Measuring the scope of inter-firm agreements in the container shipping industry: an empirical assessment

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Abstract: In container shipping industry inter-firm agreements are becoming progressively popular as ship-owners share their slot capacity with commercial partners in order to have fully loaded container ships and reduce financial risk. This manuscript focuses on the cooperative agreements among shipping firms, i.e., vessel sharing and slot charter agreements within consortia and strategic alliances. Through a quantitative approach based on network and OLS regression analysis, we scrutinise the propensity to cooperate, the geographic extent and ‘leveraging effect’ generated by this commercial practise on the container-shipping industry. Results show that carriers, usually regarded as independent, are instead fairly cooperative, especially when involved in trade lanes originating from the Far East. Finally, we show that carriers increase their commercial objectives by leveraging the operated fleet capacity. We conclude with some implications for managers and practitioners as well as a discussion on limitations and future extensions of this study.
Measuring the scope of inter-firm agreements in the container shipping industry

Keywords: container shipping lines; cooperative agreements; strategic scope; network analysis; leverage.


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1 Introduction

Over the past few decades the shipping industry has been characterised by a strong competition among carriers, that have used various cooperation agreements to gain competitive advantage, share investment risk and reduce costs (Panayides and Cullinane, 2002). The simultaneous presence of cooperative and competitive behaviour in the container industry has typified it as an oligopolistic market. In literature, Brandenburger and Nalebuff (1996) have coined the term ‘coopetition’ which represents the condition in which firms, in a dynamic industry, can achieve more advantage when they cooperate with each other (Telser, 1982; Hamel et al., 1989). In this paper, the authors refer to coopetition when cooperation and competition are both visible in the market (Bengtsson and Kock, 2000). In maritime economics various authors (Musso et al., 2000; Song, 2003; Parola and Musso, 2007; Soppé et al., 2009) have discussed this dualistic concept, thus challenging the traditional dichotomist approach of cooperation versus competition.

In the late 19th century container carriers started to negotiate conference agreements in order to stabilise the supply chain and assure steady services in several maritime routes. Consortia were introduced in the 1960s with the aim to reduce costs due to the introduction of new typologies of vessels. In the 1990s strategic alliances had the goal to share risk and widen carriers’ markets in order to develop economies of scope (Brooks et al., 1993; Ryoo and Thanopoulou, 1999; Alix et al., 1999; Midoro and Pitto, 2000) and sometimes to test if there were sufficient economic conditions for a subsequent merger (Das, 2011). Moreover, ‘coopetitive’ behaviours are observed when business involves a networked industry among firms, as maritime transport definitively is.

This manuscript focuses on the cooperative agreements among shipping firms, i.e., vessel sharing and slot charter agreements within consortia and strategic alliances. The work analyses and measures two key dimensions characterising the strategic scope of cooperative agreements:

1. the propensity to cooperate, expressed in terms of inter-firm networking
2. the ‘leverage effect’, produced through the commercialisation of joint-services, capable of ‘multiplying’ the operational capacity of ship-owners.

The original contribution of this work rests in the scrutiny of inter-firm agreements in the liner shipping industry with a methodological approach, based on network, geographic and OLS regression analysis, and testing some theoretical hypotheses with empirical findings.
2 Theoretical background and hypotheses

The economic and management literature on competition and cooperation (Caves and Porter, 1977; Goerzen and Beamish, 2005; Hoetker and Mellewigt, 2009) has pointed out three main drivers that push a firm to adopt cooperative strategies:

1. improvement of production process
2. search for new markets
3. acquisition of new information and technological advances.

In liner shipping, the efficiency of production processes mainly concerns with economies of scale of fleets (Imai et al., 2006). The oversupply of transport capacity and the consequent pressures on freights undermine the profit margins of carriers. In fact, the dramatic rise of economic and financial risks due to the deployment of new cellular vessels has progressively compelled ocean carriers to cooperate with each other in order to share their transport capacity and aggregate demand flows (Panayides and Cullinane, 2002).

The rapid growth of the containerised industry and the globalisation of markets have widened the interests of shippers in new markets also from a geographic point of view. Thus cooperation represents the quickest and cheapest way to meet increasing requests for diversified, fast, reliable and affordable container services (Yoshida et al., 2005). In trying to avoid additional investment in new ships, small firms find some advantages in cooperating with market leader carriers, whereas market leaders can in this way cover market niches through the cooperation with (small) partners. Some carriers, specialised on home markets, may cooperate with competitors in order to enlarge their market areas (Ferrari et al., 2008).

Finally, some carriers direct their industrial strategy towards cooperation in order to gain know-how and technological transfers and fill the gap with competitors (Kale and Singh, 2007). The choice for cooperation implies to share some key information among partners.

Nevertheless there is also a cost of cooperation, mainly consisting in management costs that sometimes counterbalance the benefits (Bergantino and Veenstra, 2002). Those costs tend to grow as the number of partners grows (Killing, 1988), thus contributing to explain the instability of partnerships in time (Pirrong, 1992; Sjostrom, 1989).

