



# Comparing China's city transportation and economic networks



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## ABSTRACT

The urban system has been a prevailing research issue in the fields of urban geography and regional economics. Not only do the relationships between cities in the city system exist in the form of rankings, but also in a more general network form. Previous work has examined the spatial structure of the urban system in terms of its separate industrial networks, such as in transportation and economic activity, but little has been done to compare different networks. To rectify this situation, this study analyzes and reveals the spatial structural features of China's urban system by comparing its transportation and economic urban networks, thus providing new avenues for research on China's city network. The results indicate that these two networks relate with each other by sharing structural equivalence with a basic diamond structure and a layered intercity structure decreasing outwards from the national centers. A decoupling effect also exists between them as the transportation network contributes to a balanced regional development, while the economic network promotes agglomeration economies. The law of economic development and the government both play important roles in the articulation between these two networks, and the gap between them can be shortened by related policy reforms and the improvement of the transportation network.

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## 1. Introduction

The urban system, a crucial element in economic and social development, is a spatial distribution structure in a region, country or the world consisting of cities of different types and sizes. There are cooperative and complementary relationships between cities, suggesting that all cities exist in a heavily connected network and every city in the urban system is a network node, whose formation is driven by the spatial concentration and diffusion of economic activities.

Arising as an advancement on the traditional view of the world as a 'mosaic map' of political boundaries, Taylor et al. (2003) city network research has gradually aroused the interest of academics. Conceiving the world city network as the 'skeleton' upon which contemporary globalization has been built, and city network research encompasses the infrastructure network (primarily concerned with transportation networks) and the economic network (encompassing the economic linkages between cities). Different networks can reflect different aspects of the urban system, thus a comparative study between different networks can provide insight into a deeper understanding of the formation and evolution of the urban system.

The interaction between transportation and urban systems has been a constant theme of urban and transportation geography, while the economic linkages between cities depict urban systems from another important aspect. Since transportation and economic networks have both provided the means for extracting resources over long distances and of integrating all cities into a single system, there should be certain linkages between them. The key research question in this paper, therefore, concerns how the city transportation network 'articulates' with the structure of the city economic network. This is of particular interest for several reasons: transportation systems can have a multiplier effect through the industrial chain to stimulate additional employment and investment opportunities in different industries; the transportation network can fundamentally alter the economic linkages between cities through the movement of goods and people; and rapid economic development of a city can trigger a greater employment-related movement of people to and from the city.

China is chosen as an example to inspect and analyze these two networks. This is valuable per se. As a country occupying a vast territory, a large population and with significant regional disparities, China's rapid economic growth and urbanization development in recent years has increasingly attracted attention from across the world, making it an archetypal location for city network research. The paper proceeds as follows: in Section 2 we systematically review the related literature, in Section 3 we analyze China's transportation network and economic network, in

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**Section 4** we compare the similarities and differences of these two kinds of city networks. Concluding remarks are provided in **Section 5**.

## 2. Literature review

As the connections between cities are becoming increasingly complicated instead of comprising purely vertical and horizontal linkages, and the social network analysis method is widely used, urban system research has progressed from the analysis of city attributes, to the inspection of intercity relationships in networked societies, that is, city network research (Camagni, 1993; Castells, 1996).

Widespread theoretical discussions about world city network have been rarely studied by genuine empirical network analyses (except recent attempts to rectify this situation with air transportation networks and communication networks, such as Townsend (2001a, 2001b); Rutherford (2005); Derudder et al. (2007); Neal (2010); Mahutga et al. (2010); Vinciguerra et al. (2010)), while most studies identify the world city network as an interlocking network (Beaverstock et al., 2002; Taylor, Catalano and Walker, 2002; Taylor, Walker, et al., 2002; Derudder et al., 2003; Alderson & Beckfield, 2004; Pereira et al., 2010) with three levels—network, nodes (cities) and sub-nodes (global service firms), using the measurement method of Taylor (2001). In this context, city network studies mainly comprise research into the infrastructure network and the economic (or corporate organization) network, especially in the global context (i.e., the world city network). Infrastructure network research is primarily concerned with transportation and telecommunication networks, with airline linkages (Smith & Timberlake, 2001; Matsumoto, 2004; Derudder & Witlox, 2005, 2008; Neal, 2010) offering the best illustration of the transportation role in the urban system, and the Internet (Townsend, 2001a, 2001b; Malecki, 2002; Vinciguerra et al., 2010) representing the mainstream telecommunication network. City network studies regard air passenger flows as the optimal measurement of the city transportation network (Knox & Taylor, 1995). In China's case, although the matured rail network can provide insights into the evolution of China's urban system (Dai et al., 2005; Zhong & Lu, 2011), China's air transportation network has developed enormously in the past decade and now connects most big cities. Therefore, it can largely represent the spatial structure of China's urban system (Yu et al., 2008), with an increasing number of studies based on air passenger flows having been conducted in recent years (Jin et al., 2004; Wang & Jin, 2007; Ma & Timberlake, 2008; Shaw et al., 2009; Wang et al., 2011; Lin, 2012; Xiao et al., 2013; Zhou & Hu, 2002; Hu, 2015) to align China's research more with international practice.

