Maritime Economics & Logistics (2020) 22:446–472
https://doi.org/10.1057/s41278-019-00118-6

ORIGINAL ARTICLE

Merger waves and alliance stability in container shipping

Daniele Crotti[1] · Claudio Ferrari[2] · Alessio Tei[3]

Published online: 22 February 2019

Abstract

Recently, the container shipping industry has been witnessing a wave of new mergers and reshuffling of cooperation agreements (alliances), which have heavily affected the market. This development has also taken place among vertically integrated carriers, thus affecting not just the shipping side of the business, but the different supply chains as well. By using non-cooperative merger control games, featuring carriers involved in strategic alliances and competition authorities, this paper analyses the impact of the vertical integration of carriers and terminal operators on the stability of alliances. Starting from a benchmark set-up where carriers and stevedores are separated, we first find that when the integration concerns merging carriers only, alliance stability is undermined because non-merging allied carriers are more likely to register losses due to market share reductions and possibly higher terminal tariffs. However, by assuming that alliance agreements are extended to terminal operations, for all the allied partners, we show that alliances might be more stable, since non-merging carriers are vertically integrated as well and can internalize terminal charges. Given the on-going trends of consolidations in container shipping, this last hypothesis implies that merger waves might still occur without the breaking down of alliances, as long as landside cooperation among carriers along the supply chain, is also considered.

Keywords Container shipping · Vertical integration · Strategic alliances · Endogenous mergers · Merger control

✉ Claudio Ferrari
claudio.ferrari@economia.unige.it

1 Department of Economics, Insubria University, Via Monte Generoso 71, 21100 Varese, Italy

2 Department of Economics, University of Genoa, Via Vivaldi 5, 16126 Genoa, Italy

3 School of Engineering, Newcastle University, Queen Victoria Road, Newcastle upon Tyne NE17RU, UK

1 Introduction

Since the 1990s, ocean carriers have largely resorted to strategic alliances to exploit global demand opportunities and achieve joint efficiencies at sea (Notteboom et al. 2017; Caschili et al. 2014; Slack et al. 2002). Quartieri (2017) pointed out that "*the formation and enlargement of these consortia do not alter the average variable cost of a carrier but spread it over all the members yielding a decrease in each carrier's marginal cost*", ultimately positively impacting on the possibility to compete in the market. Thus, this form of horizontal cooperation entails benefits in terms of cost savings and wider network organization, but implies challenges as well. Mainly designed to take advantage of vessel sharing arrangements, strategic alliances do not include price fixing, joint sales or sharing of profits (Panayides and Wiedmer 2011). Therefore, the stability of alliances relies upon an efficient design of agreements that motivate carriers to cooperate (Song and Panayides 2002; Midoro and Pitto 2000).

From the carriers' perspective, on the one hand, allied partners maximize own profits and impose rather strict agreements among themselves to rationalize vessel sharing and organize port calls (Bergantino and Veenstra 2002; Notteboom and Winkelmans 2001; Heaver et al. 2000). On the other hand, liner networks can be successful only if economies of scale achieved at sea are not negated by diseconomies of scale in ports, as lucidly shown in Haralambides (2019) (see also OECD 2015; Benacchio et al. 2007; Wilmsmeier et al. 2006). As a result, since the late 1990s, vertical agreements involving carriers and terminal operators started to be signed, to better compete with other allied and not-allied carriers (Parola et al. 2015; Álvarez-SanJaime et al. 2013; Ferrari et al. 2008; Notteboom 2004). Moreover, the emergence of *dedicated* container terminals has allowed allied carriers to internalize negative externalities due to double marginalisation (Van de Voorde and Vanelslander 2009; Haralambides et al. 2002).

Undoubtedly, the industry setting has been strongly affected by both the consequences of post-crisis demand shocks and the persistent over-supply of carrying capacity shown in recent years.

1.1 Consequences of M&As

Another interesting element is related to the influence of competition authorities on shipping strategy. Thus, it is possible to highlight the link between mergers and alliances also from a normative perspective. Specifically, alliance (in)stability could improve by industry-specific features (e.g. overcapacity, cascading effects) shown by main merger control reviews.

From a normative point of view, recent merger cases reviewed by the Competition Directorate of the European Commission (from now on, CD) suggest that the occurrence of mergers among carriers belonging to different alliances could result in market outcomes that are detrimental to consumer welfare (EU Commission 2004, Sect. IV, art. 39 and ss.). Beyond potential efficiency gains obtained by integrating assets, horizontal mergers reduce the number of competitors and favor the collective decision-making by carriers. Since these features tend to raise post-merger freight rates, consolidation is considered anticompetitive, whenever merger-specific efficiencies are not large enough to offset upward prices. Following current EU and US merger policy, however, merger proposals are subjected to structural remedies (e.g., assets divestiture) to make projects compatible with competition policy goals whenever prospective efficiencies are relatively low (EU Commission 2008; FTC 2012). Whereas in other transportation sectors (e.g., airline industry) merger proposals are cleared conditional to the reallocation of assets, such as plants, brands, capacity, etc., strategic alliances in container shipping have necessitated a different approach. Specifically, as the anticompetitive effects of inter-alliance mergers are very likely to spread over all the involved alliances, and to further reduce competition, in recent merger cases the EU CD revealed a clear-cut approach: merger proposals are approved subject to conditions in the form of the withdrawal of one merging party from own consortium or alliance (see, among others, EU Commission decisions in 2016a, Case CMA CGM/NOL—M.7908 and 2017, Case Maersk/Hamburg Süd—M. 8330).

Aiming at avoiding links between previously unconnected carriers that are likely to increase freight rates, however, we argue that the above merger control policy may have contributed to a most noticeable shake up of existing alliances for the following reason. Whenever acquiring carriers undertake mergers with target assets from other alliances, the latter alliances may end up lacking the capacity that would allow them to effectively compete, thus causing further alliance reshuffling (Notteboom 2016). To briefly illustrate this point: Following CMA CGM's proposal to take over Neptune Orient Lines (NOL), the merger was cleared (April 2016) by the EU CD subject to commitments resulting in the exit of NOL from the G6 Alliance (European Commission 2016a—Case M.7908). Overall, this decision weakened G6, reducing its deployed capacity from 3520 to 3100 million TEUs. This influenced Hapag-Lloyd's (also in G6) competitive behavior, who shortly thereafter submitted a merger proposal with UASC (O3), approved in November 2016 subject to the withdrawal of UASC from the NEU1/O3 (Ex-Pendulum) consortium (EU Commission 2016b—Case M.8120). Soon after, Maersk (2M alliance with MSC) decided to acquire Hamburg Süd; the merger was cleared in April 2017 conditional upon the exit of the target from five consortia (EU Commission 2017a—Case M.8330). The bankruptcy of Hanjin, in the late summer of 2016, further enticed such agreements, all making container shipping even more concentrated. In addition, the three Japanese shipping "giants", NYK, MOL and K Line, concluded a joint venture (called ONE, Ocean Network Express), approved by the EU CD in June 2017 (EU Commission 2017b—Case M.8472), after rejection by other regulators (U.S. Federal Maritime Commission; South Africa's CompCom SA). Lastly, in December 2017, the approved takeover of Hong Kong's OOCL by Cosco reduced the number of the newly born Ocean Alliance members (EU Commission 2017c—Case M.8594). In all such cases, a rather clear pattern emerged: target companies left their own alliance and/or consortia. This probably increased the incentive of remaining carriers to seek new alliances or merging partners. As a result of this wave of mergers, the past four alliances were reduced to three (OCEAN, THE, 2M), encompassing mostly the same main players. Concentration on East–West trade routes increased further as a result.

In times of consolidation that are not bound to fade, how could we foresee the impact of potential waves of inter-alliance mergers on existing alliances? Under the main hypothesis that strategic alliances may be affected by the merger control review of previous consolidations, the aim of our paper is to analyze the conditions under which vessel sharing agreements are likely to survive after sequential mergers. In some cases, approved inter-alliance mergers are more likely to induce individual carriers to exit the alliance, providing these companies with larger incentives to seek further consolidation in the short run. As a result, decisions made by competition authorities could favor alliance reshuffling. To take into account different scenarios in the current container shipping industry, our analysis will cover cases where: (i) acquiring carriers and terminal operators are not integrated (vertical separation); (ii) acquiring carriers and terminal operators are vertically integrated, but allied partners must pay charges for terminal services (partial vertical integration); and, finally, (iii) acquiring carriers and terminal operators are vertically integrated and also allied partners benefit from terminal operations without paying any charges (full vertical integration).

The paper is organized as follows. In Sect. 2, a literature review is presented to describe the adopted game-theoretical methodology. In Sect. 3, we describe the model set-up in which carriers—which compete among each other in terms of quantity of TEUs carried and have the possibility to join strategic alliances—enter a sequential merger formation game, where a consumer-oriented CD is called to review merger proposals. Assumptions about the vertical integration of carriers and terminal operators give different results discussed in Sect. 4. Section 5 discusses the results of the analysis and Sect. 6 concludes the paper, providing industry-related implications.