Cooperation in liner shipping is not a new topic in the literature. A number of scholars have already studied cooperation in liner shipping, mostly proposing qualitative studies (Ryoo and Thanopoulou, 1999; Brooks, 2000; Slack et al., 2002; Cariou, 2008). A few contributions (Ferrari et al., 2008; Panayides and Wiedmer, 2011) grounded on a strong empirical base have attempting to illustrate the dynamics in the container industry and provide findings on the collaborative schemes used. Academic literature, however, is still calling for more quantitative and empirical investigations about the drivers of major forms of agreement (vessel size, total investment in assets, firm size, etc.) as well as criteria for partner selection. In particular, more in-depth analyses on the geographical scope of cooperative agreements, the diverse attitudes of the different players to share their fleet capacity, and the consideration of the networking effect generated by cooperation are needed.
2.1 Propensity to cooperate

The propensity to cooperate is a theoretical concept linked to the industrial strategies of shipping lines, that assesses the diverse attitudes of market players which lead to stipulate a number of agreements and build networks of relationships with a variety of partners.

Various authors (Evangelista and Morvillo, 1999; Midoro and Pitto, 2000; Song and Panayides, 2002; Lu et al., 2006) emphasise the role that consortia play in controlling investments and commercial risks, especially for leading market players which undertake enormous financial outflows (Panayides and Wiedmer, 2011). In general, carriers with aggressive growth strategies secure business agreements with various partners in order to effectively manage the organisational complexity and criticalities deriving from the increase of geographic scope and firm size (Midoro and Parola, 2011). Thus, we expect that the carrier propensity to be involved in (numerous) slot charter and vessel sharing agreements, is higher for bigger firms than for smaller firms. Therefore:

H1 The bigger the firm size, the higher is the propensity to cooperate.

As previously stated, the geographic dimension of cooperative agreements still remains unaddressed by academic literature. Scholars (Ferrari et al., 2008; Parola and Veenstra, 2008; Ducruet et al., 2010) have studied the geographic scope of ocean carrier services, without expanding on the relevance of consortia and alliances within various market dynamics. In this regard, the fierce competition that is now taking place in the key geographic markets and the current unstable macroeconomic trend (Das, 2011) have discouraged shipping lines from pursuing lose-lose competitive games. Therefore, we may assume that:

H2 The bigger the geographic market size (trade lane), the higher is the propensity to cooperate.

Although ocean carriers tend to operate in a few selected trade lanes which represent their ‘core’ business (Ferrari et al., 2008), leading shipping firms work in a wider spectrum of geographic markets (e.g., transpacific, Europe-Far East and transatlantic, etc.), in order to build global customer loyalty (Evangelista and Morvillo, 1999). In this regard, shipping lines selectively choose second-tier markets and niches for differentiating their offers and for reducing competition (and more profits) areas (Frémont and Soppé, 2004). In order to protect their business from the destructive effects of competition, major carriers are often forced to join cooperative agreements in the big and highly competitive markets. Instead, in market niches, major carriers often prefer to play alone (Midoro and Parola, 2011). Therefore:

H3 Leading ocean carriers are more inclined to cooperate in a few selected geographic market areas, which represent their core business.

2.2 ‘Leveraging’ the operated capacity

Another relevant dimension capable of capturing the strategic value in stipulating a wide array of cooperative agreements is given by the notion of ‘leverage’. In liner shipping cooperative agreements allow carriers to increase their commercial capacity by chartering onboard slots in partners’ fleets. Therefore, joint-services produce a ‘leverage effect’, capable of multiplying ship-owners operational capacity. For instance, if a carrier offers a
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Service deploying just three out of nine vessels required to provide a weekly port call, the agreement generates a leveraging effect equal to 3 (i.e., 9 divided by 3). The degree of leverage provides with a reliable measure of the intensity of the cooperation in terms of asset investments and risk sharing. Thus, the degree of leverage indicates how much a carrier relies on the operational capacity of the partners for providing additional services.

To date, the literature has discussed carriers’ attitude to exploit cooperative agreements for leveraging their own capacity (Midoro and Pitto, 2000; Slack et al., 2002; Notteboom, 2004), but most scholars have limited their studies to qualitative discussions. Recently, Panayides and Wiedmer (2011) have proposed an index (‘alliance intensity’ index), which measures the vessels deployed (i.e., operated) by the members of an alliance over the total commercial capacity. Therefore, there are not yet empirical contributions which examine to what extent shipping lines resort to the ‘leverage effect’ in each cooperative agreement. In addition, also the drivers of the leverage still remain unaddressed.

The increasing adoption of cooperative agreements is now a common strategy among top carriers, traditionally rather hostile to cooperation, but currently inclined to consortia in many geographic markets (see H1). The issue of ‘leverage’, however, must be treated differently from the propensity towards cooperation. The latter simply shows the willingness to stipulate agreements without taking into consideration the multiplying effect on the production capacity and the implications on the overall commercial capacity. In this regard, the rather conservative approach traditionally adopted by the leading carriers (often labelled as ‘independent’, Slack et al., 2002; Frémon, 2007) suggests a cautious use of leverage for preserving operational and commercial independence. Therefore, we can expect that:

H4 Larger carriers are less inclined to resort to a higher ‘leverage effect’ when joining cooperative agreements.

Efficiency-driven factors (i.e., factors affecting the amount of required investments and the provision of the maritime transport services) play a central role in the leverage effect (Midoro and Pitto, 2000; Slack et al., 2002). As outlined above, carrier choice to leverage arises from the need to reduce the number of deployed vessels per service (Panayides and Wiedmer, 2011). From this perspective, we can expect a higher leverage effect in those (mostly deep-sea) services that require a higher number of vessels. Therefore:

H5 Carriers tend to increase their ‘leverage’ effect in those maritime services that require a higher number of deployed vessels.

