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Evolution of regional inequality in the global shipping network

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ABSTRACT

Global shipping is a backbone of the global economy, and as such, it evolves alongside the development of trade and the elaboration of commodity chains. This paper investigates the evolution of regional inequality in the global shipping network by analyzing the changing positions of world regions during the period from 2001 to 2012. This was a period of both prosperity and recession in maritime shipping. Using data on inter-regional flow connections, the positions of seventeen regions in the global shipping network are analyzed in terms of their traffic development, centrality, dominance and vulnerability. The East Asian, Northwest European and Europe Mediterranean regions have consistently held the highest positions, while East African and North African regions have held the lowest positions. By commanding the largest flows in the network, East Asia assumes a dominant position. The Australasian, North American West Coast, Northwest European and Southern African regions show an increasing dependency on East Asia. The analysis also identifies a few emerging regions that have had the highest growth rates in total traffic volume and connectivity for the studied period, namely South American North Coast, South American East Coast, West Africa, Southern Africa and West Asia. The empirical results of this paper supplement existing research on global shipping network evolution. One implication of the analysis is that the traffic growth of East Asia does not imply that, there is an equivalent improvement in its position in the global shipping network. The paper also shows that indicators from network analysis may be used to provide a more nuanced understanding of port-regional development than existing measures based solely on total traffic volume.

1. Introduction

Global shipping evolves alongside the development of trade and the elaboration of commodity chains, thus making it a meaningful looking glass for analyzing the global economy (Valentine et al., 2013). The significance of liner shipping to global trade can be inferred from the fact that over 70% of the seaborne trade, in terms of value, is transported by container ships (WTO, 2008). With the development of technology and the global economy, the liner shipping industry has developed in several ways, e.g. increasing ship size, prevalence of strategic alliances and other collaborative arrangements among carriers. Rapid economic growth of emerging countries in the last two decades (e.g. China, India and South Africa) had prompted shipping carriers to adjust their container deployment worldwide for better coverage of their service networks and higher revenues. As a consequence, the structure of the global shipping network (GSN) has dynamically evolved in the last two decades.

The economic conditions and trade situations of world regions are two main factors that influence the container deployment of shipping carriers. For example, Asia, Europe and North America are regarded as the three biggest trade zones, liner services among which constitute the East–west belt of the global shipping activities, while ports in Africa attract much fewer container vessels. The evolution of regional inequality in the GSN can be seen from the different development processes of world regions, thus making it a meaningful way to look into the GSN from a regional perspective. Total traffic volume has long been a widely used indicator to evaluate regional development in terms of maritime shipping, which can be seen not only from various reports on maritime transports provided by shipping consultants like Drewry and Lloyd's list, but also academic research, e.g. Notteboom (1997, 2010). However, total traffic volume fails to provide detailed information about the spatial distribution of the traffic and the proportions shared with each linked region. Therefore, total traffic volume does not fully reflect the position of a region in the global shipping network due to its essence of fairly high level of aggregation. In the context of inter-node flow connections, network

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analysis provides valid evidences for node position in the structure of a network (Freeman, 1979). The effectiveness of applying such a network perspective to global shipping has been proved by many empirical observations of port position in various shipping networks; see Ducruet et al. (2010a), Wang and Cullinane (2014) for a more extensive discussion.

Empirical evidence from traffic growth of global container port system suggests five main successive waves of containerization with a shift from advanced economies to developing economies in specific regions (Guerrero and Rodrigue, 2014), i.e. East Asia, South Asia, South America. With a rising position in global trade over the last decade, East Asia has seen its liner shipping activities improved in terms of total traffic volume. On one hand, some established transfer hubs in East Asia play a significant role in global shipping, such as port of Singapore, Hong Kong, Kaohsiung, Busan. On the other hand, there are many rapidly growing ports with large throughputs, of which are mainly Chinese ports, e.g. port of Shanghai, Shenzhen, Qingdao, Ningbo, Dalian. As reported by Clarkson Research Services (2014), traffic growth in the global container ports has focused mainly on East Asia since 2000 and will be increasingly relied on this region: On one hand, the majority of intra-regional container traffic growth is expected within intra-Asia, which will continue to be bolstered by strong growth in trades between China and rapidly developing Asian economies such as Indonesia, Malaysia, Thailand and the Philippines. On the other hand, non-mainlane trades involving Asia, especially East Asia, are expected to grow robustly into the medium-term, e.g. East Asia–South America, East Asia–West Africa. In terms of total traffic volume, it seems that East Asia has had an exclusively significant influence on the global liner shipping market for a long time. However, does East Asia really acquire an equivalent position within the structure of the GSN as is indicated by its total traffic volume?