The other aspect of city network research is the economic network that is usually measured in corporate organizations, focusing on the ownership links between firms across space. In contrast with the infrastructure network, the research on the economic network is relatively subjective, which uses proxies and modeling method because it is impossible to obtain the actual volume of economic linkages, such as the Interlocking Network method proposed by Taylor et al. (2003). Taylor et al. (2008) use the interlocking network model to measure relations between 200 cities within and beyond polycentric urban regions based on the office networks of advanced producer service firms. Using data on the headquarter and branch locations of the world's 500 largest multinationals, Alderson et al. (2010) employ techniques developed for the analysis of networks to evaluate more than 6300 cities to analyze the intercity relations in the world city system; Van Oort et al. (2010) employ data on inter-firm relations in the Dutch Randstad to test the spatial and functional integration and urban complementarities in economic network relations.

Each type of the city network, like the aforementioned infrastructure network and the economic network, captures a substantively important dimension of intercity relationships, thus reflecting the different structures of the urban system. The comparison between different city networks can provide insights into understanding intercity networks

formed by different spatial flows. Nevertheless, only a little research focuses on this topic. This includes Choi et al.'s (2006) comparative study of world city networks in terms of Internet backbone and air transportation intercity linkages, as well as Mahutga et al.'s (2010) research on the comparison between the global city hierarchy gauged by international air traffic flows and the structure of the world system based on international commodity trade. A large body of studies has focused on the important relationship between the transportation and the economic development of regions, without discussing it from the city network perspective. Among these, many studies have provided evidence of a strong link (causal relationship in both directions) between transportation infrastructure and economic development (Banister & Berechman, 2000; Bose & Haque, 2005; Fedderke et al., 2006; Zhou et al., 2007; Fernandes & Pacheco, 2010; Banerjee et al., 2012; Pradhan & Bagchi, 2013; Beyzatlar et al., 2014). Generally speaking, the transportation infrastructure is established in advance to promote economic growth, while economic development in turn influences further improvements in transportation, while other studies also analyze the governments' important role in the articulation between the transportation and economic development (Bowen, 2000; Ishutkina & Hansman, 2008).

In conclusion, therefore, a significant deficiency in the city network research is the lack of comparability, with multiple layers of city networks having been examined independently of each other. As Mahutga et al. (2010) put forward, the city network literature is full of discussions of the articulation between the world urban system (referring to the ranking of city centrality in the air transportation network) and the world system (that is, the power and position of a country in the world system measure by international trade flows), but there is surprisingly little empirical research. To rectify this situation of lacking comparative studies, taking China as an example, whose city network is large and complicated enough to be analyzed, we develop networks based on both intercity traffic flows and economic linkages, calculate city centrality in the network and explore the network topology of intercity relationships, subsequently compare the two perspectives to examine their structural similarities, differences and interrelationships. While city network studies usually focus on the world city system and western countries, it is interesting to look at China's situation of surging economic growth and the prosperous development of air transportation in the past few years. Does China also conform to some findings obtained from city network studies in Western countries and all over the world?

Though there is a great deal of literature on the relationship between transportation infrastructure and economic development, it generally analyzes the interaction or causal relationships involved using statistical approaches. This study, however, will examine the relationship between transportation and economic development from the perspective of a comparative analysis by the city network method. It is of great significance to compare the city transportation network with the economic network. First, the intercity transportation system usually comes in the form of network, and intercity economic linkages can also be regarded as networks, so it is reasonable to use the city network method for their analysis. Second, these two networks are both depictions of urban systems from different aspects, and there exists an intimate connection between them, which makes a comparative study feasible. Third, from the perspective of comparative analysis, the detailed similarities and differences between transportation and economic networks, as well as regional disparities in these two networks can be revealed. This leads to the further exploration of the underlying reasons and related policy implications, in which a purely correlation and causal analysis cannot discern. Finally, this study provides empirical evidence of the articulation between different city networks for future research, thus contributing to deepen research into the urban system and urban geography by introducing a new research method to analyze the relationship between transportation and economic development, and broadening the research scope of city network studies from the perspective of comparative studies.

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