2 Literature review

Selected studies about the evolution of strategic alliances from the 1990s onwards have been carried out, offering us different perspectives on the features and drivers of their formation. As regards horizontal cooperation, Ryoo and Thanopoulou (1999) studied the progression of agreements in Asian markets from consortia to alliances, starting from the late 1990s, and noticed how the global nature of alliances, along with a certain flexibility in alliance agreements, offered incentives for their formation, aiming at achieving economies of scale at sea. This result was also empirically stated by Evangelista and Morvillo (2000) who surveyed 341 alliances from 1990 to 1998, finding that most of them (86%) were active in the sea leg of the supply chain, rather than in inland logistics services. In terms of market-oriented drivers, Slack et al. (2002) supported the claim that—at least in the early stages—alliances might lead to higher service frequency and the possibility for alliance members to cover a higher number of ports. This strategic advantage changed over the years, with alliances often used as a means to rationalize the supplied capacity, as well as the scheduling of services, rather than expanding the offer shipping services. Concerning this latter issue, Panayides and Wiedmer (2011) studied the evolution of alliances by comparing their operational performance in several geographical areas and carrier specific aspects (e.g. capacity, routing, vessels). Their work confirmed that container shipping was indeed affected by alliances in the early stages of the recent economic downturn, from (late) 2008 to 2010, especially in terms of market-coverage, i.e. of carriers withdrawing tonnage so as to reduce costs and service characteristics. From the end of 2008, most of the abovementioned adjustments pushed alliances to modify their service structures, as a huge amount of capacity was shifted from services between Europe and Asia to emerging markets.

Relatively scarce attention has been given to the relationship between alliances and mergers in container shipping. From an empirical perspective, Alix et al. (1999) have shown how capacity can be expanded very quickly through merger actions, and this strategy could be quite effective in reacting to demand shocks, promoting mergers with rivals coming from other alliances. In a similar fashion, Das (2011) found that when the intensity of competition among carriers increases, mostly during market recessions, they are more likely to opt for mergers rather than alliances, suggesting that consolidations could be considered as a step forward of alliances in terms of market control.

Regarding to the emergence of vertical cooperation in door-to-door services along the supply chain, various authors have discussed the different levels of integration of carriers with key ports and local or global terminal operators, so as to achieve cost savings and efficient handling at container terminals. This literature has shown that carriers have become similar in terms of service routes and ship sizes, but also in strategic behavior, including efforts to vertical integration with terminal operators. Ferrari et al. (2008) showed that servicing home markets affects mega-vessel deployments in specific trade lanes, with increasing vertical links between terminal operators both in Europe and Asia (Cariou 2008). More recently, Parola et al. (2014) analyzed carriers' involvement in terminal operations through a variety of investments, starting from 2010, identifying alliances, among other types of *hidden families*, behind the choice of ports of call. As generalized by Notteboom et al. (2017), this result also tells us something about the relevant role of alliances as oligopolistic players in modern container shipping. Increasingly acting as single entities, alliances may have an impact on market conditions (i.e., freight rates, port calls, handling charges), even when the carriers are not vertically integrated.

From a methodological perspective, the analysis of strategic alliances in container shipping draws widely from game theory. Indeed, alliance members can be considered players using binding agreements to optimize collective payoffs. As cooperative games are suitable to model slot exchanges and vessel sharing (cf. Yang et al. 2011; Agarwal and Ergun 2010; Ding and Liang 2005), Shi and Voss (2011) provided a survey revealing researchers' strong inclination towards these types of games, in an effort to study the conditions under which alliances might be reshaped. Turning to non-cooperative games used to model oligopolistic shipping markets (Álvarez-SanJaime et al., 2013; Lee and Choo 2012; Boile and Theofanis 2012), liner companies are typically assumed to compete on the quantity of supplied slots, either with allied or not-allied similar firms, to maximize individual profit. In these cases, Cournot-Nash equilibria are derived, where capacity and marginal costs at sea are variables determining market outcomes (Aymelek and Turan 2016; Wang and Xiaoning 2014). In spite of its attempt to model competition in container shipping, however, this literature has so far neglected the analysis of horizontal mergers, as a primary way to cut costs and exert market power. More importantly, the emergence of carrier consolidation has not yet been investigated, to understand the interplay between existing alliances and post-merger market outcomes. Thus, should carriers belonging to an alliance pursue merger projects with other alliance members in sequential rounds? Under what conditions merger waves could be sustained in the short run without inducing alliance reshuffling or breakdown? What is the role of *merger control rules* of competition authorities (i.e., withdrawal of target carriers from own alliances) on existing alliances? And, finally, whenever carriers are directly involved in terminal operations, how could one incorporate landside operators in the analysis?

In order to investigate this interplay between horizontal mergers and strategic alliances in container shipping, we apply a game-theoretical framework, which includes players who have the opportunity to submit merger proposals in multiple rounds, that is, allowing for the concentration of different companies over time. In Cournot settings, this assumption implies that the carrying capacity supplied by players might be rationalized, with the possibility of generating market distortions (e.g. price control, anti-competitive effects). Therefore, whenever mergers occur sequentially, they would represent a so-called merger wave, with potential strong impacts on market structure. Evidently, this approach properly fits the recent wave of consolidations in container shipping, where carriers belonging to different alliances merged in response to previous takeovers (e.g., in late 2016, the merger between Hapag-Lloyd and UASC clearly came after the takeover of NOL by CMA CGM).

But how could the welfare effects of horizontal mergers in container shipping, and related behavior of competition authorities, be studied on the basis of the extant literature? Early works assumed mergers as exogenous (or partially endogenous) and welfare outcomes were discussed by simply comparing pre- and post-merger quantities/prices. Gowrisankaran (1999) studied mergers occurring sequentially, but his analysis ruled out strategic interaction between mergers. Faulì-Oller (2000) provided a game-theoretical framework but his merger games were not completely endogenous. Finally, in Horn and Persson (2001), the merger process is treated as a (static) cooperative game of coalition formation, where the players are free to communicate and write binding agreements. From a normative perspective, in fact, a more "dynamic" analysis of market outcomes, resulting after possible merger waves (especially in terms of effects on consumer welfare), strongly depends on how mergers interact with each other, but also on what variables may stimulate sequential consolidations. According to a more recent literature on the normative outcomes of merger control reviews in Cournot markets, we here argue that merger waves are likely to occur due to either large prospective efficiencies (by integrating assets) or market conditions. In the first case, efficiency gains allow merging carriers belonging to different alliances to further rationalize costs, increase their supply and thus reduce post-merger freight rates (assuming that markets are sufficiently competitive). Clearly, this effect might make a merger proposal more likely to be approved by competition authorities, as consumers/shippers are expected to be better off. In the second case (market conditions) and in the presence of tonnage overcapacity, merging parties could benefit from rationalizing their supply: a more balanced supply can imply lower marginal costs and can impact on marginal revenues as well. Still, post-merger rates tend to be lower and consolidations are more likely to be cleared (Qiu and Zhou 2007). But is it true that approved mergers would favor more mergers among carriers in the short run? By focusing attention on forward-looking, consumer-oriented, competition authorities, to assess the emergence of merger waves in Cournot markets Motta and Vasconcelos (2005) showed that merger waves could be effectively stimulated by competition authorities. In a later study, Vasconcelos (2010) targeted the conditions under which sequential mergers are sustainable. The author concluded that, in cases where firms compete on quantity, whenever starting mergers are cleared thanks to large cost savings or negative demand conditions (excess capacity), this decision conduces to follow-up consolidations.

Although these results suggest that self-reinforcing merger waves may be sustained also in container shipping, nothing is so far said about markets where, before merger rounds occur, firms are already engaged in binding agreements (alliances). In such cases, on the one hand, carriers belonging to an alliance have the incentives to merge with members of different alliances to further save on costs and cover wider shipping markets, but, on the other hand, mergers tend to increase within-alliance asymmetries. In other words, merging carriers raise their respective capacity above that of individual allied partners, which may as a result suffer from financial and/or competitive distress. To account for this feature in container shipping, we attempt to enrich the standard merger control modelling by considering two industry-specific aspects. First, following evidence from real-life reviews, we allow for a CD imposing the withdrawal of merging carriers from their own alliance. As said above, this approach seems different from other similar industries (e.g., airlines) where structural remedies are more in use. Second, with the aim to consider the integration of carriers and terminal operators as a thriving trend in the industry, we investigate how vertical relationships in container shipping might affect post-wave market structure.

3 A model of merger waves in container shipping

3.1 The basic set-up

Consider a container shipping market where carriers are involved in strategic alliances. We assume two symmetric alliances, North and South, composed of three partners each, where $i=\{1, 2, 3\}$ and $j=\{4, 5, 6\}$, respectively. By ruling out differences between eastbound and westbound shipping demand, ocean carriers operating on a given East–West route with the following inverse linear demand are considered:

$$f(q_i, q_j) = V/K - \sum_{i=1}^{3} q_i - \sum_{j=4}^{6} q_j \tag{1}$$

where f is the freight rate; q_i and q_j represent the number of TEUs moved by the carriers belonging to the North and South Alliance, respectively; K indicates the total carrying capacity (i.e. slots) that carriers deployed during the year while V is the demand for shipping services that could be satisfied by the deployed capacity. In perfectly competitive markets, V would be equal to the sum of q_i and $q_{j.}$ In the inverse demand function, the composite parameter V/K thus represents the level of industry overcapacity. Given a certain market demand V, if the total capacity K is larger than V, industry overcapacity occurs as well (the ratio shrinks) because the reservation price (willingness to pay) of shippers diminishes. Hence, by positing that K is greater than V we assume a chronic overcapacity in container shipping. For simplicity, in our model, individual carriers are endowed with pre-merger exogenous capacity $k_i = k_j = K/6$. However, since what distinguishes carriers is the amount of post-merger capacity they end up with, we assume that each carrier operates with marginal costs at sea which are downward affected by both individual and alliance-based capacity endowment:

