FACULTAT D’ECONOMIA I EMPRESA, UNIVERSITAT DE BARCELONA

# STRATEGIC ALLIANCES IN LINER SHIPPING

## CONCENTRATION AND ECONOMIES OF SCALE

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# Abstract:

The aim of this investigation is to examine the phenomena of strategic alliances among maritime carriers. During the last decade this process has accelerated, jointly with the introduction of megaships in the industry. This has caused the number of operators in the market to fall to only four big alliances controlling the 99% of the market share. The main argument provided by companies is that this process is done to gain economies of scale and operational synergies. In order to test this argument an average cost function that depends on the number of operators in the industry, thus if there are strategic agreements or not among carriers, has been estimated and it has been found to decrease when strategic alliances are established. This means a better situation in terms of efficiency due to the concentration of the sector but it does not mean lower prices or an increase in the general level of welfare. Testing this goes far from the scope of this research but it could be interesting to pursue the investigation in the future.



- Strategic alliance
- Operational synergies
- Cost function
- TEU
- Utilization
- Carrier
- Liner shipping
- Vessel
- Economies of scale
- Concentration



# Resum:

L'objectiu d'aquest treball de fi de grau és investigar el fenomen de les aliances estratègiques entre les empreses navilieres que operen en el sector del transport marítim. Durant la darrera dècada aquest procés s'ha vist accelerat i ha anat de la mà de la creació i posta en operació de portacontenidors cada cop més grans fins al punt d'arribar-se a encarregar vaixells de fins a 21.000 TEUs, la unitat estàndard de mesura en el sector de la logística marítima.

El procés de formació d'aliances ha estat justificat argumentat que aquestes suposen guanys a nivell d'eficiència, sinèrgies operacionals i economies d'escala, a més del fet de permetre posar en operativa vaixells més grans amb la reducció en el cost total mig

per TEU que això suposa. Que existeixen economies d'escala a nivell de vaixell, és a dir que el cost per TEU si s'utilitza un vaixell més gran és menor que en el cas de utilitzar-ne un de petit, és quelcom generalment acceptat en la literatura i en el sector, el que no està acceptat és que el mateix passi en el cas de les navilieres, que si en comptes de dues empreses operant de forma separada només ni ha una, és a dir que la mida mitjana de l'operador incrementi, el cost per TEU decreixi.

Aquest treball té l'objectiu de testar aquest argument, de provar si existeixen o no economies d'escala a nivell de naviliera i si una aliança estratègica significa una reducció de costos o no. Per fer-ho s'ha estimat una funció de cost total mig, cost per TEU, a nivell de vaixell. Per establir la relació entre el vaixells i les navilieres o aliances que els operen s'ha introduït en aquesta funció una variable que representa la utilització dels vaixells i s'ha estimat un model economètric per esbrinar si aquesta variable varia al formar-se aliances o no.

S'ha trobat que la concentració en la indústria i la formació d'aliances afecta positivament el grau d'utilització mig dels portacontenidors i que la funció de costos depenent del nombre d'operadors en la indústria té pendent negativa, per tant que es formessin aliances estratègiques entre les diferents navilieres suposaria increments en el nivell d'eficiència de la indústria i reduccions de costos.

Això no vol dir que hi hagin millores a nivell d'excedent del consumidor, que el benestar total incrementi o que els preus del noli baixin, tot això està lluny del que avarca aquest treball però degut a la importància que té el transport marítim per a la bona salut d'una economia global seria interessant continuar la investigació en el futur.