Over the last 20 years the deployment of mega-vessels has imposed dramatic financial burdens to shipping lines (Cullinane and Khanna, 2000; Imai et al., 2006). In recent years, the search for economies of scale has experienced a dramatic acceleration, crossing an important dimensional threshold for vessel size (i.e., 18,000 TEU vessels). The deployment of such mega-vessels potentially represents a critical point in shaping alliance, as just a few top carriers have such large vessels (Frémon, 2007). Therefore, given the limited number of available partners willing to achieve high economies of scale, we suggest that:

H6 Carriers tend to decrease their cooperative ‘leverage effect’ in those maritime services that require the deployment of mega-vessels.
In liner shipping ‘external variables’ (market related factors) are traditionally considered important determinants for strategic decisions of firms (Robinson, 2005; Cariou, 2008; Midoro and Pitto, 2000; Sjostrom, 2010). Some trade lanes, indeed, show very ‘specific’ features, because of their peculiar demand patterns and competitive scenarios (Song and Panayides, 2002). In this regard, as discussed by some scholars (Midoro and Pitto, 2000; Sjostrom, 2010), cooperative agreements are strongly driven by market factors. In particular, in highly competitive geographic markets, shipping lines are expected to experience more intense forms of cooperation, in order to avoid destabilising effects of competition (Das, 2011). Therefore:

H7 The higher the intensity of competition in a trade lane, the higher is the need to implement ‘leverage’ strategies.

Moreover, in stipulating cooperative agreements, the partner selection is commonly considered a critical point for the success or failure of the initiative (Hamel et al., 1989; Saxton, 1997). The number and the intrinsic characteristics of partners not only profoundly affect the managerial and organisational complexity of liner shipping (cooperative) ventures (Midoro and Pitto, 2000; Song and Panayides, 2002), but also the extent of ‘leverage’ for each firm. Reasonably, the availability of a high number of reliable, trustworthy and network-connected partners should motivate carriers to exploit their ‘leverage’ effect more extensively. Therefore:

H8 The higher the number of partners, the higher is the resort to the ‘leverage’ effect.

H9 The higher the degree of connectivity among partners, the higher is the implementation of the ‘leverage’ effect.

Figure 1 Conceptual framework: the determinants of the cooperative leverage

![Conceptual framework: the determinants of the cooperative leverage](image)

In Figure 1, we summarise the six factors that contribute to cooperative leverage. We have linked each dimension to one hypothesis, which is assessed in Section 4.

3 Data and method

3.1 Sampling framework

The hypotheses formulated in the previous section have been empirically tested applying quantitative tools and methods. This study proposes an analysis of 65 ocean carriers based on a dataset that covers over 85% of the global cellular fleet. Data have been extrapolated from the website of Containerisation International and refer to January 2010. The dataset concerns a set of 603 container services. For each liner service we have tracked the fleet capacity (in TEU) deployed by one or more carriers, the service
frequency, the geographic trade lane of operation, the total transit time, the carriers involved in each service line and the type of cooperative agreement (if any) established among carriers. Finally, we calculated the Weekly Container Transport Capacity (WCTC) deployed in each liner service as defined by Frémont and Soppé (2004). Table 1 reports the average value and standard deviation for the data set attributes used in this study.

Table 1  Main data set statistics of the sample 603 container shipping services

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleet capacity deployed [TEU]</td>
<td>11,338</td>
<td>14,638</td>
</tr>
<tr>
<td>Total transit time [Day]</td>
<td>35</td>
<td>22</td>
</tr>
<tr>
<td>Number of carriers</td>
<td>2.4</td>
<td>1.4</td>
</tr>
<tr>
<td>WCTC [TEU]</td>
<td>1,895</td>
<td>1,697</td>
</tr>
</tbody>
</table>

The dataset comprises services managed by a single carrier (205) and services managed with other carriers (398). For each shared service the companies interact with one another with two different kinds of agreements: vessel-sharing and slot-charter agreements.

3.2 Network analysis: the cooperative container network

The Containerisation International dataset allows us to construct the cooperative container network (CCN). In this network each node corresponds to a carrier and the links represent cooperation between carriers. Thus, the CCN is identified by an indirect graph $G (N, L)$ composed of two sets: $N$ is the set of nodes, $N \equiv \{n_1, n_2, \ldots n_m\}$, and $L$ is the set of links, $L \equiv \{l_1, l_2, \ldots l_p\}$ (Figure 2).

3.3 Analytical methodology: network correlation indices and OLS regression model

In this paper the hypotheses are tested by applying widely recognised statistical techniques, i.e., correlation indices (H1–H3) and OLS regression analysis (H4–H9). Addressing H1–H3 the variable degree $k$ (i.e., the number of connections per node in the CCN) and clustering coefficient $C$ (i.e., level of local connectivity) have been calculated in order to measure the willingness to stipulate agreements with third party. Afterwards, in the model developed for evaluating the antecedents of the ‘leverage’ effect (i.e., the dependent variable), we test six independent variables (H4–H9).

3.3.1 Dependent variable

One of the original contributions of this work rests in the introduction of an innovative way to measure the ‘leverage’ effect of cooperative patterns. We construct the dependent variable ‘leverage’ (LEVE) as follows. First, we define:

$COCA_i^j$  commercial capacity supplied by the $i^{th}$ carrier in the $j^{th}$ service

$OPCA_i^j$  capacity operated by the $i^{th}$ carrier in the $j^{th}$ service.

