



Operational and geographical dynamics of ports in the topology of cruise networks: The case of Mediterranean



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ABSTRACT

Geography is an integral part of the cruise industry since cruises are conducted in the geographical space and thus are submitted to spatial and geomorphological constraints. However, the cruise-literature lacks of research focusing on the geographical aspect of the interactions existing between ports and cruise companies. This paper attempts to fill this gap by examining the spatial networks of two contemporary cruise companies operating in the Mediterranean, using complex network analysis that has been extensively applied to other shipping sectors, such as to the container liner shipping, but not, in a comprehensive context, in the cruise industry. The complex network analysis applied in this paper provides insights about the operational and geographical dynamics of the ports participating in the Mediterranean cruise network, which can help the cruise companies and the port authorities to comprehend and to measure their competitive position in the network. The overall approach develops a novel classification of ports according to their integration in the cruise network, an optimized modularity segmentation of the Mediterranean market by considering both operational and geographical aspects of this network, and an in-depth efficiency comparison between the spatial networks of the cruise companies.

1. Introduction

Cruising suggests an emerging form of tourism. This is clearly illustrated by some key data about the sector's the evolution in the last two decades. More precisely, during the year 2017 > 25 million passengers had taken a cruise, whereas the total annual cruise load in 1998 were not exceeding 6 million passengers. Moreover, the annual change in passenger volumes during the same period remained positive, showing some notable figures during particular years, such as in 2007 where the annual change exceeded 21% (Cruisemarketwatch, 2018). The cruise tourism evolves through the interaction of various actors lying either on its supply or its demand side. Cruise passengers shape the demand of the cruise product whilst cruise companies and port authorities are the main actors shaping the supply of the cruise product (Brida and Zapata, 2009; Gui and Russo, 2011). In addition, the cruise product differentiates from other forms of tourism in the sense of incorporating both tourism and transport dimensions (Pallis, 2015; Niavis and Tsiotas, 2018).

The dynamics of the cruise industry are reflected in the relevant literature where the cruise-related studies are constantly advancing. For instance, Papathanassis and Beckmann (2011) detected an exponential growth in cruise studies during the period 1983–2009. Moreover,

focusing on cruise studies using quantitative and empirical analyses, Marcussen (2016) has found that almost the 2/3 of 125 in total identified studies were published within the period 2010–2014, whereas only the 1/3 was published during the period 1984–2009. In addition, the rather complex structure of the cruise industry has made this kind of industry an interesting field of research for scholars of different disciplines. In this vein, Papathanassis and Beckmann (2011) identify six general categories of disciplinary targets in the cruise industry, namely business and management, economics, sociology and psychology, technology and engineering, environment and geography, and medicine. According to these authors, the vast majority of studies are focusing on the business and management domain of the cruise industry, the 1/3 of the studies tackle relevant issues, whereas other aspects, such as geography, are rather under-researched.

In terms of geography, this lack of studies (Papathanassis and Beckmann, 2011) appears to be a quite unexpected finding, since geography regards a fundamental factor affecting both the supply and demand aspect of cruising. More precisely, in a prime for the cruise-geography paper, Marti (1990) identifies that the proximity of ports against popular cruise routes or regions shape their potential for attracting cruise ships either as a home ports or as a port-of-call (POC). According to Wang et al. (2016), the distance of ports included in an

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itinerary affects the overall schedule of cruise companies, due to cost and time efficiency issues. This appears to be the reason why itineraries are mainly repeated on rather closely located ports. Moreover, the ports' proximity to major tourism attractions has a notable effect on the passengers' preferences amongst the different offered itineraries (McCalla, 1998; Gui and Russo, 2011; McCalla, 1998).

Furthermore, the geomorphological characteristics of each port, such as the berth's depth and length, as well as its physical protection against the weather conditions, also suggest critical factors considered by the cruise liners in their decision-making processes about which POC should be included in an itinerary (Lekakou et al., 2009; Castillo-Manzano et al., 2014). In addition, geographically varying factors (e.g. the climatic and weather conditions) affect the seasonality of operations and define the ships' deployment strategies of the cruise companies amongst different geographical markets, such as the Caribbean and Mediterranean (Rodrigue and Notteboom, 2013). Moreover, the natural and cultural environment of the ports defines the type of cruises that these can attract. For instance, a port on a river delta can attract both sea and river cruises. In addition, a port in a city with rich archeological assets can attract thematic cruises with an archeological background, whilst ports on destinations with valuable natural ecosystems and wildlife, such as those in the North and South Pole, are mainly engaged in exploration cruises (Pallis, 2015).