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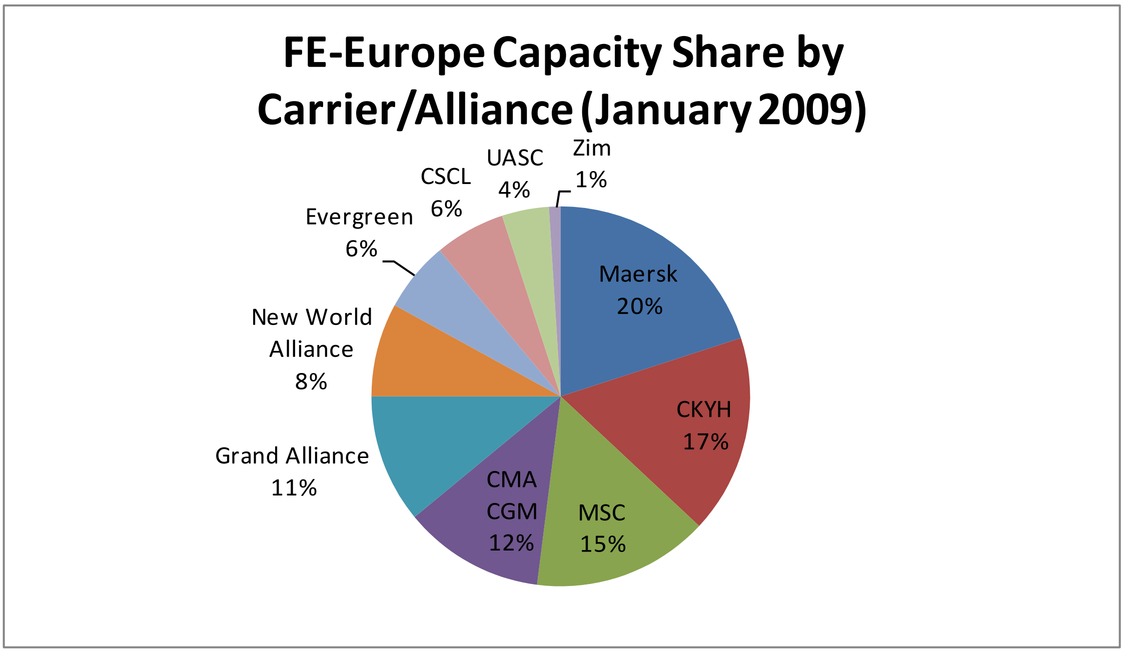
# Introduction:

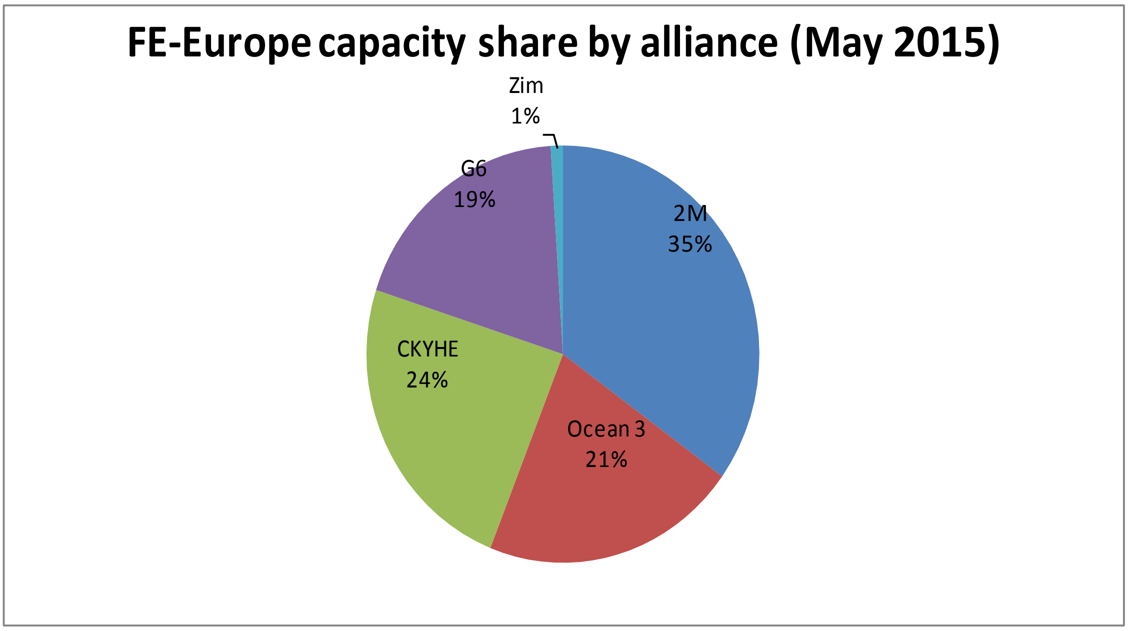
Recent years, especially after the global crisis that hit the world and had tremendous effects on global maritime transport, have been truly interesting for agents implicated in this economic sector. Things have changed really fast and the new scenario is highly complex and has numerous implications for all of the stakeholders. Operators have acted and, in the process of reducing costs, vessel size has almost doubled.

