades. In the Yun-Gui-Chuan region, road coverage increased from 170 million m$^2$ in 2005 to 496 million m$^2$ in 2012 (data sources: Yunnan Statistical Yearbook, Guizhou Statistical Yearbook, and Sichuan Statistical Yearbook). In the Jiang-Zhe-Hu region, road density increased from 659 million m$^2$ in 2005 to 1379 million m$^2$ in 2012 (data sources: Jiansu Statistical Yearbook, Zhejiang Statistical Yearbook, and Shanghai Statistical Yearbook).

These two regions respectively represent a highly developed region (Jiang-Zhe-Hu) and a less developed region (Yun-Gui-Chuan) in China. The Jiang-Zhe-Hu region is one of the earliest regions open to the outside, while the Yun-Gui-Chuan region is one of the most delayed developed hilly regions in China. The socioeconomic conditions and road infrastructure construction vary significantly between the two regions (see indicators in Table 1, p value for T test<0.01). Additionally, the socioeconomic conditions and road infrastructure construction in the Yun-Gui-Chuan region are significantly lower than the national average ($p < 0.01$; data source: China Statistical Yearbook, 2006, 2013), while those in the Jiang-Zhe-Hu are higher than the national average ($p < 0.01$; data source: China Statistical Yearbook, 2006, 2013). These two regions provide useful cases to compare the pathway for the influence of the road infrastructure on the local economy between regions with DLOD.

2. Theorizing the transport-region economic relationship

2.1. Literature review

Prior studies linking the local economy to road infrastructure can be divided into two principle categories. The first category attempts to reveal the economic mechanisms using an econometric approach. The basic notion is that greater transportation activity and road infrastructure construction promote economic growth, and in turn, economic growth may also stimulate road infrastructure improvements. One branch of literature treats road infrastructure as a production of employment, human capital and service sectors, thus increasing economic productivity. Glaeser et al. (2004) argued that increased human capital and decreased poverty were important pathways between infrastructure and economy. Baum-Snow (2007) estimated that new highway construction would decrease 18% of the central urban population, promoting suburbanization and economic growth in suburban areas. Zou et al. (2008) suggested that transport infrastructure development promoted China’s economic growth through poverty alleviation. A study of the US showed that highway networks had a positive influence on employment in services but a negative influence on employment in manufacturing (Jiwattanakulpatassarn et al., 2010). Using the Slow growth model, Faridi et al. (2011) evidenced the contribution of transportation infrastructure on Pakistan economic growth. Chen and Haynes (2012) confirmed the causality of transportation infrastructure to employment and income. Eruygur et al. (2012) evidenced the role of transportation infrastructure in formulating non-residential total capital by using a Cobb–Douglas production function. Eichengreen and Gupta (2013) indicated that transportation infrastructure improvements led to the development of the services sector. Ahlfeldt et al. (2015) applied structural vector autoregressive (VAR) models and revealed that the mediating factors between road transportation and economy can be land value and population attractiveness. Yu et al. (2016) examined the role of the motorway network in the spatial formulation of economic agglomerations. Another branch of literature regards road infrastructure as commuting and trade cost reduction (Berndt and Hansson, 1992; Boarnet, 1998; Conrad and Seitz, 1994; Nadiri and Mamuneas, 1994). Bouheas et al. (2000) found long-run economic growth in response to transportation infrastructure improvements when introducing transportation infrastructure as a cost-reducing technology. In addition, other studies typically applied the Granger causality test and confirmed the directional causality between the road infrastructure and local economy (Beyzatlar et al., 2014; Fernando and Pacheco, 2010; Lean et al., 2014; Liddle and Lung, 2013).

Using the vector error correction model, Pradhan and Bagchi (2013) identified bidirectional causality between road transportation and economic growth in India. In summary, the first category of literature demonstrates that road infrastructure contributes to the economy through three pathways: (1) enhancing overall production productivity, (2) accelerating technological spillovers across economic units, and (3) increasing the transport-connected business profitability (reduced trade costs and enlarged sale spatial scope).

The second category employs the classical statistical method to...
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