$$C_i(k_i, t_\mathrm{N}) = \left[\left(\frac{K - k_\mathrm{N}}{k_i}\right)g + t_\mathrm{N}\right]q_i \tag{2}$$

$$C_j(k_j, t_\mathrm{S}) = \left[\left(\frac{K - k_\mathrm{S}}{k_j}\right)g + t_\mathrm{S}\right]q_j \tag{3}$$

where C_i and C_j are the total cost functions of the North and South alliance members, respectively; k_N and k_S represent the overall alliances' capacity endowment (TEUs); the parameter g measures (exogenous) cargo-related costs at sea[1]; and t_N and t_S represent the unit terminal handling charges (THCs) paid by the North and South members at port. As the way in which costs are modelled is relevant, some remarks are necessary at this point. Specifically, the formulation in [2, 3] does capture three distinctive features of the container shipping industry. First, our assumption of exogenous overall capacity means that whenever the total capacity of one alliance increases, that of the second declines. In other words, the more capacity-wise an alliance is, the stronger are its related joint economies of scale with respect to other alliances. Since vessel sharing agreements allow alliance members to optimize a larger capacity and reduce operational costs, in our model the alliance-based synergies generated by the aggregation of capacity are assumed to combine in order to determine each carrier's marginal costs at sea. Second, in cases of horizontal concentrations, merging carriers are assumed to achieve merger-specific cost savings by integrating production assets (Motta and Vasconcelos 2005; Perry and Porter 1985). Since asset-based mergers bring the capacity of involved carriers into a larger liner company, further efficiencies arise. However, both merging and non-merging carriers' marginal costs at sea are affected. To illustrate, let us consider the two types of mergers pertinent to our analysis. If only one merger is finalized between two carriers (say, 1 and 5), drawn from North and South, such a merger would make industry

[1] Including expenses such as stuffing, stripping, measuring, tallying, cargo inspection, custom examination, documentation, etc.

capacity biased towards the alliance that would host the merged carriers. Whenever a carrier leaves its alliance to join that of its merging partner (e.g., by merging with 1, carrier 5 will join the North Alliance), the capacity of the first alliance shrinks (i.e., k_S shifts downward to $K/3$, while k_N goes up to 2 $K/3$). If, instead, two mergers occur (i.e., after the initial merger, also carriers 4 and 2 *react* by merging together), then the capacity structure of the industry will return to its symmetrical set-up.[2] Third, the last component of carriers' marginal costs is terminal-based (reflecting the vertical link between carriers and terminal operators), represented by terminal charges required to handle cargo containers.

3.2 Pre-merger equilibrium

In terms of shipping network structure, all the North (South) Alliance members are assumed to call at port N (S). Typically, competition between hubs within the same region (e.g., Algeciras competes with Port Said East in Southern Europe) suggests that *individual* carriers' demand for transshipment is rather elastic. Indeed, the related *alliance-based* demand tends to be inelastic as allied carriers consolidate cargoes at the same terminal to exploit *hub-and-spoke* techniques and lower shipping costs (Parola et al. 2014; Wiegmans et al. 2008). For instance, along the Europe-Far East route, CKYHE (via Cosco) transships at Piraeus, whereas 2M (via Maersk) does it at Algeciras.

According to the pre-merger structure described above, at each transshipment hub carriers and terminal operators are involved in a non-cooperative two-stage market game. As in the present benchmark setting terminal handling charges (THC) are set independently by terminal operators in the first stage of the game, we assume that terminal operators set THCs t_N and t_S to maximize profit.[3] In the second stage of the game, given the optimal THCs previously established, carriers maximize own profits by choosing the quantity of TEUs to be carried.

From a game-theory perspective, dealing with non-cooperative sequential games implies that we look for symmetric sub-game perfect Nash equilibria (SPNE) in pure strategies, in its turn meaning that, at each stage of the pre-merger game, carriers and terminal operators simultaneously make decisions to maximize their own payoffs (Fudenberg and Tirole 1991). Before deriving the pre-merger equilibrium in case of vertical separation (labelled with s), we make the following assumption to ensure positive TEUs supplied by each carrier.

Assumption Industry overcapacity is sufficiently small with respect to marginal costs at sea, i.e., $V/K > 3$ g.

By applying the *backward induction procedure*, we first derive carriers' decisions about the quantity of TEUs in the second stage of the market game. Given the

[2] A more general model should also consider cases in which merging carriers are endowed with asymmetrical capacity. However, this assumption would complicate the mathematical tractability of the model without changing its outcomes. As mergers often occur involving both large companies and major/minor ones, a "defensive" merger would try to obtain a similar aggregate capacity.

[3] For simplicity and without loss of generality, port costs are set to zero.

terminal charges t_{N}^{s} and t_{S}^{s}, set by operators in the first stage, the North and South Alliance partners choose q_i^s and q_j^s, respectively, by solving the following problems:

$$\max_{q_i^s}\left\{\pi_i^s=\left(V/K-q_i^s-\sum_{h\neq i}^{3}q_h^s-\sum_{j=4}^{6}q_j^s-3g-t_{\mathrm{N}}^{s}\right)q_i^s\right\} \tag{4}$$

$$\max_{q_j^s}\left\{\pi_j^s=\left(V/K-q_j^s-\sum_{i=1}^{3}q_i^s-\sum_{l\neq j}^{6}q_l^s-3g-t_{\mathrm{S}}^{s}\right)q_j^s\right\} \tag{5}$$

Solving the related second-stage first order conditions ($\partial\pi_i^s/\partial q_i^s=0$ and $\partial\pi_j^s/\partial q_j^s=0$, for every i and j), the individual carriers' equilibrium TEUs (as function of terminal charges) are derived by:

$$q_1^s\left(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s}\right)=q_2^s\left(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s}\right)=q_3^s\left(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s}\right)=\frac{1}{7}\left(V/K-3g-4t_{\mathrm{N}}^{s}+3t_{\mathrm{S}}^{s}\right) \tag{6}$$

$$q_4^s\left(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s}\right)=q_5^s\left(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s}\right)=q_6^s\left(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s}\right)=\frac{1}{7}\left(V/K-3g-4t_{\mathrm{S}}^{s}+3t_{\mathrm{N}}^{s}\right) \tag{7}$$

By comparing [6, 7] and taking carriers 1 and 4 as alliance representatives, we note that THCs have a clear-cut effect on carriers' equilibrium decisions (in terms of TEUs), as:

$$\frac{\partial q_1^s(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s})}{\partial t_{\mathrm{N}}^{s}}=\frac{\partial q_4^s(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s})}{\partial t_{\mathrm{S}}^{s}}<0\quad \frac{\partial q_1^s(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s})}{\partial t_{\mathrm{S}}^{s}}=\frac{\partial q_4^s(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s})}{\partial t_{\mathrm{N}}^{s}}>0 \tag{8}$$

Whereas increasing tariffs at terminal N (S) will reduce the TEUs supplied by North (South) Alliance's carriers, in turn, the output set by the carriers of the rival alliance increases. This effect suggests that the vertical separation of carriers and terminal operators tends to reduce carriers' supply (i.e., marginal revenues are lower).

Turning to the first stage of the market game, terminal operators at transshipment hubs N and S set tariffs by maximizing own profit function as follows:

$$\max_{t_{\mathrm{N}}^{s}}\left\{\pi_{\mathrm{N}}^{s}=t_{\mathrm{N}}^{s}\left[q_1^s(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s})+q_2^s(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s})+q_3^s(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s})\right]\right\} \tag{9}$$

$$\max_{t_{\mathrm{S}}^{s}}\left\{\pi_{\mathrm{S}}^{s}=t_{\mathrm{S}}^{s}\left[q_4^s(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s})+q_5^s(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s})+q_6^s(t_{\mathrm{N}}^{s},t_{\mathrm{S}}^{s})\right]\right\} \tag{10}$$

The first-stage best response functions ($\partial\pi_{\mathrm{N}}^{s}/\partial t_{\mathrm{N}}^{s}=0$ and $\partial\pi_{\mathrm{S}}^{s}/\partial t_{\mathrm{S}}^{s}=0$) imply that increasing rival's terminal charges would make own tariffs rise as well:

$$t_{\mathrm{N}}^{s}(t_{\mathrm{S}}^{s})=\frac{1}{8}\left(V/K-3g+3t_{\mathrm{S}}^{s}\right)\quad t_{\mathrm{S}}^{s}\left(t_{\mathrm{N}}^{s}\right)=\frac{1}{8}\left(V/K-3g+3t_{\mathrm{N}}^{s}\right) \tag{11}$$

By solving the system in [11], we get the equilibrium THCs in the pre-merger benchmark scenario:

$$t_{\mathrm{N}}^{s} = t_{\mathrm{S}}^{s} = \frac{1}{5}(4 - 3g) \tag{12}$$

Finally, by inserting [12] in [1], [6], [7] and [11], we can state that:

Proposition 1 (Pre-merger equilibrium with vertical separation). *In cases of vertical separation of carriers and terminal operators, either the industry overcapacity or marginal costs at sea reduce allied carriers' supply and profits. At equilibrium, the quantity of TEUs by individual carriers; freight rates; and carriers' profits are derived as follows:*

$$q_1^s = q_2^s = \ldots = q_6^s = \frac{4}{35}(V/K - 3g) \tag{13}$$

$$f_s = \frac{1}{35}(11V/K + 72g) \tag{14}$$

$$\pi_1^s = \pi_2^s = \ldots = \pi_6^s = \frac{16}{1225}(V/K - 3g)^2 \tag{15}$$

3.3 Merger formation game

In this subsection, merger waves among carriers and their relationship with strategic alliances are modelled. The sequential non-cooperative merger formation game firstly assumes two rounds of merger proposals (to allow for potential merger waves). Secondly, as target carriers involved in a merger proposal typically leave their own alliance, in the case of a merger between carriers 1 and 5, the latter would join the North Alliance, whereas in the case of a merger between carriers 4 and 2, the South Alliance would eventually include carrier 2. Finally, only merger proposals preserving current alliances are assumed feasible. There are two reasons for this hypothesis. First, it would be easier to compare conditions under which single mergers or merger waves could occur. Then, in this way, we can assess the alliance stability by contrasting post-merger market structures, where alliances can be reshaped (but not break down) due to individual carriers exiting the market.