That process has been completed in the last years by an important concentration in the container shipping carriers. The market structure has changed and were we had in 2009 more than 10 operators now we have only 4 big alliances, formed by the previous operators, controlling the market. What is more important two of the biggest shipping lines, Maersk and MSC, have formed the 2M alliance which controls the 35% of containership trade in the Europe-Far East route. At the same time that the 2M shipping alliance was formed the Oceans 3 alliance, formed by the agreement among CMA CGM, CSCL and UASC began to operate. This process, in addition with the agreement between two on the historic alliances, Grand alliance and New World alliance to form the G6 alliance in November 2011 and the inclusion of Evergreen, one of the predominant carriers, in the CKYHE agreement on April 2014 has ended to a really concentrated market with 4 big alliances, 2M, OCEANS 3, CKYHE and G6 controlling de 99% of the Europe-Far East containerized trade. The only carrier that remains outside the process of concentration is Zim, with a 1% market share in the Europe-Fare East route and a 3% in the transatlantic route.

The change in the supply structure of the maritime transport market between 2009 and 2015 can be summarized by the following graphs:




*Source: Alphaliner monthly monitor*




*Source: Alphaliner monthly monitor*

An alliance is a long term agreement between two or more carriers where a shipping liner commits to collaborate with the other operators when operating ships, rationalizing capacity through joint-scheduling, slot-chartering, terminal and equipment sharing, and designing operational networks, to name just a few of their functions. Not all the routes and services are operated by the alliances, there are some services that are operated by only one carrier or by the others acting separately but these pattern of actuation has to be accorded by the members of the agreement. Theoretically members of an alliance are not involved in price-setting when they operate out of the alliance but it is true that there seem to appear strong incentives to collude when designing the agreement.

Members of alliances justify their collaboration because of cost reducing but there is no empiric evidence about that. This cost reduction could happen mainly because of two reasons: The first one is that alliances would allow shippers to operate larger vessels, due to the economies of scale that vessels present up to certain point collaboration between carriers would mean a more efficient allocation of resources. The second reason emphasizes operational synergies between different shipping lines when operating together. This would mean fewer vessels to carry the same number of TEUs or even a superior level of total output due lower freight rates, higher levels of vessel capacity utilization and lower logistics inland costs, to sum up operational synergies would mean fuller vessels at lower prices. This would obviously have a positive effect on efficiency and average total costs.

Alliances have been justified by members by efficiency reasons, but is it the true reason? Acting together could mean lower output levels so higher prices and monopoly power. Theoretically alliances are not involved in price setting but this is not a guarantee that they do not do it. Which is the real motivation of alliances? Does the average total cost reduction really exist?

# Objectives:

To try to answer the previous questions, to investigate if economies of scale really exist in the maritime transport sector at the company level is the principal aim of this research. There is little literature on this field; previous research focuses on scale economies at the ship level and implications for ports and regulators. Carriers have been analyzed mainly from a competition policy and regulation point of view, but I have not found a paper trying to assess the behavior of the average cost function of a carrier.  I will focus on trying to assess the cost per TEU and to link it with the size of the alliance.

Maritime transport is the main transport mode in the modern economy, it allows labor division and specialization, it has caused an increasing level of welfare for the world population and it is one of the main factors behind globalization and reduction of poverty, this is why it is so important that it behaves correctly and that carriers, the main operators in that sector act efficiently so, understanding why carriers are forming alliances seems to be really important in order to guarantee that the positive effects of maritime transport will continue or even increase.

Strictly talking an alliance is not a company, when two or more carriers form an alliance they remain independent and do not merge but, from an economic point of view it can be understood that, collaborating through a long term agreement, they act as one so through an alliance independent liners would achieve the same gains in efficiency as if they merge.