We find that the ‘leverage’ of the $i^{th}$ carrier in the $j^{th}$ service is:
LEVE_i = \frac{COCA_i}{OPCA_i}

where

\[ LEVE_i \geq 1 \]

Finally, we also define the average (\( \mu \)) leverage for the \( i^{th} \) carrier:

\[ LEVE_i(\mu) = \frac{\sum_{j=1}^{N} LEVE_j}{N} \]

### 3.3.2 Independent variables

We operationalise six independent variables in order to scrutinise the determinants of the ‘leverage’ effect (Table 2): ‘firm size’ (FSIZE), ‘number of vessels’ deployed in each service (VESS), achieved level of ‘economies of scale’ (VSIZE), measured as the average vessel size used in each shipping service, the ‘competition intensity’ (COMP) in a specific trade lane, the ‘NPAR’ collaborating in the joint-service, and the ‘partner connectivity’ (PACO).

<table>
<thead>
<tr>
<th>Code</th>
<th>Variable</th>
<th>Operationalisation</th>
<th>Predicted sign</th>
<th>Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSIZE</td>
<td>Firm size</td>
<td>Total operated fleet capacity expressed in thousands of TEU</td>
<td>–</td>
<td>H4</td>
</tr>
<tr>
<td>VESS</td>
<td>Number of vessels</td>
<td>Number of vessels deployed in each service</td>
<td>+</td>
<td>H5</td>
</tr>
<tr>
<td>VSIZE</td>
<td>Economies of scale</td>
<td>Average vessel size deployed in each maritime service expressed in TEUs</td>
<td>–</td>
<td>H6</td>
</tr>
<tr>
<td>COMP</td>
<td>Competition intensity</td>
<td>Number of competing carriers in the selected trade lane</td>
<td>+</td>
<td>H7</td>
</tr>
<tr>
<td>NPAR</td>
<td>Number of partners</td>
<td>Numbers of partners belonging to each joint-service</td>
<td>+</td>
<td>H8</td>
</tr>
<tr>
<td>PACO</td>
<td>Partner connectivity</td>
<td>Average ‘degree K’ of the carriers belonging to a specific joint-service</td>
<td>+</td>
<td>H9</td>
</tr>
</tbody>
</table>

*Source:* Variables have been operationalised utilising data from Containerisation International online.

### 4 Main outcomes

#### 4.1 Complex network analysis in consortium alliances

This section presents the analysis of the CCN by studying its topological structure. Highly connected carriers in the CCN are expected to have a strategic role in acquiring agreements and thus competitive advantage. In order to test H1, we scrutinise the correlation between firm size and inter-firm networking propensity of each carrier.
The node connectivity (i.e., degree $k$) in the CCN discloses a first pattern generated by the mutual agreements between carriers. The degree $k$ ranges between 1 and 31, while the average value is equal to 8.8. Table 3 ranks the ten most connected carriers in the CCN. Four carriers (CMA-CGM, Evergreen, China Shipping Container and Hamburg Sud) are not members of the three major alliances (CKYH Alliance, Grand Alliance and New World Alliance). Figure 2 shows the CCN. Each node represents a carrier while links the level of cooperation among carriers. Colours and nodes’ size are drawn as a function of degree k: the higher the degree k, the bigger the node size and more intense colour.

Furthermore, there is a strong linear correlation between the degree $k$ and FSIZE (coefficient of correlation $\rho = 0.86$). This result allows us to accept H1: larger carriers are more inclined to cooperate, thus the larger the firm size, the higher the propensity to cooperate. However, the two mega-carriers MSC and Maersk Line apply a different industrial strategy. Especially MSC has a large FSIZE but a low level of cooperation and establish itself as independent carrier.
Table 3

<table>
<thead>
<tr>
<th>Rank</th>
<th>Ocean carrier</th>
<th>Degree $k$</th>
<th>% WCTC in cooperation</th>
<th>Total fleet capacity (TEU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hapag-Lloyd AG</td>
<td>31</td>
<td>91.73%</td>
<td>564,916 (8)</td>
</tr>
<tr>
<td>2</td>
<td>CMA CGM SA</td>
<td>29</td>
<td>81.89%</td>
<td>1,041,429 (4)</td>
</tr>
<tr>
<td>3</td>
<td>Mitsui OSK L. Ltd</td>
<td>28</td>
<td>87.74%</td>
<td>369,095 (13)</td>
</tr>
<tr>
<td>4</td>
<td>Cosco Container Ltd</td>
<td>23</td>
<td>63.07%</td>
<td>571,102 (7)</td>
</tr>
<tr>
<td>5</td>
<td>Evergreen L.</td>
<td>22</td>
<td>53.22%</td>
<td>579,735 (5)</td>
</tr>
<tr>
<td>6</td>
<td>China Ship. Cont.</td>
<td>22</td>
<td>92.95%</td>
<td>471,534 (9)</td>
</tr>
<tr>
<td>7</td>
<td>APL Co Pte Ltd</td>
<td>21</td>
<td>73.84%</td>
<td>579,274 (6)</td>
</tr>
<tr>
<td>8</td>
<td>Hanjin Shipping Ltd</td>
<td>21</td>
<td>80.93%</td>
<td>463,952 (10)</td>
</tr>
<tr>
<td>9</td>
<td>Hamburg S. KG</td>
<td>21</td>
<td>83.85%</td>
<td>329,949 (16)</td>
</tr>
<tr>
<td>10</td>
<td>NYK Container L.</td>
<td>20</td>
<td>91.10%</td>
<td>354,629 (14)</td>
</tr>
</tbody>
</table>

In the remaining of this paragraph we report on network measures which scrutinise how carriers tend to locally interlink with their partners. The CCNs average shortest path (2.2) scales as the logarithm of the number of nodes in the network (65). The CCNs average clustering coefficient $<C(i)>$ is equal 0.55, a very high value, which is higher than the case of a random graph with the same number of nodes ($<C_{\text{rand}}(i)> = 0.1$). Moreover, we observe a strong linear correlation between clustering coefficient $C$ and degree $k$ (correlation coefficient $\rho = 0.81$) for each carrier. Thus, carriers with a few cooperative links and smaller fleet capacity tend to link with each other when they do not have relevant agreements with highly cooperative carriers. As degree $k$ increases, carriers tend to establish a dominant position by not allowing other carriers connected with them to cooperate with each other.