Before the two-stage market competition, described in Sect. 3.2, can take place, the carriers belonging to a certain alliance play a four-stage merger game with CD, involving the following sequence of actions (depicted also in the Fig. 1):

- In the first stage, North Alliance's carrier 1 can merge with South Alliance's carrier 5. If no mergers are proposed, the benchmark competition (labelled with M_0 in Table 1) occurs;

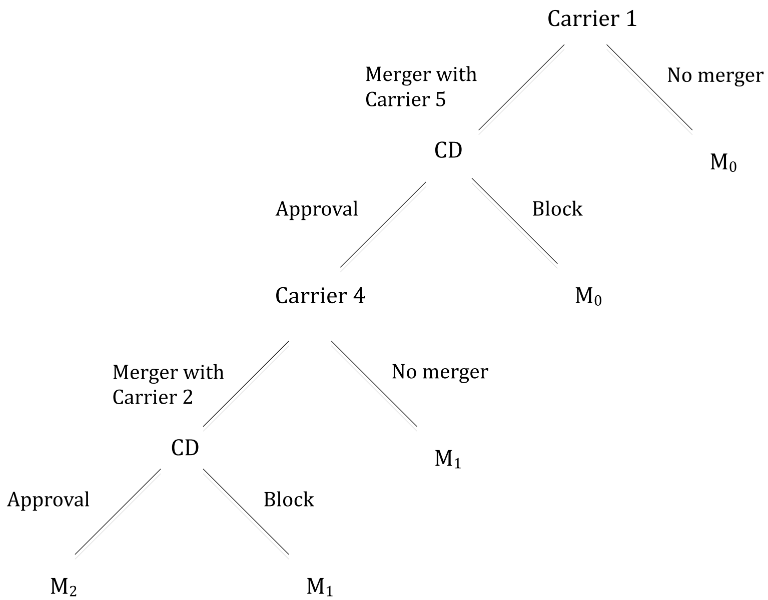

Fig. 1 Merger formation game

Table 1 Mergers among allied carriers and post-merger structures

Type of merger	Label	Market structure by alliances	
No mergers	M_0	North: 1, 2, 3	South: 4, 5, 6
One merger	M_1	North: 15, 2, 3	South: 4, 6
Two mergers (or merger wave)	M_2	North: 15, 3	South: 42, 6

- In the second stage, depending on what was proposed in the first stage, CD decides whether to approve or block the project by considering its potential anti-competitive effects to the detriment of consumers, i.e., higher freight rates compared to pre-merger conditions (EU Commission 2004, par. 8). At this stage, if CD does not approve the proposal, we assume that no other carriers will be able to submit different merger projects, and again the benchmark competition occurs, with structure M_0. By contrast, if the merger proposed in the first stage is cleared by CD, the game moves to the following stage;
- In the third stage, if a merger between carriers 1 and 5 has been previously approved, then South Alliance's carrier 4 can react by merging with North Alliance's carrier 2. At this stage, if such a merger is not proposed, the benchmark competition occurs (with stucture labelled M_1);

- In the fourth stage of the game, CD decides whether to approve the merger between carriers 4 and 2, as proposed in the previous stage. In case of approval, the market structure would be M_2, otherwise the market structure will be M_1.

3.4 Post-merger equilibrium analysis

By backward induction we seek the sub-game perfect Nash equilibrium (SPNE) in pure strategies of the above described four-stage merger formation game as follows.

3.4.1 Analysis of the fourth stage of the game

Before comparing the freight rates corresponding to structures M_1 and M_2, to evaluate the impact of a potential merger wave on consumer surplus, we check whether this merger proposal would induce an *alliance-preserving* market structure or not. By making use of profits presented in Appendix A (derived as in the two-stage market game above), in the case of structure M_2, $\pi_3^{2,s} = \pi_6^{2,s} > 0$; $\pi_2^{1,s} = \pi_3^{1,s} > 0$; and $\pi_4^{1,s} = \pi_6^{1,s} > 0$ are satisfied for $V/K > 7.25$ g. This means that, for $V/K \leq 7.25$ g, merger waves are assumed to be not feasible (as non-merging allied carriers would exit the market). Since $f_s^2 \leq f_s^1$ only if $V/K \leq 9.06$ g, therefore, merger waves would be accepted by CD for V/K between 7.25 g and 9.06 g.

3.4.2 Analysis of the third stage of the game

If the merger game reaches this stage, carriers 4 and 2 decide whether to propose a merger or not. In the former case, the two carriers would enjoy joint profits $\pi_{42}^{2,s}$, while in the latter they would earn $\pi_4^{1,s}$ and $\pi_2^{1,s}$, respectively. Making use of Appendix A, simple algebra shows that $\pi_{42}^{2,s} > \pi_4^{1,s} + \pi_2^{1,s}$ for V/K between 1.71 g and 36.03 g. By recalling the results in the above analysis, i.e. for values of V/K between 7.25 g and 9.06 g, merger waves are always profitable and thus proposed.

3.4.3 Analysis of the second stage of the game

In the second stage, if carrier 1 has submitted a merger proposal with carrier 5, CD is called upon to review it. Here, we consider three sub-cases (derived from the previous analysis): (i) for $V/K > 9.06$ g, CD correctly anticipates that, in this range, the market structure could be M_1, as carriers 4 and 2 would not propose a merger. However, since $f_s^1 \leq f_s$ only if $V/K \leq 7.44$ g, the CD will not approve any merger submitted in the first stage and thus the market structure M_0 prevails; (ii) for V/K between 7.25 g and 9.06 g, the expected market structure, M_2, reflects a merger wave. Since $f_s^2 \leq f_s$ if $V/K \leq 8.25$ g, then, for V/K between 7.25 g and 8.25 g, the CD approves a merger involving carrier 1 and 5 (inducing a merger wave), and blocks it otherwise; (iii) for $V/K < 7.25$ g, the CD anticipates that $\pi_2^{1,s} = \pi_3^{1,s} > 0$ and $\pi_4^{1,s} = \pi_6^{1,s} > 0$ only for $V/K > 6.3$ g. Therefore, a single merger is always approved, as $f_s^1 \leq f_s$ for $V/K \leq 7.44$ g.

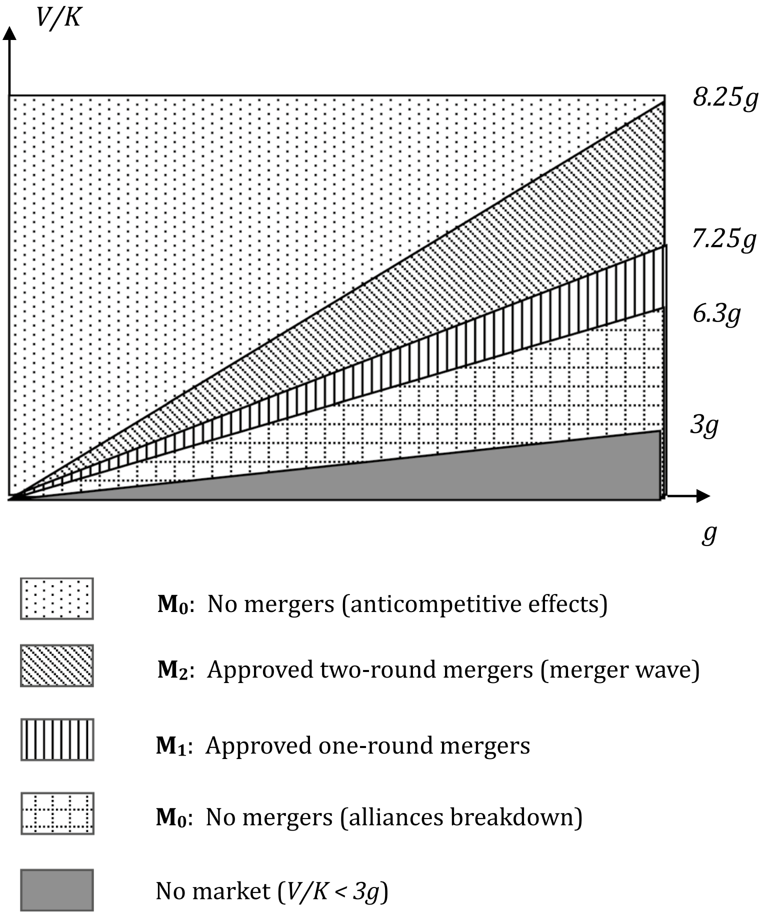

Fig. 2 Post-merger equilibrium (vertical separation)

3.4.4 Analysis of the first stage of the game

In the first stage of the merger formation game, carrier 1 is given the chance to merge with carrier 5. Because of further concentrations reviewed in the successive stages, this choice would entail different (expected) final market structures. In this sense, carrier 1 compares the (joint) profits that merging carriers would gain in each situation with the benchmark scenario. By investigating the preferences over possible final market structures, we summarize carrier 1's choice in the first stage as follows. For $V/K > 8.25$ g, no merger is proposed, since the CD would not clear it (higher freight rates with any type of merger); for V/K between 7.25 g and 8.25 g, the condition $\pi_{15}^{2,s} > \pi_1^s + \pi_5^s$ is satisfied for $V/K < 77.20$ g, thus, in this range, the merger between carriers 1 and 5 (followed by a merger wave) would be always proposed (and then cleared); (iii) for V/K between 6.3 g and 7.25 g, a single merger (inducing the market structure M_1) implies larger joint profits for merging carriers vis à vis the benchmark scenario (i.e., $\pi_{15}^{2,s} > \pi_1^s + \pi_5^s$) as this is satisfied for $V/K < 27.61$ g. This means that any merger is proposed (and successively approved); (iv) for $V/K < 6.3$ g, carrier 1 is not allowed to propose any merger because alliances would break down anyway.