I will propose some reasons that would justify the scale economies, I will propose a methodology to adapt the cost per TEU function from the ship level to the operator level and I am going to estimate this function. After my research I hope I will be able to answer the following question: Are shipping carriers achieving economies of scale through their alliances?

# An overview on previous literature

Maritime transport is clearly one of the most important fields in a globalized economy, most of long-distance traded goods are transported by ship so the efficiency of the maritime transport industry is obviously a necessary condition for the world economy to achieve a sustainable path of growth, to increase welfare, allocate resources correctly and to provide cheap goods to the population.

According to the importance that this field has to our society a huge amount of literature has been created covering a broad range of topics such as regulatory aspects, effects of trade liberalization on welfare and growth, technical and economic characteristics of vessels, the industry structure and organization or the behaviour of the principal agents, to name just a few.

Shipping liners are, jointly with ports, the principal actors of maritime transport sector and literature about these companies is also huge and covering different aspects. The regulatory framework and its effects have been largely examined and the same can be said about the theoretical impossibility of a perfectly competitive market within this industry, mainly following the "empty core" theory that proposes that due to the extremely high fixed costs and the relatively low marginal costs a competitive market would not allow agents to recover their investment so the maritime transportation services would not be provided. This is the main reason and theoretical argument to give an exemption of main competition laws to the operators and even to allow liners to form cartels, the so called "shipping conferences" that ruled the market before the 21th century began.

Strategic alliances are relatively new phenomena, the first wave was at the end of 1996 with the New World Alliance and the Grand Alliance agreement and the acceptance process of this horizontal integration method has been slow and focused on particular geographical regions. It is not until our days that alliances have consolidated and are viewed by operators as the right way to proceed, if not the only way of continuing in the industry. This is why literature is not as focused in this phenomenon as it is in other fields but, fortunately, some authors have been studying alliances among liner shipping operators from different points of view. There is an inherent degree of instability in a joint venture as strategic alliances are, Midoro and Pitto (2000) studied it and founded that organizational complexity, the way of designing incentives and competition among alliances members where the main rulers of this instability, which postponed the consolidation of the alliance way of operating. This complexity appears to be lower nowadays, when the alliances process is consolidating and there is much more knowhow of the right way of doing these agreements. Network designing, route frequency, the allocation of vessels and other operational issues have been investigated by Ryan (2001) and Slack et al. (2002) and they found some significant changes caused by strategic alliances such as the intensification of services and the deployment of larger vessels. Cariou (2002) built an operational model which had the function to assign different vessels among different routes depending on the number of carriers operating in the industry. He found that fewer operators would be more efficient in assigning correctly the vessels in the specific routes to cover a determinate demand.

Kadar (1996) submitted an hypothesis really similar to the one examined in this investigation, that in the case of liner shipping companies alliances one plus one is more than two so an strategic alliance would mean an increase of the joint output greater than the sum of previous individual outputs. This is clearly an explanation of economies of scale in the liner shipping industry. Unfortunately the period where this analysis was done, at the beginning of the first generation of alliances, could not allow Kadar to test his hypothesis and do empirical research.

Economies of scale have been intensively tested at the vessel level, the so called economies of size. The main hypothesis is that an increase in the total capacity of the ship, the amount of TEUs it can carry, would mean a decrease of the average total cost, the average cost per TEU. On the other hand an opposite effect is produced by an increase of the ship capacity, when this size increases some negative effects are produced such as an increase in the problems of going into the port, the increase of auxiliary ships to operate and an increase in the problems for loading the total slots of the ship, among others. That could mean a transfer of costs from maritime operators to the inland agents, to ports, terminals, inland logistics companies and finally to the shippers, companies that import and export goods using maritime transport services.

As it usually happens in economic fields, the two effects are always present and the predominant view is that as the vessel size increases the first effect, the scale economies, tends to disappear so the second derivative of the cost function would be lower than zero. The second effect, the problems of cascade, problems of completing the ship utilization and cost transfers to inland operators would increase more than proportionally with the increase of the ship size. This phenomena has been studied by Kendall (1972), Graham(1994), Lim (1994), Cullinane and Khanna (2000), Stopford (2004) Gkonis and Psaraftis (2009), and OECD/ITF (2015), to say some names among a long list. Their general conclusion is similar, that there are scale economies for containerships but tend to disappear as vessel size increase.

