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RESEARCH PAPER

Cointegration Relationship of Regional Integrated Transport Demand and Industrial Structure

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Abstract: In order to reveal the connection between regional integrated transport demand and industrial structure, the paper adopts the cointegration theory to analyze the interaction of freight and passenger traffic volume and the value of primary, secondary and tertiary industry in Shanghai. The result reveals that there exists long-term equilibrium relationship respectively between freight/passenger traffic volume and the value of secondary/tertiary industry. The development of primary industry does not account for the increase of either passenger transport demand or freight transport demand. Using freight traffic volume per gross domestic product (GDP) to forecast freight transport demand is no longer suitable for industry developing direction nowadays. The freight traffic volume Granger causes tertiary industry and the tertiary industry Granger causes passenger traffic volume in the 10% confidence level. Meanwhile, the short-term elasticity of passenger volume logarithm due to tertiary industry logarithm is 1.15 while the long-term elasticity is 0.41. Thus, it is reasonable to predict passenger transport demand using passenger traffic volume per tertiary industry value. Passenger traffic volume and tertiary industry has a bidirectional causal relationship in the 25% confidence level. However, the promotion of tertiary industry to passenger transport demand is stronger than that of the latter to the former. It means that the modest leading development of transport systems would be helpful for the economic development and the structural adjustment of industry in China.

Key Words: integrated transport demand; industrial structure; cointegration theory; Granger causality; error correction model

1 Introduction

The rapid development of the society and the economy as well as a brand new situation of reform and open policy stimulate the planning and construction of a transport system, to a great extent, in China. Facing the speedy urbanization, China's increase of the economy and improvement of the transport infrastructure result in the growth of transport demand. Each level of the government has considered and even started planning a regional integrated transport system in concern of the society and the economy developing demand. As the basis of planning, demand forecasting determines the reasonable quantity and spatial distribution for transport infrastructure in construction. Above all, the planning of the society and economic development are always considered superior during the practical process of regional integrated transport planning. Consequently, it is very useful to conduct research in depth on the relationship between economic development and an integrated transport system.

In 1987, Engle and Granger[1] presented the cointegration concept, which was soon afterward extensively adopted to seek the connections of macroscopic variables in the society and economic fields. While in transport fields, cointegration theories are used to explore the relationships between transport demand and economic development. Using the method of cointegration analysis and the error correction model (ECM), Ramanathan[2] studied the influence of macroscopic economic variables on the transport industry development, and found that the passenger-kilometers (PKM) are likely to increase faster than urbanization in India; the tonne-kilometers (TKM) are highly correlated to industrial growth; the PKM and TKM adjust to their long-term equilibrium at about 35% and 40% adjustment, respectively. The study impresses us with one of those valuable findings on

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the relationship between freight transport demand and industrial structure, but the relationship between passenger transport demand and industrial structure is still not clearly discussed. Dritsakis *et al*.[3–5] conducted research on tourism demand from Germany and Britain to Greece; quarterly tourism demand from Europe to Tunisia, and interstate tourism demand in Australia. All the research focused on the influence of costs for different services in tourism (e.g., accommodation, transport, recreation, and restaurant) on passenger transport demand at the microscopic level. However, tourism passenger transport demand is only one part of the entire passenger transport demand; whereas the other parts such as business passenger demand are likely to be influenced by the financial industry. Using the cointegration theories, Jou *et al*.[6] studied the effect of income on household vehicle (car and motorcycle) ownership of different cities or regions in Taiwan and found that the effects are not entirely identical as the researched city or region varies, revealing that to some extent cointegration theories are adopted widely, but might lead to dissimilar conclusions.

Domestic researchers also tried to use cointegration theories to explain the interaction relationship between the transport system and the social economy. Liu and He[7] analyzed the relationship between domestic passenger/freight traffic volume and GDP using the national data from 1949 to 1999 and arrived at the conclusions that a cointegration relationship exists between freight traffic volume and GDP and at a 5% confidence level, freight traffic volume is the Granger cause of GDP. However, the reverse is not true, which is inconsistent with Lin and Luo's research results[8]. With Shanghai data from 1990 to 2005, Lin and Luo concluded that road freight traffic volume is not the Granger cause of GDP but the reverse is true. Although these two studies differ with regard to research objects, areas, and time intervals, the nearly opposite conclusions make it extremely necessary to deeply explore the relationship between transport volume and a macroscopic economy in a condition of distinguishing industrial structure. In addition, in the practical process of planning for a regional integrated transport system, freight traffic volume generated by per GDP is usually taken as an index that is used for forecasting the entire freight traffic, which might lead to a significant deflection, especially in the medium- and long- term demand forecasting if developing and adjusting direction of the regional industrial structure is not properly seized.

Most of the earlier studies focused on one mode, for example, road traffic, and assumed the whole GDP as the symbol of the society and the economic development level, ignoring the influence of the developing direction of the industrial structure on transport. However, from the aspect of China's industry dividing characteristic, the primary and secondary industries mainly refer to collecting, manufacturing, and producing living materials, and their development might result in a great demand in freight traffic. The tertiary industry provides variable services for producing and living, whose development are unlikely to cause an increase of freight traffic demand but passenger traffic demand easily. More importantly, China's economy developing pattern is experiencing critical period of transferring from extensiveness to intensiveness, and some cities or regions are trying to establish a sustainable developing pattern by adjusting the industrial structure. All these unprecedented marked changes are worth serious considerations and should be discussed. This research thereby aims at revealing relationship between transport demand and industrial structure based on cointegration theories, taking Shanghai as a case study.

2 Index selection and data note

2.1 Index selection

(1) Integrated transport demand. Two usual statistic indexes are used for describing the workload of the transport system: passenger or freight traffic volume and passenger- or tonne-kilometers. The former one only reflects the quantities of transport objects, whereas the latter one represents the quantities and transport distance at the same time. Traffic volume is selected as an index of regional integrated transport demand due to the relatively small area of the case in Shanghai. According to the transport objects, it is divided into freight traffic volume (*fv*), which excludes in-city freight exchange, and passenger traffic volume (*pv*), which excludes in-city trips.

(2) Industrial structure. GDP is a frequent index that is used for measuring a region's developing status due to its reflection for output of the entire region. Following the domestic characteristics of the industry division, the study breaks GDP down to the primary, secondary, and tertiary industries in order to give expression to the influence of industrial structure on transport demand, and the values for the three industries are marked by *pi*, *si*, and *ti*.

2.2 Data note

The data used in this study are obtained from the Shanghai statistical yearbook 2011[9], with an interval from 1996 to 2010. Five time series referred to earlier are calculated by the natural logarithm, and their first differences are illustrated in Fig. 1.

3 Stationary test and cointegration relationship Analysis

In order to avoid "spurious regression" phenomenon[10], a stationary test on the time series should be introduced before regression. The stationary time series is marked $I(0)$, and the non-stationary time series X_t is d-order integrated if its d-order difference is stationary, as shown by $X_t \sim I(d)$.