Having explored the network structure generated by cooperative agreements among carriers, in the next section we scrutinise the geographic scope of the CCN and the relevant spatial patterns generated by carriers’ cooperation (H2–H3).

4.2 Geographic scope of cooperation in liner shipping

In order to answer H2 and H3, we have classified the 603 container services into 20 major trade lanes that include both transoceanic and interregional lanes. Figure 3 displays the trade lanes as function of their relevance over the global shipping market. In Table A1, we have reported the average degree $k$ of carriers operating in each trade lane and some major statistics. It is interesting to note that the Far East trade area and all Intraregional lanes are operated by carriers with a low level of cooperation. This means that in the intraregional lanes containers are mostly transported by small carriers that are less inclined to cooperate, or have exclusive contracts with large carriers. Trade lanes such as Round the World, Europe – South Asia, Pendulum and Europe – Far East on average are operated by carriers inclined to cooperation (average degree $k > 19$).
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Figure 3  A visualisation of the 20 major trade lanes as function of the WCTC breakdown (see online version for colours)

In order to scrutinise the relation between the geographic market size and the propensity to cooperate (H2), we have calculated the number of services that operate in each trade lane and % of WCTC moved in cooperation (Table A1). There is a strong positive linear correlation between these two features (coefficient of correlation $\rho = 0.80$). Therefore we can accept H2: the bigger the geographic market size (trade lane), the higher the propensity to cooperation.

Table 4  GINI index for the leading carriers in the 20 major trade lanes

<table>
<thead>
<tr>
<th>Rank</th>
<th>Ocean carrier</th>
<th>GINI index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MSC</td>
<td>0.834</td>
</tr>
<tr>
<td>2</td>
<td>Evergreen L.</td>
<td>0.830</td>
</tr>
<tr>
<td>3</td>
<td>NYK Container L.</td>
<td>0.798</td>
</tr>
<tr>
<td>4</td>
<td>Hanjin Shipping Co. Ltd.</td>
<td>0.764</td>
</tr>
<tr>
<td>5</td>
<td>Orient Overseas Container L. Ltd.</td>
<td>0.750</td>
</tr>
<tr>
<td>6</td>
<td>Hamburg S. D-G KG</td>
<td>0.735</td>
</tr>
<tr>
<td>7</td>
<td>China Shipping Container L. Co. Ltd.</td>
<td>0.725</td>
</tr>
<tr>
<td>8</td>
<td>Hapag-Lloyd AG</td>
<td>0.717</td>
</tr>
<tr>
<td>9</td>
<td>Cosco Container L. Ltd.</td>
<td>0.695</td>
</tr>
<tr>
<td>10</td>
<td>APL Co. Pte Ltd.</td>
<td>0.694</td>
</tr>
<tr>
<td>11</td>
<td>Mitsui OSK L. Ltd.</td>
<td>0.678</td>
</tr>
<tr>
<td>12</td>
<td>CMA CGM SA</td>
<td>0.668</td>
</tr>
</tbody>
</table>

Finally, in order to inspect the geographic scope of the leading cooperative carriers (top ten carriers and the two mega-carriers MSC and Maersk), we have calculated the GINI index (Table 4). In Appendix 2, we also show the geographic scope of the leading ocean carriers using radar charts. Leading ocean carriers prefer to cooperate in a few selected...
geographic markets having a GINI index close to 1 (unequal presence concentrated in specific trade lanes). Therefore, H3 is verified: top ocean carriers are more inclined to join forces in a few selected geographic markets, which represent their core business.

These carriers are highly cooperative (except MSC) and almost exclusively cooperate on transoceanic lanes. They prefer to operate and cooperate along transoceanic lanes while small carriers mostly operate in intraregional lanes. Only Evergreen Line and Cosco Container Line have a large cooperation in the Intraregional Asian lane.

4.3 The antecedents of the ‘leverage’ effect

4.3.1 Descriptive statistics

In order to address H4–H9, a linear regression analysis between the independent variables and LEVE(µ) has been performed. The aim is therefore to disclose the main correlations and what factors generate leverage.

Figure 4 LEVE (µ) versus FSIZE for the top 25 surveyed carriers (see online version for colours)

First, Figure 4 provides some descriptive outcomes combining variables LEVE(µ) and FSIZE for the top 25 carriers. On a service basis, the linear correlation between LEVE and FSIZE indicates a weak negative relationship ($\rho = -0.1703$). This is in line with the assumptions of mainstream literature, which postulates that major shipping firms have a scarce willingness to cooperation (Frémont and Soppé, 2004; Ferrari et al., 2008; Cariou, 2008; Panayides and Wiedmer, 2011). Empirical findings (Figure 4) reveal that players’ behaviour is clustered around three groups. The larger group is composed of small and medium-sized carriers (FSIZE < 0.6) that have low cooperation intensity (LEVE < 3.0). The other two groups show a very diverse strategic approach towards cooperation. Maersk, MSC and CMA-CGM, i.e., the largest shipping lines in the world, demonstrate a
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low willingness to join forces with some partners. Conversely, China Shipping Line, Hyundai MM, CSAV and some other carriers reveal a very aggressive propensity to leverage their operational capacity by employing the vessel capacity provided by the other alliance members.

