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Impacts of information technology and urbanization on less-than-truckload freight flows in China: An analysis considering spatial effects

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ABSTRACT

Understanding the relationship between socioeconomic factors and the Less-than-Truckload (LTL) freight flows is important for transportation planners and policy makers. This paper explores the impacts of information technology, urbanization on LTL freight flows by using a spatial autocorrelation model with freight flow data from a leading LTL company in China. The results show that all IT variables and urbanization variables have positive effects on freight flows. Distance, as expected, is negatively correlated with the freight flow volume. The application of the spatial autocorrelation model further shows that origin dependence, destination dependence and OD dependence are all significant, justifying the consideration of spatial interdependence. Finally, policy implications are discussed based on the estimated results. These findings shed light on the impacts of internet and urbanization on freight transportation, and contribute to the design of freight policies and the development of the LTL industry.

1. Introduction

The importance of freight transportation, shown by both its positive effects on modern economic activities, and its negative externalities, has been discussed extensively in existing literature. Within freight transportation, an important sector is the Less-than-truckload (LTL) freight. LTL is an interregional freight transportation mode that handles shipments smaller than full-truckload but larger than small packages (Ozkaya, 2008). In recent years, the share of LTL in freight transportation has been stably increasing. In the United States, the LTL sector is valued at $32 billion (Aguiar and Woolard, 2014). In China, LTL freight market scale had more than 30 billion dollars in 2012 and its annual growth rate was more than 10% between 2010 and 2012.

A main cause that may explain the increase of LTL freight flows is the development of information technology (IT). More specifically, information technology enhances the LTL freight from both the demand and the supply sides. On the demand side, IT promotes supply chain integration and fosters e-commerce. As Gunasekaran and Ngai (2004) explained, IT functioned as the nerve system of supply chain management systems. The accessibility to IT improves the agility level of manufacturers and retail industries, leading to the increase of small-volume, multi-batch, short-cycle and multi-item freight

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flows. In terms of the development of e-commerce, IT has allowed growing numbers of enterprises and individual shoppers to do business online. In China, as of December 2014, the number of internet users was 649 million, 2.1% higher than the number in 2013, and accounting for 47.9% of the entire population. The number of registered websites reached 3.35 million, 4.6% higher than the number in 2013. The number of online shoppers reached 361 million, a 5.953 million increase compared to December, 2013. On the supply side, IT greatly enhances efficiency of freight delivery service. The improved operation efficiency and the reduced costs of LTL, together with the growing demand, lead to the increase of LTL freight flow.

Another factor influencing LTL freight flow is the rapid urbanization in China. According to China's National Bureau of Statistics data, Chinese urban resident population has reached 749.16 million in 2014, accounting for 54.8% of the total population. In 2005, this number is only 43.0%, indicating a 1.18% growth of urbanization rate per year. This trend of urbanization is expected to continue at a stable growth rate for the next 30 years until it reaches 80%. Urbanization means specialization and agglomeration. Urban residents rely more on freight transportation, especially LTL freight, to maintain a modern lifestyle and access products they need.

Apart from various influential factors, freight flow also exhibits spatial autocorrelation, which can be characterized as origin (O) dependence, destination (D) dependence and OD dependence, respectively. Origin dependence means that freight flows out of the origin's neighbors are spatially influential to each other. For example, Fig. 1 illustrates a flow pattern from 3 origins to 3 destinations. When analyzing the flow from A to Z, one should recognize that it may be influenced by the flow from B to Z and the flow from C to Z because B and C are the neighbors to A. Such spatial influence is generated at the origin end and is thus defined as origin dependence. Similarly, destination dependence means that freight flows into neighboring destinations are impactful to each other. In Fig. 1, this means the freight flow from A to Z may also be impacted by flow from A to X and flow from A to Y. Because the spatial influence occurs due to the destination end, it is defined as destination dependence. OD dependence means that the freight flows from the origin's neighbors to the destination's neighbors may also influence the OD flow of interest. Fig. 1 means that the four flows from B and C to X and Y may all have 2nd-order influence on the flow from A to Z. Missing such spatial autocorrelation will result in insufficient understanding of the impacts of various factors on freight flow.

To the authors' best knowledge, none of the existing studies have systematically investigated factors influencing LTL freight flow on a macro-level. This study investigates the impacts of IT and urbanization on LTL freight flow in China using empirical data provided by a representative Chinese LTL company and China National Statistical Yearbook. The analysis also emphasizes spatial autocorrelation across freight flow. The next section summarizes methodology and findings from previous literature, followed by description of data and the spatial autocorrelation model used for this analysis. The paper concludes with analysis of the effects of IT and urbanization, using results from spatial econometric model of OD flows, based on which the policy implications are discussed.

2. Literature review

2.1. The impacts of IT on freight system

Many studies agree that IT has extensive impacts on the freight system. By restructuring the distribution system and sharing real-time information, IT contributed to efficient production arrangement, better logistics administration, cost reduction, and the improvement of customer satisfaction in supply chain (Nair et al., 2009; Aggarwal and Garg, 2014). DeGroote and Marx (2013) stated that IT improved perception and response capabilities of supply chain to market, especially for the firms in a highly complicated market environment (Wong et al., 2015). IT was the prerequisite for companies to compete in market (Mishra, 2012). Therefore, IT affects supply chain greatly. Li et al. (2009) also indicated that IT had positive effects on supply chain integration, further improving supply chain performance. From the perspective of operations, IT

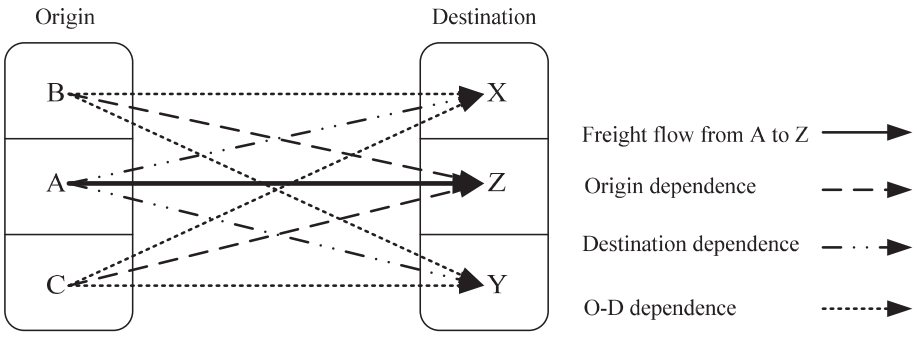

Fig. 1. Spatial autocorrelation of freight flow.