Thus, the general conclusion is that there is an optimal size of the ship that is the point as from negative effects are greater than the economies of scale cost reductions. This point has never been reached and empirical literature, industry agents and stakeholders are always increasing the size of the theoretical optimal ship, as well as dynamic factors such as technology or port gains in efficiency are confirming that pattern. By the year 2000 the commonly accept optimal size was about 9000 TEUs, nowadays the industry accepts ships of about 20.100 TEUs as the optimal ones, and we are almost at a step to surpass this barrier, liners are constantly ordering new vessels to cover transport demand and this vessels are every day bigger and more efficient. If this ship is the optimal one will depend on many factors such as the industry and ports flexibility and capacity of adaptation, technology and the behaviour of the demand.

Theoretical and empirical literature about maritime literature is huge and covers a broad range of topics, however the hypothesis that strategic alliances can cause scale economies has been little studied and not at all with modern data, is this why it can be really interesting to investigate this phenomenon.

# Methodology

The relevant market in this research is the Europe-Far East route, this route has been chosen in order to introduce simplicity in the research and assuming that the behavior of the average cost does not depend on the route. Furthermore it is the route where the four alliances control a more significant share of the total capacity.

The service analyzed is transporting a TEU from Europe to a Far East port, including port costs and container loading and unloading, so the final function will be the cost per TEU in a Europe-Far East service.  A TEU, acronym of twenty-feet-equivalent unit is the standard measure unit used in the transport and logistics sector and more specifically in the maritime transport sector. It is an inexact unit of measure equivalent to a standardized twenty feet container; the exterior measures of these containers are 6,1m x 2,4m x 2,6m.

Following Lim (1994) and Stopford (2004) cost structure of container shipping can be separated in fixed costs (Operating costs and capital costs), that are defined independently of the number of services that a ship does in an year or the number of TEUs that it carries, and variable costs (Port charges, container costs and bunker costs), that depend on the number of services or the amount of TEUs carried in a service.

Taking all this into account I have defined an average total cost function that depends on ship size and total TEUs carried per voyage:

$$\frac{CT(Q,Ss)}{Q} = \frac{Op(Ss)\times Tt}{Q} + \frac{K(Ss)\times Tt}{Q} + \frac{\left(P(Q)\times Q + P(Ss)\right)\times 2}{Q} + \frac{2Hc+Z+M}{Sc} + \frac{B(Ss,Q)}{Q}$$

Where;

**Q:** Number of TEUs carried

**Ss:** Ship size, total capacity expressed in TEUs that the vessel is supposed to be able to carry when it is fully carried.

**Op:** Operating costs per day. This is defined as crew expenses, stores and lubricants, maintenance and insurance cost per day, as well as the expenses of administration of the vessel.

**Tt:** Total time of the operation (Turnaround), it includes time in port and time at sea and time in port includes time in the European port and time in the Chinese port. The total turnaround time used is of 31 days; it is divided as 27 days at sea and 4 in port, two at each one. That data is from the regular liner observatory of the Port Authority of Barcelona.

**K:** Capital costs per day taking into account an expected life of 20 years, 4% of annual interest rate and no residual value (OECD, 2015).

**Pq:** Port cost per container set by the local port authority, this cost is present in both the departure and the arrival port. This cost is the median of costs provided by the port bill of the Port Authority of Barcelona.

**Ps:** Port cost per ship set by the local port authority, this cost varies with the ship size and will be taken into account two times because it is present in the two ports. This cost is the median of costs provided by the port bill of the Port Authority of Barcelona. In this bill the cost per ship is expressed as a function of GT, a unit of measure of the total size of a ship, in order to transform this unit to the standard one, TEUs, a formula provided by the "ECOcalculadora" of the Port Authority of Barcelona has been used.

**Hc**: Handling cost per container set by the terminal operator, it is taken into account two times, loading and downloading.