As illustrated in Fig. 2, we complete the post-merger equilibrium analysis and state the following:

Proposition 2 (Post-merger equilibrium with vertical separation). *In the presence of vertical separation of carriers and terminal operators in the container shipping industry, the merger formation game would induce the following market structures:*

- *No merger* (M_0) *for* $V/K > 8.25$ g
- *Two mergers* (M_2) *for* 7.25 g $< V/K < 8.25$ g
- *One merger* (M_1) *for* 6.3 g $< V/K < 7.25$ g
- *No merger* (M_0) *for* $V/K < 6.3$ g

Proposition 2 highlights two important results. First, and as expected, mergers among carriers are more likely to take place in situations of increasing overcapacity. In recent years, as carriers' excess supply has negatively affected freight rates, allied carriers mostly had the incentive to merge with other alliance members to soften price competition. From a normative perspective, as K increases, the parameter *V/K* decreases, thus merger waves are more likely to be approved (i.e., for *V/K* between 7.25 g and 8.25 g). The intuition behind this result is explained as follows. To clear mergers, the CD requires that the overall output (in terms of TEUs moved) would expand so as to lower freight rates. Thus, given a certain market size, overcapacity effects outweigh rising rates due to lower marginal revenues for merging carriers. Second, as discussed in Vasconcelos (2010), whenever Cournot mergers are cleared, follow-up concentrations must be cleared too. This fact, however, undermines alliance stability. In our case, a merger between carriers 1 and 5 (followed by a similar merger between carriers 4 and 2) would imply a larger overall quantity of TEUs being moved.

4 What is the impact of vertical integration on alliance stability?

This section investigates the impact of vertical integration among carriers and terminal operators on their incentive to pursue mergers, but also on *alliance stability*. By assuming linkages between carriers and terminal operators, our main objective is to study the potential effects of this integration on the outcomes of the merger review. Moreover, it would be interesting to identify the extent to which the occurrence of merger waves in container shipping may channel to the stability of alliances. To do so, two cases are contrasted. In this first case, we assume that, either in the first or second round of mergers, carriers who have the chance to submit merger projects also own controlling stakes in terminals they call. According to this *partial vertical integration* case, individual allied non-merging carriers do not internalize terminal charges. In the second case, instead, we assume a *full vertical integration* of allied carriers and terminal operators, allowing for cost efficiencies that might extend from sea to terminal operations.

4.1 Market competition with partial vertical integration

This alternative scenario (labelled p) considers a more realistic setting where carriers controlling terminal operations are more likely to have financial resources to undertake mergers. Notable examples are recent takeovers in which vertically integrated acquirers were dominant in their alliances and had more advantages over other allied carriers (e.g., CMA CGM, controlling Marsaxlokk in Malta, acquired NOL in 2016). In such merger cases, however, sharing agreements did not extend to terminal operations, with integrated carriers charging terminal tariffs to allied partners (Parola et al. 2014).

Still, by applying the backward induction procedure, we first derive the carriers' decision in the second stage of the market game. By taking terminal tariffs t_{N}^{p} and t_{S}^{p} as given, the vertically integrated carriers 1 and 4, together with their allied partners 2, 3 (North Alliance) and 5, 6 (South Alliance) choose own quantity of TEUs by solving the following respective maximization problem:

$$\max_{q_1^p}\left\{\pi_1^p=\left(V/K-q_1^p-\sum_{i\neq 1}^{3}q_i^p-\sum_{j=4}^{6}q_j^p-3g\right)q_1^p+t_{\mathrm{N}}^p\left(q_2^p+q_3^p\right)\right\} \tag{16}$$

$$\max_{q_{i\neq 1}^p}\left\{\pi_{i\neq 1}^p=\left(V/K-q_{i\neq 1}^p-\sum_{h\neq i}^{3}q_h^p-\sum_{j=4}^{6}q_j^p-3g-t_{\mathrm{N}}^p\right)q_{i\neq 1}^p\right\} \tag{17}$$

$$\max_{q_4^p}\left\{\pi_4^p=\left(V/K-q_4^p-\sum_{j\neq 4}^{6}q_j^p-\sum_{i=1}^{3}q_i^p-3g\right)q_4^p+t_{\mathrm{S}}^p(q_5^p+q_6^p)\right\}. \tag{18}$$

$$\max_{q_{j\neq 4}^p}\left\{\pi_{j\neq 4}^p=\left(V/K-q_{j\neq 4}^p-\sum_{l\neq j}^{6}q_l^p-\sum_{i=1}^{3}q_i^p-3g-t_{\mathrm{S}}^p\right)q_{j\neq 4}^p\right\} \tag{19}$$

By solving the above system of best response equations ($\partial\pi_1^p/\partial q_1^p=0$, $\partial\pi_{i\neq 1}^p/\partial q_{i\neq 1}^p=0$, $\partial\pi_4^p/\partial q_4^p=0$, $\partial\pi_{j\neq 4}^p/\partial q_{j\neq 4}^p=0$), we again derive equilibrium of TEUs as a function of terminal charges:

$$q_1^p(t_{\mathrm{N}}^p,t_{\mathrm{S}}^p)=\frac{1}{7}(V/K-3g+2t_{\mathrm{N}}^p+2t_{\mathrm{S}}^p) \tag{20}$$

$$q_2^p(t_{\mathrm{N}}^p,t_{\mathrm{S}}^p)=q_3^p(t_{\mathrm{N}}^p,t_{\mathrm{S}}^p)=\frac{1}{7}(V/K-3g-5t_{\mathrm{N}}^p+2t_{\mathrm{S}}^p) \tag{21}$$

$$q_4^p(t_N^p, t_S^p) = \frac{1}{7}(V/K - 3g + 2t_N^p + 2t_S^p) \tag{22}$$

$$q_5^p(t_N^p, t_S^p) = q_6^p(t_N^p, t_S^p) = \frac{1}{7}(V/K - 3g - 5t_S^p + 2t_N^p) \tag{23}$$

Differently from the case of vertical separation between carriers and terminal operators, the impact of terminal charges on integrated carriers (1 and 4) is different from that on non-integrated ones (carrier 2, 3, 5 and 6). Since integrated carriers internalize the reducing-effect of THCs on TEUs moved (as described in Sect. 3.2), by increasing THCs they thus lower the output of non-integrated carriers, while, in turn, their supply increases. Formally:

$$\begin{aligned} \partial q_1^p(t_N^p, t_S^p)/\partial t_N^p &= \partial q_4^p(t_N^p, t_S^p)/\partial t_S^p > 0 \\ \partial q_2^p(t_N^p, t_S^p)/\partial t_N^p &= \partial q_3^p(t_N^p, t_S^p)/\partial t_N^p < 0 \\ \partial q_5^p(t_N^p, t_S^p)/\partial t_S^p &= \partial q_6^p(t_N^p, t_S^p)/\partial t_S^p < 0 \end{aligned} \tag{24}$$

Turning now to the first stage of the market game, we insert the second-stage equilibrium TEUs, as in [20–23], into the vertically integrated carriers' profits and maximize them with respect to related terminal charges as follows:

$$\max_{t_N^p} \pi_1^p[q_i^p(t_N^p, t_S^p), q_j^p(t_N^p, t_S^p)] \tag{25}$$

$$\max_{t_S^p} \pi_4^p[q_i^p(t_N^p, t_S^p), q_j^p(t_N^p, t_S^p)] \tag{26}$$

By solving the related system of two best response functions ($\partial\pi_1^p/\partial t_N^p = 0$, $\partial\pi_4^p/\partial t_S^p = 0$), we derive the THCs charged to respective allied partners, as follows:

$$t_N^p = t_S^p = \frac{1}{16}(V/K - 3g) \tag{27}$$

By inserting [27] in [20–23], [1], and [16–19], we state the:

Proposition 3 (Pre-merger equilibrium with partial vertical integration). *In cases of partial vertical integration among carriers and terminal operators, vertically-integrated carriers move more TEUs and enjoy larger profits compared to non-integrated allied carriers. At equilibrium, individual TEUs, freight rates and carriers' profits are as follows:*

