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Container port competitiveness and connectivity: The Canary Islands main ports case

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ABSTRACT

The Canary Islands' economy is extremely dependent on sea transport. Since accessibility and connectivity are major determinants of international transport costs, the analysis of their main ports' connectivity is crucial for keeping costs under control. Since different port authorities manage the major ports of the Canary Islands, they could be tempted to compete for transshipment cargoes, instead of working together to facilitate supply chain integration that would increase their competitive standing.

The aim of the paper is twofold. First, the infrastructure and superstructure endowment of the main Canarian ports and their accessibility, by evaluating site and situation factors, is documented. Secondly, the connectivity of the main Canarian ports is assessed by means of graph theory. This provides important measures that define a port's competitiveness, and its potential to achieve or keep regional or global hub status, and also to follow its evolution. A brief review of papers measuring port connectivity based on graph theory is included to illustrate the current approaches in port network analysis, and to justify our methodological framework. A sub-network of 53 ports directly related with Las Palmas and Tenerife ports has been selected for this purpose.

Our findings are mainly related to the connections among the nodes in the sample network, and to the position that the targeted ports hold. Additionally, some policy recommendations, regarding how to improve the connectivity and competitiveness of the Canarian ports, are also enumerated. Previous analysis indicates that, at present, the Las Palmas port is the only regional hub in the Canaries. Both Canarian port authorities should differentiate themselves by specializing in certain valued added services and increasing traffic in these services. This would avoid the danger of a destructive competition between them to attract transit traffic. In summary they should be proactive in maintaining and improving the main Canarian ports' connectivity.

1. Introduction

As interchangers between sea and land transportation modes, ports constitute a central element within any transportation system, and by extension for the economy as a whole. The significance of a port is even greater for the economy in island regions where practically the totality of goods enter and leave through ports. This is the case for the Canary Islands whose tourism-based economy is highly dependent on the sea transport that satisfies the needs of the population and the millions of tourists visiting the islands each year. Significant levels of connectivity contribute to the competitiveness of ports (Lee et al., 2014), and generate network effects that contribute to the economy (Laird et al., 2005). Moreover, and as Martinez and Hoffmann (2007) show, connectivity is one of the main determinants of international transport costs, so improving port connectivity is crucial for keeping transport costs under control.

The Canary Islands form one of Spain's 17 autonomous communities, and are one of the outermost regions of the European Union. Located in the Atlantic Ocean and consisting of seven islands, they are situated 115 km from the northwest African coast and are at an average distance of 1750 km from Madrid. The Canary Islands main ports, Las Palmas and Tenerife, are located in the islands of Gran Canaria and Tenerife, respectively; together they accounted for more than 88% of the total freight moved to

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and from other geographical areas in 2013. They are managed by different port authorities.[1]

Both centrality and intermediacy play a role in defining the merits of a port as a transshipment hub. Ideally such ports need to be both central to the market they serve and intermediary to the shipping lanes linking markets (McCalla, 2008). Las Palmas port is currently a transshipment hub and the Mediterranean Shipping Company (MSC), one of the leading global shipping lines worldwide, has channeled part of its operations in the region through it. On the other hand, Tenerife port, which has the same situation factors, plans to improve its site factors, in order to be capable of assuming more international container traffic. Currently, it falls far short of Las Palmas' port records.

The advantages of having good port connectivity were accrued to the Canary Islands once one of their ports became an international hub. Due to the global nature of the transshipment business, where global operators are seeking their own strategies and objectives, it seems sensible to ask whether both port authorities should cooperate. This might avoid placing themselves in a weaker position to negotiate with shipping companies, due to overcapacity.

In the actual context of intense competition and declining freight rates Asgari et al. (2013) have introduced the idea of cooperation as a potential substitution for competition. They state cooperation can take the form of (i) horizontal cooperation between/among the ports, (ii) vertical cooperation between the ports and the shipping company, and (iii) full cooperation among all of these stakeholders. Moreover, it has been increasingly recognized that some degree of coordination among ports can enable increases in efficiency and in supply chain integration, which far from reducing competition, in fact increases the ports' competitive standings. Moreover, the building of cooperative relationships with other ports allows them to provide a range of incentives to shippers and operators, in order to attract trade volumes (Merk, 2013).