**Z:** Insurance cost per container

**M:** Maintenance cost per container

**Sc:** Size of container, it is the number of TEUs that are equivalent to a container. The sample container is of 40 standardized feet so its size equivalency expressed in TEUs is of two TEUs

**B:** Bunker cost (Fuel cost) per voyage. This cost has been calculated assuming a constant speed of 22 knots and a price of 300$ per ton of fuel (OECD, 2015). The distance used is of 8.776,6 nautical miles (Regular liner observatory of the Port Authority of Barcelona).

All these costs have been adapted and converted in order to represent the total cost per day. The turnaround time of a service beginning at the Port of Barcelona (Europe) and ending in Shanghai (China) is of 31 days thus, multiplying the number of days by the cost per day the result is the effective cost per TEU and per day

The previous equation can be rewritten as:

$$\frac{CT(U,Ss)}{U\times Ss} = \frac{Op(Ss)\times Tt}{U\times Ss} + \frac{K(Ss)\times Tt}{U\times Ss} + \frac{\left(P(U,S)\times U\times Ss + P(Ss)\right)\times 2}{U\times Ss} + \frac{2Hc+Z+M}{Sc} + \frac{B(Ss,U)}{U\times Ss}$$

Where;

**U:** Degree of utilization of the total ship's capacity. This U term has been introduced in order to link the cost function with the operational synergies that are supposed to happen due to the strategic alliances between carriers. The degree of utilization is calculated dividing the effective amount of TEUs carried by a vessel with the total capacity of that vessel.

With the estimation of this cost function and its representation the hypothesis of the scale economies of containerships will be tested, if the cost per TEU, the equivalent of the average total cost, decreases when the size of the vessel increases, this is the equivalent of the total output for a ship assuming 100% of utilization, then it will be proved than larger vessels cause economies of scale and gains in efficiency.

Up to this point all the estimations of different costs have been analyzed at a ship level and strategic alliances have not been introduced in the analysis. The next step is to introduce a link between costs of chartering a containership to Shanghai and strategic alliances, in order to do it a utilization rate term has been introduced previously. This term might be correlated with the number of operators acting in the market, when strategic alliances are created the level of utilization of the ships in the industry might increase due to the operational synergies among the different operators.

In order to test this relationship an OLS model will be estimated:

$$U_{i,t} = \alpha_t + \beta_1 N_t + \beta_2 Ss_t + \beta_3 D_t + \varepsilon_{i,t}$$

Where;

**α:** Constant term

**U:** Is the average rate of utilization of vessels in the market, data comes from the estimation of alpaliner consultancy provided in their monthly market monitor publication. This is the dependent variable of the estimation and it is assumed to show operational results in the industry, a low rate of utilization of vessels means that the effective capacity does not match with the real demand, that ships are underused and that there is inefficiency in the operational network. If ships are not fully loaded that is supposed to cause negative effects that will result on higher costs for shippers, liners and stakeholders.

**N:** Number of operator in the industry. Carriers or alliances that represent more than a 1% of the total market share are considered operators. When an alliance is formed the total number of operators decreases by the number of carriers forming the alliance minus one. This variable is the key term in order to test the scale economies caused by strategic alliances. If the coefficient of this variable appears to be significant it will mean that there is an effective correlation between the two terms. Some lags of this variable will also be introduced in the analysis following the reasoning that effects of a strategic agreement may take some time to appear.

**Ss:** Average size of the ship. This variable has been estimated using data of alphaliner consultancy and dividing the total operative capacity of the whole market by the number of operative ships. It is an average of all ships operating in the market and it is assumed to show the effect of the introduction of megaships in the maritime transport industry. As it is an average the effect of the introduction of a new megaship will be partially compensated by the fact that older and smaller ships are not substituted but still maintained operative. It is possible that this variable underestimates the complete effect in the rate of utilization of the introduction of new megaships but it is still a good proxy because it is pondering that effect by the effective importance that megaships have in the industry. It is true that the tendency to order big ships is accelerating but the importance that this megaships have in the total supply is still small.