Research question here is: To what extent can total traffic volume be regarded as an accurate indicator of actual regional development in light of maritime shipping? In other words, does the position of a region in the GSN rise synchronously with its traffic growth? Hypothesis proposed in this study is that the growth of traffic in East Asia does not necessarily imply an equivalent improvement in its position in the GSN. Within this context, the objective of this paper is to measure and map the evolution of positions of world regions in the GSN based on inter-regional flow connections from 2001 to 2012. This was a period of both prosperity and recession in maritime shipping, i.e. 2003–2008 and 2009–2012 respectively. Such an aim is achieved by analysis of traffic development, centrality, dominance and vulnerability. Regions possessing larger traffic volume, higher level of network centrality and dominance are of a higher position in the GSN. In addition, this paper also tries to assess whether or not there are emerging regions of maritime activity in the GSN that differ from those of 2001.

The remainder of this paper starts with a review of shipping network research in Section 2. Section 3 introduces the division of the world regions and data sources, and Section 4 deals with the methodology and provides an exposition of sub-analyses in the position analysis of world regions. Empirical results are presented in Section 5, namely traffic evolution, centrality, dominance and vulnerability of word regions. Further discussions on some emerging regions are made in Section 6. Finally, the implications of the research findings and some conclusions are drawn.

2. Review of shipping network research

With the wide prevalence of complex network theory and its application to transportation systems in recent decades, network analysis of real shipping systems is rising (Ducruet and Lugo, 2013). Most current studies can be classified into three categories in terms of the geographical coverage of the studied shipping network: Global level (Hu and Zhu, 2009; Kaluza et al., 2010; Woolley-Meza et al., 2011), regional level (Ducruet et al., 2010b; Low et al., 2009; McCalla et al., 2005; Wang and Cullinane, 2014) and specific shipping lines (Fremont, 2007; Mu et al., 2009). Based on service data from global shipping lines, these studies are fruitful in two main aspects: Firstly, centrality indicators, mainly degree and betweenness, were proved as effective parameters in evaluating port position in the structure of shipping networks. Secondly, some statistical properties of the overall network structure were revealed, e.g. small world and scale free. As most of these studies focus on the static state of shipping networks in one year, further questions about the evolution dynamics of shipping networks can hardly be answered.

In regard to investigation into the evolution of regional inequality in the GSN, there are a few studies that have done some relevant works on a port level. For instance, Ducruet et al. did a series of illuminating works on the evolution of liner shipping network from 1996 to 2006, a period of rapid change in port hierarchies and liner service configurations in the world. Starting with investigating the modification of hub-and-spokes structure in the Atlantic container shipping system (Ducruet et al., 2010b), Ducruet et al. (2010a) then explored the position changes of major hub ports within Northeast Asia and their respective tributary areas, and eventually the changing port hierarchy of the global liner shipping network (Ducruet and Notteboom, 2012). Fremont and Soppe (2004) examined changes in the position of Europe in the global shipping network during the period from 1994 to 2002, as well as the position of European ports within regional and global shipping network. These studies added empirical evidence to the ongoing process of regional integration in maritime shipping activities, where ports tend to exchange relatively more with ports within their regions rather than with ports outside their regions. Meanwhile, inter-regional shipping services are fundamental to commodity trade among the world regions. As such, investigation into the evolution of inequality in the GSN with a renewed interest in regional perspective analysis, which focuses on inter-regional flow connections, may provide a nuanced understanding of regional development within the context of global shipping.

However, most of the current regional shipping network studies tend to focus on intra-regional flows and especially on regions with large volume of seaborne trade, i.e. Europe, East Asia and North America. For example, Notteboom (1997) examined concentration and deconcentration tendencies to illustrate how load center development had occurred in the European continental container port system for the period from 1980 to 1994. Notteboom (2010) again updated the above study by extending the research period into 1985–2008, and confirmed that containerization would not necessarily lead to further port concentration in Europe. Meanwhile, there are several studies interested in the evolution process comparison of different regions. For instance, in terms of port throughput, number of container ports and the concentration level, similar evolution processes were detected between the container port systems in China from 1979 to 2009 and the USA from 1970 to 2009 (Li et al., 2012). Traffic inequality in container port systems of Europe during a period from 1975 to 2003 and North America from 1985 to 2003 was investigated by a Gini decomposition analysis (Notteboom, 2006), and an obvious traffic concentration tendency was observed in the latter. Wilmsmeier and Notteboom (2011) compared the evolution processes between Northern Europe and South American West Coast in terms of their liner shipping network configurations, and sought for the determinants of maritime network development between two differently developed regions.

Although the fact that evolution of world regions, in terms of liner shipping development, is unequal is well admitted in most of the existing studies, the way to explore their evolution processes