Prior to perform the OLS regression models we estimate the correlations between dependent and independent variables. Table 5 shows the main descriptive statistics, the correlation matrix and unveils substantial variability of the regressors. The finding sunveil a rather weak (positive) correlation between LEVE and VSIZE. The correlation between LEVE and VESS is moderate and positive. Further analysis demonstrates that multicollinearity does not represent a serious concern, as the tolerance and the variance inflation factors (VIF) are within an acceptable range (Belsley et al., 1980; Johnston, 1984).

Table 5  Descriptive statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>LEVE</th>
<th>FSIZE</th>
<th>VESS</th>
<th>VSIZE</th>
<th>COMP</th>
<th>NPAR</th>
<th>PACO</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVE</td>
<td>2.21</td>
<td>2.14</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSIZE</td>
<td>570.75</td>
<td>487.86</td>
<td>−0.170**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VESS</td>
<td>4.82</td>
<td>3.08</td>
<td>0.402*</td>
<td>−0.081</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VSIZE</td>
<td>3,012.73</td>
<td>2,160.88</td>
<td>0.175**</td>
<td>−0.059</td>
<td>0.625*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMP</td>
<td>25.30</td>
<td>10.82</td>
<td>−0.034</td>
<td>−0.345**</td>
<td>−0.126*</td>
<td>−0.019</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPAR</td>
<td>2.40</td>
<td>1.42</td>
<td>0.327**</td>
<td>−0.280**</td>
<td>0.464*</td>
<td>0.518*</td>
<td>0.054</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PACO</td>
<td>17.67</td>
<td>6.23</td>
<td>0.101</td>
<td>−0.063</td>
<td>0.137*</td>
<td>0.234**</td>
<td>−0.002</td>
<td>0.179**</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes: *p-value < 0.01, **p-value < 0.001 (Pearson’s index).

4.3.2 OLS regression analysis

The regression analysis investigates the determinants of the ‘leverage effect’ which is produced through the commercialisation of joint maritime services. The empirical model developed (Table 6) is composed of six independent variables as stated above. The model has the following form:

\[
\text{LEVE} = \beta_0 + \beta_1 \text{FSIZE} + \beta_2 \text{VESS} + \beta_3 \text{VSIZE} + \beta_4 \text{COMP} + \beta_5 \text{NPAR} + \beta_6 \text{PACO} + \varepsilon
\]

The model presents a high global significance (F-statistic = 28.4049, p-value < 0.001). The coefficients \( \beta_1 \) (p-value < 0.05), \( \beta_2 \) (p-value < 0.001), \( \beta_3 \) (p-value < 0.001) and \( \beta_4 \) (p-value < 0.001) as well as the intercept are significant. Conversely, coefficients \( \beta_5 \) and \( \beta_6 \) are not significant.

The coefficient of the variable FSIZE has a negative sign and verifies that large carriers are less inclined to cooperate than medium-size shipping lines. This confirms the assumption of mainstream literature (Cariou, 2008; Panayides and Wiedmer, 2011) which states that players such as Maersk and MSC have a lower cooperative attitude. Therefore, H4 can be accepted.
Table 6  OLS regression analysis output

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Estimate</th>
<th>S.E.</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_0$</td>
<td>0.7863</td>
<td>0.3834</td>
<td>2.0510</td>
<td>0.0407*</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>-0.0004</td>
<td>1.7677E-07</td>
<td>-2.4262</td>
<td>0.0156*</td>
</tr>
<tr>
<td>$\beta_2$</td>
<td>0.2915</td>
<td>0.0333</td>
<td>8.7425</td>
<td>2.3179E-17**</td>
</tr>
<tr>
<td>$\beta_3$</td>
<td>-0.0002</td>
<td>4.94877E-05</td>
<td>-4.2770</td>
<td>2.2064E-05**</td>
</tr>
<tr>
<td>$\beta_4$</td>
<td>-0.0060</td>
<td>0.0077</td>
<td>-0.7699</td>
<td>0.4417</td>
</tr>
<tr>
<td>$\beta_5$</td>
<td>0.3140</td>
<td>0.0681</td>
<td>4.6136</td>
<td>4.8469E-06**</td>
</tr>
<tr>
<td>$\beta_6$</td>
<td>0.0170</td>
<td>0.0128</td>
<td>1.3311</td>
<td>0.1837</td>
</tr>
</tbody>
</table>

Notes: *p-value < 0.05, **p-value < 0.001.
Residual standard error 1.8948 on 596 degrees of freedom.
Multiple R-squared: 0.4716, adjusted R-squared: 0.2145.