Proposition 3

$$q_1^p = q_4^p = \frac{1}{4}(V/K - 3g) \tag{28}$$

$$q_2^p = q_3^p = q_5^p = q_6^p = \frac{1}{16}(V/K - 3g) \tag{29}$$

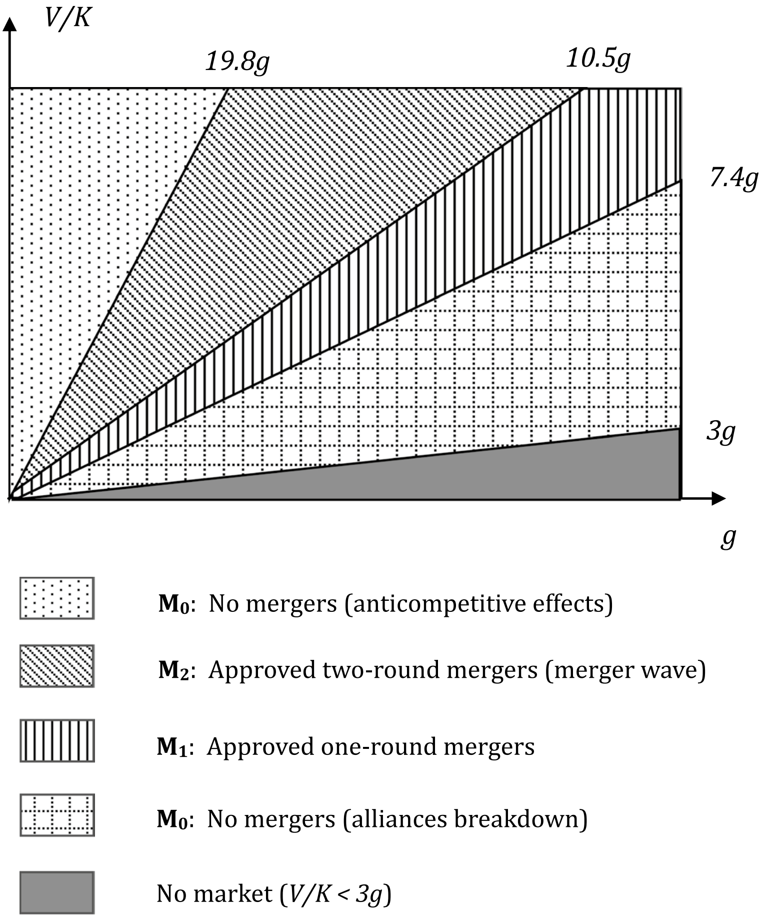

Fig. 3 Post-merger equilibrium (partial integration)

$$f_p = \frac{1}{4}(V/K + 9g) \tag{30}$$

$$\pi_1^p = \pi_4^p = \frac{11}{128}(V/K - 3g)^2 \tag{31}$$

$$\pi_2^p = \pi_3^p = \pi_5^p = \pi_6^p = \frac{1}{256}(V/K - 3g)^2 \tag{32}$$

With respect to the merger game involving vertically integrated merging carriers, again we go backward to derive the SPNE and state the following:

Proposition 4 (Post-merger container shipping with partial vertical integration). *In the case of partial vertical integration of carriers and terminal operators, the merger formation game would induce the following market structures:*

- *No merger* (M_0) *for* $V/K > 19.8$ g
- *Two mergers* (M_2) *for* 10.5 g $< V/K < 19.8$ g
- *One merger* (M_1) *for* 7.4 g $< V/K < 10.5$ g
- *No merger* (M_0) *for* $V/K < 7.4$ g

In this scenario, Proposition 4 clearly demonstrates that the vertical integration of carriers and terminal operators may have a striking impact on post-wave container shipping. By comparing Figs. 2 and 3, for increasing levels of excess capacity (parameter K goes up), vertical integration *does* increase the likelihood of merger approvals. More interestingly, consolidations involving more carriers (merger waves) are cleared by CA for V/K between 10.5 g and 19.8 g, that is, for a relatively lower overcapacity compared to the non-integration case. By recalling Proposition 3, as internalized THCs allow vertically integrated carriers to move more TEUs, two-round concentrations are cleared for a relatively less striking industry overcapacity (proofs of the proposition are available upon request from the authors).

4.2 Market competition with full vertical integration

In this section, further integration options are explored by assuming that terminal operations are completely shared among allied partners. More specifically, horizontal and vertical cooperation mix together in a competitive scenario where logistics and shipping systems are fully integrated. As noted above, although alliances include forms of cooperation at sea (slot chartering, vessel sharing), they usually tend to exclude terminal sharing to rationalize costs in port (Satta and Persico 2015). In other words, whereas carriers share vessels on the main routes, instead, they are generally not prepared to share port facilities at their ports of call.[4] The main reason is that, by requiring a high level of control over terminals in terms of handling costs and schedule reliability, vertically integrated carriers are unwilling to share the residual capacity of their terminals to partners (Parola et al. 2015).

In formal terms, by assuming vertical integration involving terminal operators and *all* the allied carriers, the market equilibrium can be simply derived by maximizing carriers' profits with respect to the individual TEUs supplied (i.e., without recurring to the backward induction procedure). In this setting (labelled f), each carrier is vertically integrated and sets quantities of TEUs, q_i^f and q_j^f, such that:

$$\max_{q_i^f} \left\{ \pi_i^f = \left(V/K - q_i^f - \sum_{h \neq i}^{3} q_h^f - \sum_{j=4}^{6} q_j^f - 3g \right) q_i^f \right\} \tag{33}$$

[4] A notable exception is the Maersk-Cosco terminal under construction at the Savona-Vado port in Italy.

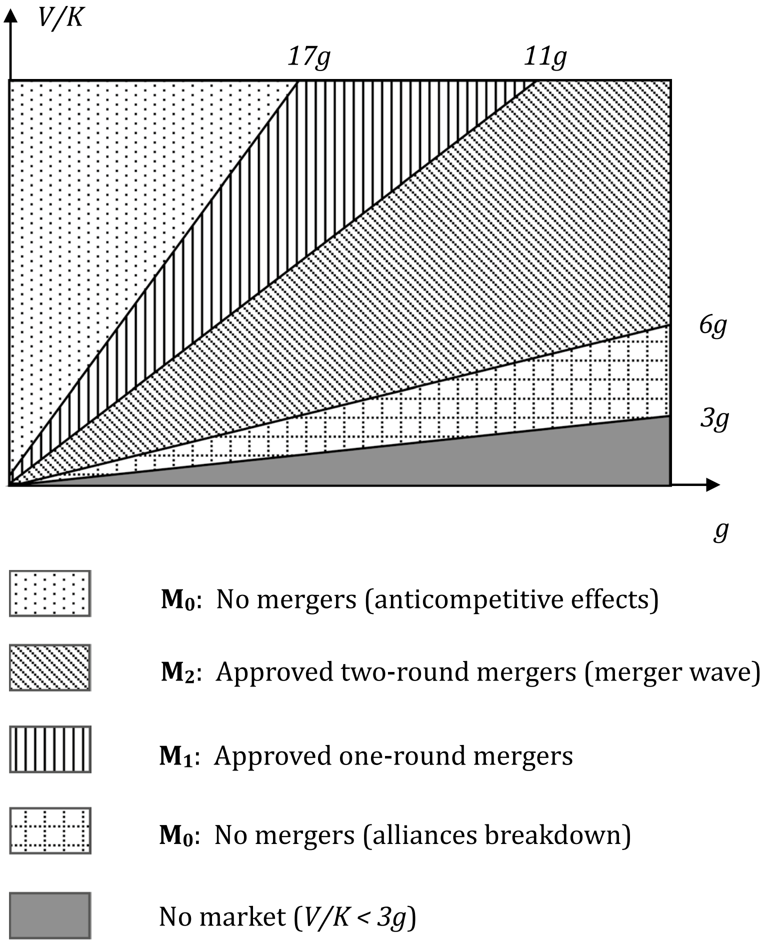

Fig. 4 Post-merger equilibrium (full integration)

$$\max_{q_j^f} \left\{ \pi_j^f = \left(V/K - q_j^f - \sum_{i=1}^{3} q_i^f - \sum_{l \neq j}^{6} q_l^f - 3g \right) q_j^f \right\} \tag{34}$$

It is here important to note that, whenever terminal sharing agreements involve integrated and non-integrated carriers, the supply of TEUs does not depend on terminal charges, now assumed to be internalized by all the allied carriers. By solving the related system of six equations and inserting equilibrium quantities of TEUs in [1] and [33], [34], the pre-merger equilibrium with full vertical integration is as follows:

Proposition 5 (Pre-merger equilibrium with full vertical integration). *In case of full vertical integration (terminal sharing) of carriers and terminal operators, at equilibrium, individual quantities, freight rates and carriers' profits are given by:*

Table 2 Merger control games outcomes with different vertical integration

Range of *V/K*	Vertical separation	Partial vertical integration	Full vertical integration
(3 g, 6 g)	No merger	No merger	No merger
[6 g, 6.3 g)			Merger wave
[6.3 g, 7.25 g)	One merger		
[7.25 g, 7.4 g)	Merger wave		
[7.4 g, 8.25 g)		One merger	
[8.25 g, 10.5 g)	No merger		
[10.5 g, 11 g)		Merger wave	
[11 g, 17 g)			One merger
[17 g, 19.8 g)			No merger
[19.8 g, ∞)		No merger	

$$q_1^f = q_2^f = \ldots = q_6^f = \frac{1}{5}(V/K - 3g). \tag{35}$$

$$f_f = \frac{1}{7}(V/K + 6g) \tag{36}$$

$$\pi_1^f = \pi_2^f = \ldots \pi_6^f = \frac{1}{49}(V/K - 3g)^2 \tag{37}$$

With respect to the merger formation game, we obtain the SPNE of the game as in Fig. 4. Hence,

Proposition 6 (Post-merger equilibrium with full vertical integration). *In the presence of full vertical integration (terminal sharing) of carriers and terminal operators in container shipping, the merger formation game would induce the following market structures*:

- *No merger* (M_0) *for V/K* > 17 g
- *One merger* (M_1) *for* 11 g < *V/K* < 17 g
- *Two mergers* (M_2) *for* 6 g < *V/K* < 11 g
- *No merger* (M_0) *for V/K* < 6 g

By assuming both the vertical integration of carriers and terminal operators and the existence of terminal sharing agreements among allied carriers, the result in Proposition 6 theoretically puts forward the hypothesis for which extending cost savings to terminal operations might enable more merger waves to be approved. The outcome of the related merger game, as depicted in Fig. 4, does support the above argument. Differently from what was observed in the previous scenario where terminal services are not shared among allied carriers, merger waves are sustainable (and approved) also for relatively higher levels of industry overcapacity. This result suggests that, in this case, the primary condition that stimulates horizontal mergers in container shipping (indeed, the overcapacity) could be compatible with the occurrence of merger waves among global carriers (proofs of the proposition are available from the authors upon request).