Finally, the hinterland characteristics of the ports, such as the population, the economic development, and the overall sea, air, and road connectivity seem to play a key role in whether a port will operate as a home-port or as a (POC) (Lekakou et al., 2009; Esteve-Perez and Garcia-Sanchez, 2015; Niavis and Vaggelas, 2016). This distinction between POCs and home-ports is very critical for the cruise industry and it is directly connected to the benefits that destinations can acquire from engaging in cruise operations. This is because cruise passengers' spending is higher at homeports than at POCs. For instance, according to a report of Cruise Lines International Association – CLIA (2017), the average spending of passengers at homeports was estimated at \$356.10, whilst the respective spending at POCs was \$94.61. With rough estimations, these figures portray that in order for a POC to acquire the same economic benefits with a homeport it should attract nearly four times more the passenger volumes of a homeport.

Such findings imply that geography is an integral part of the cruise industry, which configures the types of interconnections between the cruise actors. At the stage of the itinerary planning, cruise companies have to select amongst a set of ports encompassing various geographical attributes, in order to build attractive itineraries for passengers and thus to fulfill their primary target of profit maximization (Rodrigue and Notteboom, 2013; Niavis and Tsiotas, 2018). The total of itineraries belonging to a single cruise-company build the company's cruise-network, whereas, the total number of itineraries of all the companies operating in a certain geographical area formulate an aggregated cruise-network representing a cruise-market, where ports selected by the cruise companies represent the network nodes (Cusano et al., 2017; Niavis and Tsiotas, 2018).

On the other hand, port and local authorities seek to tap on their geographical advantages in order to strengthen their competitive position against other ports and further increase their involvement in the cruise network (Castillo-Manzano et al., 2014; Pallis, 2015). The positioning of ports within this network has been at the center of a considerable number of studies and various scholars have developed port-classifications, according to how they are integrated on the network or how they are exploiting the network-opportunities for boosting their cruise-traffic. A review of such studies providing various classifications of ports is shown in Table 1.

Finally, apart from the general competitive structure of the ports' network, ports also draw cooperative strategies (Pallis, 2015). This cooperation is mostly observed over quite adjacent ports forming in this way latent groups of ports within the cruise network. This grouping has been studied up-to-now under a strict geographical perspective. For

instance, in the annual statistical report of Med-Cruise the Mediterranean market is divided in four sub-markets, namely the West Med, the Adriatic Sea, the East Med, and the Black Sea (MedCruise, 2017). In addition, Cusano et al. (2017) used the West-Med, East-Med, and Black Sea division schemes in order to study the port hierarchy within the cruise network of the Mediterranean.

The previous remarks reveal that the geographical effect on the cruise-company itinerary planning and on the aggregate cruise-market could be better explained under the network perspective. Nevertheless, although it is challenging, the operational cruise-structure has been rarely studied with the use of complex network analysis (CNA). Within this context, the CNA can be proven effective to provide new insights about the operational and geographical dynamics of the cruise-network market. The CNA, called broader by other scholars as Network Science (Barabasi, 2013; Brandes et al., 2013; Ducruet, 2014; Tsiotas and Polyzos, 2017), is a modern research field or discipline using the network paradigm to model complex interacting systems into graphs, namely into pair-sets of nodes and links (Albert and Barabasi, 2002; Boccaletti et al., 2006; Newman, 2010). As the analysis within the Literature Review section will portray, the newly established discipline of Network Science has already provided insights about the structure and the functionality of maritime systems such as those of liner shipping (Ducruet and Notteboom, 2012).

Based on the finding of Wang et al. (2016), who detected structural and functional similarities between the cruise and the liner shipping networks, the application of CNA in the cruise industry can be proven sufficient to provide new insights in this field of research, as it has already done for other maritime transport systems. Towards this direction, this paper exploits the publicly available information regarding the Mediterranean itineraries of two contemporary cruise companies, namely Costa and MSC Cruises, and it studies the topology of their spatial networks using CNA. Taking into account that these two companies share about the 40% of the total itineraries in the Mediterranean market (Marusic et al., 2012; Cusano et al., 2017), the aggregate spatial network we build represents in a satisfactory level the structure of the Mediterranean cruise market. Within this context, the analysis on this aggregate spatial network (hence called Mediterranean Cruise Network - MCN) appears sufficient to provide insights about the interrelations between the cruise companies and the port authorities or, more generally, between the operational (company-driven) and geographical (port-driven) dynamics ruling this cruise market. Based on the CNA, the objectives of this paper are to:

- Analyze and compare the structure of the networks of two major contemporary cruise-companies.
- Formulate a novel port-classification based on absolute complex network terms, in order to enrich the typologies appearing in Table 1. The proposed classification will be evaluated using non-network variables, in order to illustrate the allocation of ports to different classes.
- Reveal groups of ports and market segments based on a composed network and geographical perspective.

The remainder of this article is as follows; in section 2, a brief literature review on the use of CNA in the shipping and cruise industry is conducted. Section 3 describes the methodological approach, the CNA models used in the analysis, and the variables participating in the empirical research. Section 4 presents the main findings of the analysis and discusses the results. Finally, Section 5 provides the conclusions and some policy implications for both cruise-companies and port-authorities along with some addresses for future research.

2. Literature review

Modeling a complex system into a complex network outperforms to the fact that the produced non-parametric graph-model incorporates

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