Furthermore, the higher the number of VESS the higher the resort to cooperation, thus this confirms H5. This outcome is not in contrast with the previous analysis and reveals a common behaviour of most carriers: the higher the number of (small and medium-sized) vessels required for setting up a new service, the higher the resort to cooperation. The variable VSIZE is negatively signed, which means that the higher is the vessels size (VSIZE), the lower is the propensity to cooperation. Therefore, H6 can be accepted: ocean carriers involved in deep-sea services with big ships are inclined to operate autonomously or to be more selective in looking for a few reliable partners. Moreover, it is worth to remind that just a few carriers have invested in mega-vessels and therefore the partner selection is an absolutely limited choice. Despite the acceptance of H6, however, further investigation is needed on the negative impact of VSIZE on LEVE. The positive (weak) correlation between the two variables with a negative coefficient (VSIZE) in the regression model could be the symptom of a second order relation between the two variables.

Finally, the higher the number of available (and reliable) partners (NPAR) the higher the leverage of cooperation. This finding supports H8 and confirms it. Conversely, no evidences are found about the predicting role of PACO and competition intensity (COMP). Indeed, H7 and H9 are rejected.

5 Discussion and implications for academics and practitioners

Focusing on the cooperative agreements amongst shipping firms, i.e., vessel sharing and slot charter agreements, this study contributes to the literature supplying nine theoretical hypothesis that aim to:

- measure and estimate the extent of the cooperative behaviour through a connectivity index (H1)
- investigate the geographic scope of cooperative agreements (H2–H3)
- scrutinise the intensity of cooperation, introducing the concept of ‘leverage’ of transport capacity, and investigating its main determinants (H4–H9).
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Addressing Hypothesis 1, we have modelled cooperation among carriers as a network. The outcomes revealed a positive correlation between the tendency to cooperate and commercial capacity of each carrier. Quite surprisingly, some players usually referred to as independent – such as CMA CGM, Evergreen Line and China Shipping – show a fairly high interconnectivity. This means that such carriers are inserted in a wide network of agreements, confirming that their strategic approach to cooperation has deeply changed from the past. Conversely, the two mega-carriers, i.e., MSC (in particular) and Maersk Line, apply a different industrial strategy as they record high volumes of container transport capacity but a low extent of cooperation, thus playing as independent carriers.

From the topological point of view carriers with small handled capacity have a few cooperative links with other carriers, and when linked, they are often related in their service operations with carriers sharing similar characteristics. Empirical findings therefore reach interesting implications for the development of the container shipping industry, since outcomes have shown that the economic success of a container carrier is indeed based on cooperation, but when a container carrier increases its handled capacity it tends to achieve low level of cooperation and those mega-carriers can impose their dominant position within the market. This result complements the existing literature on competition in container services (Song and Panayides, 2002; Song, 2003; Sjostrom, 2010). From a geographic viewpoint (H2–H3), carriers involved in trade lanes originating from Far East are more inclined to cooperate while large carriers prefer to operate and cooperate along transoceanic lanes. Only Evergreen Line and Cosco Container Line largely cooperate in the Intra-regional Asian lane (Frémont, 2007; Ferrari et al., 2008).

Finally, the remaining hypotheses (H4–H9) addressed the inclination of carriers to leverage the operated fleet capacity to increase their commercial objectives. In this regard, our analyses revealed that carriers’ behaviour is clustered into three groups. The larger group is composed of small and medium-sized carriers that have low cooperation intensity. The other two groups show a very diverse strategic approach towards cooperation. Maersk, MSC and CMA-CGM demonstrated a low willingness to join forces with some partners, while China Shipping Line, Hyundai MM, CSAV and other players disclosed a very aggressive propensity to leverage their operational capacity through the transport capacity provided by other alliance members’ fleet.

The linear regression analysis unveiled that the higher is the VSIZE the lower is the propensity to cooperation. This confirms that ocean carriers involved in deep-sea services with large vessels are less cooperative, mainly because cooperation is possible only with those carriers that are perceived as direct competitors (i.e., competitors with similar firm size). We demonstrated that the higher the number of vessels deployed (VESS), the higher the resort to cooperation. Thus, the prevalent carriers’ attitude aims to balance a wider network of agreements with a reduced operating risk. Finally, we also confirmed the mainstream literature assumptions which assumes that larger carriers are less inclined to cooperate than medium-size ones.

The empirical results of this paper, indeed, provide some insightful implications for managers and practitioners. First, small and medium carriers aiming at achieving aggressive growth strategies are recommended to secure business agreements with various partners, in order to effectively manage the organizational complexity and the criticalities deriving from the increasing geographic scope and firm size (Midoro and Parola, 2011). This represents a valid and quick alternative, with a low commitment, to an internal growth strategy. Analogously, a strong propensity to establish cooperative
agreement is also suggested if shipping lines want to enter major and highly competitive markets, where a large amount of resources and investment (namely in mega vessels) is required. Besides, carriers are also invited to preserve a certain strategic and operational autonomy in market niches, where there is some room for differentiating the offer and looking for less competitive (and more profitable) segments (Frémont and Soppé, 2004).

Furthermore, in relation to the achievement of a high operational ‘leverage’ in cooperative agreements, large carriers are recommended to adopt a rather conservative approach, for preserving their operational and commercial independency (Slack et al., 2002; Frémont, 2007). Besides, managers should increase the ‘leverage’ effect in those maritime services that require a higher number of deployed vessels, in order to reduce the financial and operational commitment of their companies (Panayides and Wiedmer, 2011). Focusing their activity on those maritime services that require the deployment of mega-vessels (Frémont, 2007), mega-carriers are clearly forced to reduce the ‘leverage’ because of the intrinsic difficulty to find partners that deploy a similar fleet and to maintain a clear distinction with direct competitors. Finally, managers are generally invited to extensively resort to ‘leverage’, if a high number of reliable, trustable and well network-connected partners is available.