5 Discussion

Relevant post-merger market outcomes associated with different types of vertical integration of carriers and terminal operators are summarized in Table 2. Our analysis started with a scenario in which carriers and terminal operators are separated. Although this occurs only in relatively small ports where big liner companies have not invested in terminals, we considered it a benchmark setting to tackle the impact of vertical integration on the post-merger stability of alliances.

Overall, we have argued that the withdrawal of target carriers from their respective alliances (because of merger control review) would inevitably weaken alliances. This, because non-merging allied carriers might realize low profits and financial distress (the bankruptcy of Hanjin in 2016 is a case in point here). In case of vertical separation of carriers and terminal operators, for relatively low levels of overcapacity with respect to marginal costs at sea (i.e., *V*/*K* between 3 g and 6.3 g), no alliance-preserving mergers are feasible. For *V/K* between 6.3 g and 7.25 g, only single mergers (labelled M_1) are finalized. In those two cases, merger waves would force non-merging carriers out of the market. Instead, for *V*/*K* between 7.25 g and 8.25 g merger waves are allowed as they could be beneficial to consumers. In other words, increasing levels of overcapacity would trigger sequential consolidations, as non-merging carriers are more likely to enjoy less profit (they have also to pay terminal charges to landside operators).

What happens, however, when merging carriers are linked to terminal operators (through controlling stakes)? As seen in Table 2, when considering a more real-life scenario, in which major carriers are both vertically integrated at ports *and* can acquire other carriers (e.g., Maersk, CMA CGM, Cosco, Hapag Lloyd), the scope for consolidation is heightened: for *V/K* between 7.4 g and 19.8 g, at least one merger is finalized. However, when restricting attention to merger waves only, the partial vertical integration is compatible only for *V/K* above 10.5 g; this suggests a rather restrictive scenario when dealing with the stability of alliances. When the levels of relative overcapacity are instead between 3 g and 7.4 g, any merger project would imply negative profits for allied non-merging carriers and thus the alliances' breakdown. Since vertically integrated carriers are assumed to be acquirers in merger proposals (as supported by evidence in the industry), non-merging carriers are indeed more likely to exit the market with respect to the vertical separation case. Therefore, in this scenario, the occurrence of merger waves overall reduces alliance stability.

Finally, the hypothesis of full vertical integration gave remarkable results, as the resulting sequence of concentrations does not necessarily induce alliances to be reshaped post-merger. In fact, full terminal sharing agreements among allied carriers mean that even non-merging carriers do not pay terminal charges and they can thus enlarge own supply accordingly. Therefore, in the presence of larger industry overcapacity over marginal costs (i.e., for *V/K* between 6 g and 11 g), non-merging (but now vertically integrated) allied carriers have enough capacity to realize a profit.[5] As it is more difficult for carriers to incur post-merger losses, alliances are likely to survive also in situations where merger waves occur.

6 Conclusions

This paper contributes in explaining how horizontal merger waves influence the stability of alliances in the container shipping industry, considering also the circumstances in which carriers and terminal operators are vertically integrated. Whenever overcapacity in container shipping leads to consolidation among carriers, we find that resulting merger waves may weaken alliances and lead to their reshaping. Using non-cooperative merger formation games, we find that, in a Cournot framework (i.e., carriers compete by supplying TEUs), should financial conditions worsen due to chronic overcapacity, the likelihood of merger waves—together with the existing normative approach in the merger control review—is correlated with the reshaping of alliances. By analyzing recent EU merger cases in container shipping, we observe that merger proposals are preferably approved subject to the withdrawal of selected merging parties from their own alliance. In turn, non-merging allied carriers might have the incentive to seek similar mergers with liner companies belonging to other alliances to rationalize costs as well. Cases in point in 2016 were APL/NOL leaving G6 when merging with CMA CGM (O3), or UASC abandoning NEU1/O3 consortium to join Hapag-Lloyd (G6). In such cases, alliance stability might be undermined by the fact that capacity-wise distressed alliances are deprived of members, with remaining carriers unable to make profit. This effect could explain the reshaping of alliances we have witnessed in the last 2 years, where four alliances (2M, G6, O3 and CKYHE) were replaced by three coalitions (2M, Ocean Alliance and THE Alliance).

We have seen that the emergence of vertical integration between carriers and terminal operators raises questions on the effect of this on the stability of post-wave alliances. To address this specific issue, we expanded our merger formation set-up by contrasting two real-life cases. In the first, by assuming vertically integrated carriers not willing to share terminal facilities with allied members, we show that merger waves might make alliances unstable. When internalizing terminal charges, however, merging carriers enlarge their supply in terms of TEUs not only due to the approved concentration but also because of the vertical integration. This effect will further stimulate follow-up mergers, to the point where carriers belonging to a certain alliance exit the market and, as result, alliances must reshape. In the second case, yet we argued that a full integration among all allied partners and terminal operators could instead make alliances more stable. By allowing for vertically-integrated

[5] Notice that, given that slight demand shocks are not able to make overall TEUs expand to offset rising sea freight rates, then, in the region for which *V/K* is between 11 g and 17 g, single mergers are welfare-preferable and thus approved.

carriers willing to share terminal assets with non-merging allied partners (de facto, terminal charges are ruled out), very large levels of overcapacity may indeed stimulate merger waves but, at the same time, these are not likely to cause the breakdown of alliances in the short run. Since non-merging allied partners might also benefit from reduced costs in port, they have a larger probability to yield post-merger profits. As a result, as the current integration among sea and terminal operators seems to be unavoidable due the continuous cost-saving strive of carriers, we argue that if such form of vertical cooperation is alliance-based (that is, all the partners share terminal facilities), merger waves are more sustainable, without necessarily inducing the breakdown of alliances.

Appendix

A. Post-merger equilibrium w/vertical separation (freight rates, profits and terminal charges)

	M_1	M_2
f	$f_s^1 = \frac{1}{14}\left(5V/K + \frac{73}{3}g\right)$	$f_s^2 = \frac{1}{5}\left(2V/K + \frac{27}{4}g\right)$
π	$\pi_{15}^{1,s} = \frac{1}{1764}[5V/K + 29g]^2$ $\pi_2^{1,s} = \pi_3^{1,s} = \frac{1}{1764}[5V/K - 13g]^2$ $\pi_4^{1,s} = \pi_6^{1,s} = \frac{1}{441}[3V/K - 19g]^2$	$\pi_{15}^{2,s} = \pi_{42}^{2,s} = \frac{9}{6400}(4V/K + 11g)^2$ $\pi_3^{2,s} = \pi_6^{2,s} = \frac{9}{6400}(4V/K - 29g)^2$
t	$t_N^{1,s} = \frac{1}{21}(5V/K + g)$ $t_S^{1,s} = \frac{1}{14}(3V/K - 19g)$	$t_N^{2,s} = t_S^{2,s} = \frac{1}{4}\left(V/K - \frac{9}{4}g\right)$

B.1 Post-merger equilibrium w/partial integration (sea freight rates, profits and terminal charges)

	M_1	M_2
f	$f_p^1 = \frac{1}{202}(55V/K + 401g)$	$f_p^2 = \frac{1}{31}(9V/K + 45g)$
π	$\pi_{15}^{1,p}\ \frac{3993}{40804}(V/K)^2 + \frac{9559}{20402}gV/K + \frac{36485}{40804}g^2$ $\pi_2^{1,p} = \pi_3^{1,p} = \frac{1}{40804}(11(V/K) - 41g)^2$ $\pi_4^{1,p} = \frac{145}{40804}(5V/K - 37g)^2$ $\pi_6^{1,p} = \frac{9}{40804}(5V/K - 37g)^2$	$\pi_{15}^{2,p} = \pi_{42}^{2,p} = \frac{95}{961}(V/K)^2 - \frac{228}{961}gV/K + \frac{2277}{3844}g^2$ $\pi_3^{2,p} = \pi_6^{2,p} = \frac{1}{961}(2V/K - 21g)^2$
t	$t_N^{1,p} = \frac{1}{101}(22V/K + 19g)$ $t_S^{1,p} = \frac{1}{101}(20V/K - 148g)$	$t_N^{2,p} = t_S^{2,p} = \frac{1}{31}(7V/K - 27g)$

C.1 Post-merger equilibrium w/full integration (sea freight rates and profits)

	M_1	M_2
f	$f_f^1 = \frac{1}{6}(V/K + 13g)$	$f_f^2 = \frac{1}{5}(V/K + 9g)$
π	$\pi_{15}^{1f} = \frac{1}{36}(V/K + 7g)^2$	$\pi_{15}^{2f} = \pi_{42}^{2f} = \frac{1}{100}(2V/K + 3g)^2$
	$\pi_2^{1f} = \pi_3^{1f} = \frac{1}{36}(V/K + g)^2$	$\pi_3^{2f} = \pi_6^{2f} = \frac{1}{25}(V/K - 6g)^2$
	$\pi_4^{1f} = \pi_6^{1f} = \frac{1}{36}(V/K - 11g)^2$	

References

Agarwal, R., and O. Ergun. 2010. Network design and allocation mechanisms for carrier alliances in liner shipping. *Operations Research* 58 (6): 1726–1742.

