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Key factors to annual investment in public transportation sector: The case of China

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ABSTRACT

In this paper, we establish panel models to examine the relationships between the annual investment in the public transport sector (AIP) and bus network facility scale, and between AIP and the land area for urban roads in different tiers of Chinese cities. The empirical study uses panel data of 160 Chinese cities and a time span over 2000–2015. To capture the characteristics of the panel models, including the individual effects, variable intercepts, and coefficient values, different regression functions are adopted for the relevant analysis. As for these regression functions, seven explanatory variables are selected. These variables are: the length of operated bus transit routes (LR), the total number of annual passengers trips (PT), the land area for urban roads (LA), the density of urban road networks (ND), the resident population (POP), the gross domestic production (GDP), and the value-added tax (TAX). On the other hand, the explained variable in these regression models is the AIP of each city. According to model results, it is found that AIP is positively related to LR and GDP, and negatively to PT, LA, and TAX. However, the effects of ND and POP are negative on the increase of AIPs of mega-cities and medium-size cities. It could also be found that the increase in bus infrastructure investment caused by the expansion of land area for urban roads is not negligible, especially in small cities. When the LR changes greatly, LA should be considered as a more stable factor to predict the AIP in mega-cities. Based on the findings, related implications for the policy-making on annual budget allocations for different tiers of cities are listed.

1. Introduction

Bus transit system plays a vital role in modern cities, due to that it is available to meet the daily travel requirements with a low cost for a large group of passengers. A well-planned bus transit system encourages the highest level of modal shift from private vehicles to public transport means (Fatima and Kumar, 2014), and provides invaluable benefits to our society (Paget-Seekins and Tironi, 2016). From the perspective of environmental protection, bus transit also helps to reduce carbon dioxide emission, decrease gasoline consumption, and relieve traffic congestion in metropolitan areas (Badami and Haider, 2007; Dubé et al., 2011; Iseki, 2008). At the same time, it is one of the safest transport modes, as evidenced by the lowest passenger fatality rates in recent years

Abbreviations: VIM, Variable-Intercept Model; VCM, Variable-Coefficient Model; AIP, The annual investment in the public transport sector; LR, The length of operated bus transit routes; PT, The total number of annual passengers trips; LA, The land area for urban roads; ND, The density of urban road networks; POP, The resident population; GDP, The gross domestic production; TAX, The value-added tax; CBD, Central business district

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(Brakewood et al., 2014).

The development of bus transit system has great influence on the urban economic development and social coordination (Dubé et al., 2011). For instance, in the developed countries of North America, such as the U.S. and Canada, where bus transit is not as popular as the private car in the daily life, it still services a large group of people who cannot use the car, i.e., the handicapped, the aged, and low-incomers. Conversely, as far as cities in South America, such as Rio de Janeiro, Curitiba, and Santiago, they depend much upon the bus transit system than those cities in North America. Bus transit systems in the developing countries of Asia also have made significant progress over the past decade (Haque et al., 2013). However, bus transit systems in most countries of Asia still fall behind from the perspectives of infrastructure and service quality levels. In Africa, because many countries are being in the relatively unstable political situations, the living standards of residents in cities sometimes cannot be well guaranteed. Thus, bus transit systems have not been well-developed in many cities of Africa.

Although we all know that the bus transit system is important to the urban development and the commuting of residents, we are still confused about how to make the most reasonable use of investment in the public transport sectors of different tiers of cities to advance the performance bus transit systems (Lanuale et al., 2015). Whether the increase of investment in the public transport sector could help the expansion of bus infrastructure, and vice versa? – There has yet no evident clue or strong quantitative model to answer this question. Moreover, the relationship between the investment in the public transport sector and urban land development is still complicated to capture and qualify, especially in different tiers of cities where the investment policies are diverse.

Hence, this paper systematically reviews the annual investment (i.e., the annual budget) in the public transport sector (shortened as AIP in this paper) of 160 Chinese cities above the Prefecture-administrative level within a time span over 2000–2015. Panel data models are built to explore the relationships between the AIP and the bus network facility scale, annual passenger volume and land area for urban roads. Our findings could help related decision-makers to make an appropriate investment in the public transport sector, as well as to make clear the relationship between the reasonable bus network facility scale and land area for urban roads.

The rest of this paper has been organized as follows. The related literature is reviewed in Section 2. The background and methodology are presented in Section 3. Section 4 details the input data, estimated results and corresponding findings of the panel model. Section 5 presents the implications of the findings for related policy establishment. Section 6 concludes.

2. Literature review

2.1. Transport infrastructure investment and related policy

A large number of articles have examined the investment of urban infrastructures from urban economics. Kemmerling and Stephan (2002) used a simultaneous-equation approach to estimate the contribution of infrastructure construction to the production of the private sector. Knight (2004) analyzed the 1998 Congressional votes by the transportation project funding, and tested reactions of how the public supported the transport project. He found that the probability of supporting the projects was increasing in own district spending and decreasing in the tax burden associated with aggregate spending. Cadot et al. (2006) used panel data of France's regions over 1985–1992 to examine the impact of transport infrastructure investment on local economic growth. Ahlfeldt et al. (2015) surveyed the demand and supply of transport services by using the autoregressive method with panel data of Berlin, Germany during 1880 and 1914. Similarly, a swing voter model was used to examine the investment in transport infrastructure in Swedish municipalities according to the three National Transport Infrastructure Plans of 2004, 2010 and 2014 (Jussila Hammes, 2015). In Del Bo and Florio (2012) and Nijkamp (1986)'s work, three empirical methods were used to investigate the relationship between transport investment and regional economic growth, such as Cobb-Douglas production function framework, time series models, and structural equation modeling. Moreover, decisions on transport investment were traditionally by the Cost-Benefit Analysis, which was reflected by various assessment criteria, including the Net Present Value, Benefit/Cost and Internal Rate of Return (Nellthorp and Mackie, 2000; Teng and Tzeng, 1996).

As for the prioritization of urban infrastructure, Ziara et al. (2002) presented a methodology to score urban infrastructure in Pakistan, and used six indicators to assess the investments. Lambert et al. (2012) presented a model to rank the major civil infrastructures in Afghanistan with fourteen indicators to compose the model. Pardo-Bosch and Aguado (2016) presented a model to assess the beforehand sustainability of the newly-planned urban infrastructure project with the sustainability index of infrastructure projects.

However, few studies have examined the relationships between transport facility investment and infrastructure sale and urban land use. Especially, for different tiers of cities which own different public transportation network scales, how to link the transport infrastructure investment with the public transport network scale as well as the urban land use, is essential to transport policy establishment. However, the gap between the practical demand and theoretical study always exists, sometimes due to lack of related data and the transparency of policy evaluation, especially, in the developing countries.

2.2. Panel model for transport investment policy analysis

It has been proved that the panel model owns distinguishing advantages over the conventional cross-sectional or time-series data models (Hsiao, 2003; Wooldridge, 2010). For this sake, panel model has become widely available since 1990 and greatly facilitated economic studies.

Li et al. (2002) proposed a semiparametric panel model in a cross-sectional setting, where covariates (i.e., variables affecting the coefficients) were assumed to be continuous. Li and Racine (2010) extended their work to a more general circumstance, which