6 Limitations and further research avenues

The present paper contributes to the literature with new insights on the reasons for liner companies to cooperate through vessel sharing and slot charter agreements. The research hypothesis have been tested and validated through network indices and regression analysis.

Nevertheless, since the applied research in this field is still in the initial stage (Wilmsmeier and Hoffmann, 2008; Caschili et al., 2011) there is ground for further researches. A possible further step of this research could test the same hypothesis addressing the universe of liner carriers and not only a sample of it (even if extremely representative). Moreover, the temporal dimension could be added to such analyses in order to investigate the effect of cooperation agreements over time. A temporal comparison could allow us to study the extent of cooperation with economic cycles in international trades and/or with the evolution of the liner shipping industry.

We have pointed out that Asian carriers have a higher tendency to cooperate than the other carriers. Future studies should investigate the reasons for such behaviour. In this study we have found no evidences about the factors that predict PACO and COMP. Thus, a deeper investigation related to partners’ availability and networking as well as market attractiveness and COMP id definitely needed.

To conclude, this paper contributes to the literature demonstrating that the adoption of networks toolbox can usefully contribute to a better understanding of cooperative behaviours of shipping liners; results achieved by the present manuscript represent a starting point for further research in this field.
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References


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Notes

1 From now on all variables are reported without subscripts for ease of reading.
Appendix 1

Table A1  Major trade lanes: descriptive statistics

<table>
<thead>
<tr>
<th>Trade lane</th>
<th>No. of services</th>
<th>% WCTC</th>
<th>Top 25 carriers</th>
<th>Overall sample</th>
<th>Average degree k</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transpacific</td>
<td>76</td>
<td>21.71%</td>
<td>21</td>
<td>29</td>
<td>20.3</td>
</tr>
<tr>
<td>Europe-Far East</td>
<td>54</td>
<td>19.44%</td>
<td>21</td>
<td>23</td>
<td>20.6</td>
</tr>
<tr>
<td>Intraregional Asia</td>
<td>146</td>
<td>15.91%</td>
<td>20</td>
<td>39</td>
<td>16.3</td>
</tr>
<tr>
<td>Far East-South Asia</td>
<td>41</td>
<td>8.26%</td>
<td>17</td>
<td>32</td>
<td>17.0</td>
</tr>
<tr>
<td>Transatlantic</td>
<td>69</td>
<td>8.19%</td>
<td>16</td>
<td>28</td>
<td>17.4</td>
</tr>
<tr>
<td>Intraregional Europe</td>
<td>39</td>
<td>4.13%</td>
<td>8</td>
<td>9</td>
<td>17.6</td>
</tr>
<tr>
<td>Pendulum</td>
<td>19</td>
<td>3.62%</td>
<td>14</td>
<td>20</td>
<td>19.0</td>
</tr>
<tr>
<td>Far East-Pacific</td>
<td>25</td>
<td>3.02%</td>
<td>13</td>
<td>23</td>
<td>18.5</td>
</tr>
<tr>
<td>Europe-Africa</td>
<td>25</td>
<td>2.57%</td>
<td>8</td>
<td>12</td>
<td>13.6</td>
</tr>
<tr>
<td>Far East-Africa</td>
<td>23</td>
<td>2.50%</td>
<td>14</td>
<td>20</td>
<td>16.9</td>
</tr>
<tr>
<td>Round the world</td>
<td>12</td>
<td>2.21%</td>
<td>9</td>
<td>16</td>
<td>19.5</td>
</tr>
<tr>
<td>North America-Latin Amer.</td>
<td>16</td>
<td>1.88%</td>
<td>9</td>
<td>13</td>
<td>20.2</td>
</tr>
<tr>
<td>Europe-South Asia</td>
<td>4</td>
<td>1.29%</td>
<td>4</td>
<td>5</td>
<td>17.0</td>
</tr>
<tr>
<td>Intraregional South Asia</td>
<td>10</td>
<td>1.28%</td>
<td>5</td>
<td>5</td>
<td>17.4</td>
</tr>
<tr>
<td>South Asia-Africa</td>
<td>8</td>
<td>0.98%</td>
<td>6</td>
<td>7</td>
<td>14.1</td>
</tr>
<tr>
<td>Intraregional North Amer.</td>
<td>12</td>
<td>0.92%</td>
<td>9</td>
<td>11</td>
<td>19.4</td>
</tr>
<tr>
<td>Intraregional Africa</td>
<td>9</td>
<td>0.64%</td>
<td>4</td>
<td>7</td>
<td>11.2</td>
</tr>
<tr>
<td>Intraregional Latin Amer.</td>
<td>8</td>
<td>0.56%</td>
<td>4</td>
<td>7</td>
<td>14.6</td>
</tr>
<tr>
<td>Europe-Pacific</td>
<td>3</td>
<td>0.30%</td>
<td>2</td>
<td>5</td>
<td>21.7</td>
</tr>
<tr>
<td>Intraregional Australasia</td>
<td>3</td>
<td>0.25%</td>
<td>2</td>
<td>4</td>
<td>13.3</td>
</tr>
</tbody>
</table>

Source: Authors’ elaboration
Figure A1  Level of cooperation (degree $k$) of the most cooperative carriers (Table 3) in the 20 trade lanes (see online version for colours)

Note: The radar diagrams are also plotted for the two ‘independent’ mega-carriers Maersk and MSC.