Alix, Y., B. Slack, and C. Comtois. 1999. Alliance or acquisition? Strategies for growth in the container shipping industry, the case of CP ships. *Journal of Transport Geography* 7 (3): 203–208.

Álvarez-SanJaime, Ó., P. Cantos-Sánchez, R. Moner-Colonques, and J. Sempere-Monerris. 2013. Vertical integration and exclusivities in maritime freight transport. *Transportation Research Part E* 51 (C): 50–61.

Aymelek, M., Boulougouris, E., and O. Turan. 2016. *A game theory competition analysis of quadropolistic liner container shipping market*. Proceedings of International Association of Maritime Economists (IAME) 2016 Conference, Germany, 171.

Benacchio, M., C. Ferrari, and E. Musso. 2007. The liner shipping industry and EU competition rules. *Transport Policy* 14 (1): 1–10.

Bergantino, A.S., and A.W. Veenstra. 2002. Interconnection and co-ordination: An application of network theory to liner shipping. *Maritime Economics and Logistics* 4 (3): 231–248.

Boile, M., H. Lee, and S. Theofanis. 2012. Hierarchical interactions between shippers and carriers in international maritime freight transportation networks. *Procedia: Social and Behavioural Sciences* 48: 3651–3660.

Cariou, P. 2008. Liner shipping strategies: an overview. *International Journal of Ocean Systems Management* 1: 2–13.

Caschili, S., F. Medda, F. Parola, and C. Ferrari. 2014. An analysis of shipping agreements: the cooperative container network. *Networks and Spatial Economics* 14: 357–377.

Das, S. 2011. To partner or to acquire? A longitudinal study of alliances in the shipping industry. *Maritime Policy and Management* 38 (2): 111–128.

Ding, J.F., and G.S. Liang. 2005. Using fuzzy MCDM to select partners of strategic alliances for liner shipping. *Information Sciences* 173 (3): 197–225.

EU Commission. 2004. *Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings*, 2004/C 31/03. (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52004XC0205(02)&from=EN).

European Commission. 2008. *Commission Notice on remedies acceptable under the Council Regulation (EC) No 139/2004 and under Commission Regulation (EC) No 802/2004*, Official Journal C/267, 2008. (http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52008XC1022(01)).

EU Commission. 2016a. *CMA CGM/NOL* (merger case M.7908). http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=2_M_7908.

EU Commission. 2016b. *Hapag-Lloyd/UASC* (merger case M.8120). http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=2_M_8120.

EU Commission. 2017a. *Maersk/Hamburg Süd* (merger case M.8330). http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=2_M_8330.

EU Commission. 2017b. *NYK Line/MOL/K Line* (JV, merger case M.8472). http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=2_M_8472.

EU Commission. 2017c. *Cosco Shipping/OOCL* (merger case M.8594). http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=2_M_8594.
Evangelista, P., and A. Morvillo. 2000. Alliances in liner shipping: an instrument to gain operational efficiency or supply chain integration? *International Journal of Logistics: Research and Applications* 2 (1): 21–38.
Faulì-Oller, R. 2000. Takeover waves. *Journal of Economics and Management Strategy* 9 (2): 189–210.
Ferrari, C., F. Parola, and M. Benacchio. 2008. Network economies in liner shipping: the role of home markets. *Maritime Policy and Management* 35 (2): 127–143.
FTC. 2012. *Negotiating Merger Remedies*. Statement of the Bureau of Competition of the Federal Trade Commission, January 2012. (https://www.ftc.gov/system/files/attachments/negotiating-merger-remedies/merger-remediesstmt.pdf).
Fudenberg, D., and J. Tirole. 1991. *Game theory*, vol. 1. Cambridge: The MIT Press.
Gowrisankaran, G. 1999. A dynamic model of endogenous horizontal mergers. *RAND Journal of Economics* 30: 56–83.
Haralambides, H., P. Cariou, and M. Benacchio. 2002. Costs, benefits and pricing of dedicated container terminals. *International Journal of Maritime Economics* 4 (1): 21–34.
Haralambides, H. 2019. Gigantism in container shipping, ports and global logistics. *Maritime Economics and Logistics* 21 (1): 1–60.
Heaver, T., H. Meersman, F. Moglia, and E. Van de Voorde. 2000. Do mergers and alliances influence European shipping and port competition? *Maritime Policy and Management* 27 (4): 363–373.
Horn, H., and L. Persson. 2001. Endogenous mergers in concentrated markets. *International Journal of Industrial Organization* 19 (8): 1213–1244.
Lee, H., M. Boile, S. Theofanis, and S. Choo. 2012. Modelling the oligopolistic and competitive behaviour of carriers in maritime freight transportation networks. *Procedia: Social and Behavioural Sciences* 54: 1080–1094.
Midoro, R., and A. Pitto. 2000. A critical evaluation of strategic alliances in liner shipping. *Maritime Policy and Management* 27 (1): 31–40.
Motta, M., and H. Vasconcelos. 2005. Efficiency gains and myopic antitrust authority in a dynamic merger game. *International Journal of Industrial Organization* 23 (9–10): 777–801.
Notteboom, T.E., and W. Winkelmans. 2001. Structural changes in logistics: How will port authorities face the challenge? *Maritime Policy and Management* 28 (1): 71–89.
Notteboom, T.E. 2004. Container shipping and ports: An overview. *Review of Network Economics* 3 (2): 86–106.
Notteboom, T.E. 2016. *Alliances in container shipping: Impact of Korean/Japanese carrier dynamics*. (http://www.porteconomics.eu/2016/11/01/portgraphic-alliances-in-container-shipping-impact-of-koreanjapanese-carrier-dynamics/).
Notteboom, T.E., F. Parola, G. Satta, and A.A. Pallis. 2017. The relationship between port choice and terminal involvement of alliance members in container shipping. *Journal of Transport Geography* 64: 158–173.
OECD. 2015. OECD: Competition issues in liner shipping, Comp, WP2(3).
Panayides, P., and R. Wiedmer. 2011. Strategic alliances in container liner shipping. *Research in Transportation Economics* 32 (1): 25–38.
Parola, F., G. Satta, and S. Caschili. 2014. Unveiling co-operative networks and 'hidden families' in the container port industry. *Maritime Policy and Management* 41 (4): 384–404.
Parola, F., G. Satta, and P.M. Panayides. 2015. Corporate strategies and profitability of maritime logistics firms. *Maritime Economics and Logistics* 17 (1): 52–78.
Quartieri, F. 2017. Are vessel sharing agreements pro-competitive? *Economics of Transportation* 11: 33–48.
Qiu, L.D., and W. Zhou. 2007. Merger waves: A model of endogenous mergers. *RAND Journal of Economics* 38 (1): 214–226.
Ryoo, D., and H. Thanopoulou. 1999. Liner alliances in the globalization era: A strategic tool for Asian container carriers. *Maritime Policy and Management* 26 (4): 349–367.
Satta, G., and L. Persico. 2015. Entry mode choices of rapidly internationalizing terminal operators: The determinants of the degree of control on foreign ventures. *Maritime Economics and Logistics* 17 (1): 97–126.
Shi, X., and S. Voss. 2011. Game theoretical aspects in modelling and analysing the shipping industry. *Computational Logistics* 6971: 302–320.

Slack, B., C. Comtois, and R. McCalla. 2002. Strategic alliances in the container shipping industry: A global perspective. *Maritime Policy and Management* 29 (1): 65–76.
Song, D.W., and P.M. Panayides. 2002. A conceptual application of cooperative game theory to liner shipping strategic alliances. *Maritime Policy and Management* 29 (3): 285–301.
Van de Voorde, E., and T. Vanelslander. 2009. *Market Power and Vertical and Horizontal Integration in the Maritime Shipping and Port Industry*. OECD/ITF Discussion Papers, 2009-2.
Vasconcelos, H. 2010. Efficiency gains and structural remedies in merger control. *Journal of Industrial Economics* 58 (4): 742–766.
Wang, H., M. Qiang, and Z. Xiaoning. 2014. Game-theoretical models for competition analysis in a new emerging liner container shipping market. *Transportation Research Part B: Methodological* 70 (C): 201–227.
Wiegmans, B.W., A. Van Der Hoest, and T.E. Notteboom. 2008. Port and terminal selection by deep-sea container operators. *Maritime Policy and Management* 35 (6): 517–534.
Wilmsmeier, G., J. Hoffmann, and R.J. Sanchez. 2006. The impact of port characteristics on international maritime transport costs. *Research in Transportation Economics* 16 (1): 117–140.
Yang, D., M. Liu, and X. Shi. 2011. Verifying liner shipping alliance's stability by applying core theory. *Research in Transportation Economics* 32 (1): 15–24.