Therefore, and trying to shed light on the aforementioned argument the aim of the paper is twofold. First, it aims to document the port infrastructure and superstructure endowment of both the main Canary Island ports, and to give the first qualitative approximation of their sea accessibility through an evaluation of their site and situational factors. The second objective is to complete the previous analysis by providing the first direct evaluation of the main Canarian port connectivity based on graph theory. These are important measurements in establishing the competitiveness of a port (Low et al., 2009), and in measuring its potential for achieving or keeping hub status, either regionally or globally. These let us follow future evolution. To this end, in the ensuing section, a survey on the current state of literature measuring port connectivity, based on graph theory, is presented.

The paper is structured as follows. In Section 2 we provide a brief but comprehensive review of studies of port connectivity using graph theory techniques. Moreover, the Canary Islands main ports are described. Section 3 describes the data and presents the methodological issues. Results, discussion and policy implications are presented in Section 4. Finally, Section 5 presents the most relevant conclusions and directions for future research.

2. Background

2.1. Graph theory and port connectivity

Although the introduction of the maritime connectivity concept is relatively recent in the literature, it has rapidly gained popularity. An increasing number of studies analyze the influence of maritime connectivity on different aspects such as maritime transport cost (i.e. Kumar and Hoffmann, 2002; Wilmsmeier et al., 2006; Martinez and Hoffmann, 2007; Márquez-Ramos et al., 2011; Duval and Utoktham, 2011), port/regional competitiveness (i.e.; Yeo et al., 2008; Wang and Cullinane, 2008; Verhetsel and Sel, 2009; Freire and Pais, 2011; Yeo et al., 2011) logistics connectivity[2] (i.e. Notteboom, 2004; Kronbak and Cullinane, 2011) and maritime security (i.e. Bichou, 2004; Angeloudis et al., 2007). Relatively a few studies have analyzed port connectivity using graph theory (see Table 1).

Roughly defined, graph theory is a branch of mathematics concerned with how networks can be encoded and their properties measured (Rodrigue et al., 2006). As far as we are aware, the first paper to use the twin geographical concepts of centrality and intermediacy is Fleming and Hayuth (1994). They identify both characteristics as spatial qualities that enhance the traffic levels of transportation hubs, and hence indicate which places are strategically located. However, their analysis is qualitative because they approached both concepts via port throughput, instead of calculating them by constructing a network.

The first empirical studies that have attempted to measure port connectivity based on graph theory appear in the 2000s. This is probably due to the commencement in 2001 of the installation of Automatic Identification System (AIS) equipment in ships and ports. This has facilitated easier access to the data demands entailed by the maritime network construction. Table 1 provides an overview of studies using this technique, and it can be seen that, in all of them, a maritime network was built using data basically from two sources: Containerization International (e.g. McCalla et al., 2005; Cullinane and Wang, 2009 and 2012; Wang and Cullinane, 2014) and Lloyd's Marine Intelligence Unit (e.g. Ducruet et al., 2010a; Kaluza et al., 2010; Gonzalez et al., 2012).

Regarding the graph definition itself, there is no unanimity on the circumstances in which a pair of ports should be considered linked, so as to take into account the complexity of the maritime networks. Two graph configurations have appeared to deal with this particular problem, and while some authors do not refer to this issue many others define their networks according to this framework, and perform parallel studies for both models. These two representations are referred to as Graph of Direct Links (GDL) and Graph of All Links (GAL). The GDL represents the sequence of ports a vessel calls at within a liner service (Fig. 1), and results in a simple approximation of the topology of the network; this is because two ports will be connected, only if they are called at consecutively. GAL, however, includes the consecutive links between ports on a specific route, and also completely connects the ports of the service, by making the assumption that ports in the same service are linked either directly or indirectly. This latter approach is expected to be a better representation of liner shipping.

These studies can be grouped in terms of the method used to build the network, and these may adopt important differences in their respective structures. The first set of studies uses a network representation that only includes direct successive calls between ports, i.e. GDL, (McCalla et al., 2005; Ducruet et al., 2010a; Kaluza

[1] For a detailed analysis of the port management model in Spain, see Rodríguez-Álvarez and Tovar (2012) and Tovar and Wall (2014).

[2] Whereas port connectivity is focused on the connectivity among ports, logistics centered connectivity goes a step further and in its analysis includes other areas influenced by a port such as foreland and hinterland.