**D:** Demand. This variable shows the evolution of the demand for maritime transport services in the economy. This variable is a good proxy of economic activity as well as of the substitutive industries to maritime transport. It is assumed to be closely correlated with the dependent variable and to explain the most of its variability. Data has also been collected at the alpaliners monthly monitor newsletter. This is an estimation carried out by alphaliner and the specific methodology of this estimation is unknown.

**ε:** Error term

The result will be an estimation using 75 monthly observations and covering the period from January 2009 to March 2015, so a temporal series of 3 independent variables.

Once this model has been estimated it is possible to introduce the proxy of the size of carriers, the number of operators, as a determinant of the average cost function. To show and test the effect of establishing an alliance in the average total cost function the variable utilization in the second cost function is substituted by the model that explains utilization as a dependent variable of the number of operators, demand and average ship size, then the demand and average vessel size variables are maintained constant, the first one 880.000 TEUs and the second at 3.735 TEUs, this values correspond to the real values of February 2014, month that has been chosen arbitrarily.

The last step is analyzing the resultant function, that only has one independent variable as a random variable so changing the values of it will show whether strategic agreements, thus the increase of the size of an operator, are causing scale economies or not.

To sum up, the main data sources are:

*Port Authority of Barcelona*: Port costs, both for container and for vessels and handling costs, turnaround time and distances, GT to TEUs formula.

*OECD, International transport forum: The impact of Mega-ships (paper):* Capital costs, operating costs and bunker costs.

*Stopford (2004)*: In this book data from *Drewry consultancy* about costs of maintenance and insurance of a container are showed. This data has been used to estimate the correspondent costs.

*Alphaliner consultancy: Monthly monitor:* Average ship size, demand of maritime transport services and average utilization of vessels in the market.

# Results:

The first step in order to analyze the existence of scale economies and gains in efficiency due to the formation of strategic alliances among carriers has been analyzing the presence of scale economies at the vessel level. Almost all the costs that result from transporting a good from Europe to the Far-East, the service analyzed in this paper, can be imputed to costs of fleeting a vessel with its crew and its containers.

This is the main reason why it is fundamental to have a first overview on the cost function from the ship point of view. A carrier, or a strategic alliance, is not more than a company that has different vessels among different routes so the cost function of fleeting a vessel from an initial port to another port will be truly related with the cost function of the shipping liners.

The cost function of a ship doing the Europe-Far East route is defined as follows:

$$\frac{CT(Q,Ss)}{Q} = \frac{Op(Ss)\times Tt}{Q} + \frac{K(Ss)\times Tt}{Q} + \frac{\big(P(Q)\times Q + P(Ss)\big)\times 2}{Q} + \frac{2Hc + Z + M}{Sc} + \frac{B(Ss,Q)}{Q}$$

This cost function contains the main components of the costs paid by operators. The main parts of the function are; operating costs such as crew wages, lubricants, stores and spares or dry docking. The next component is capital costs that are determined by the new building price as well as the cost of financing it. Costs in port are also a fundamental part of the function and here is where the first diseconomies of scale are supposed to appear, looking at ports legislation, prices for big vessels are greater so it can produce a negative effect in terms of costs. Finally costs per container, unrelated with the vessels size, and bunkering costs, are the last determinants of the cost of transporting on TEU from Europe to the Far-East region.

The main data source that has been used to estimate the different costs has been the OECD paper: "The impact of megaships" (2015), as well as data coming directly from the Port Authority of Barcelona used to estimate direct port costs. From these data sources some calculus, estimations and changes have been introduced in order to have a better overview on costs structures. These costs can be summarized as follow; all costs are costs per TEU, the equivalent of talking of average total costs. The monetary unit of measures is US$:

| TEUs | 5.652 | 7.500 | 9.000 | 12.500 | 15.000 | 19.000 |
|---|---|---|---|---|---|---|
| Bunkering | 186 | 173 | 162 | 123 | 116 | 92 |
| Operating | 47 | 39 | 34 | 28 | 27 | 23 |
| Capital | 81 | 80 | 77 | 73 | 68 | 63 |
| Port costs per ship (2) | 0.34 | 0.33 | 0.33 | 0.31 | 0.30 | 0.30 |
| Port costs per container (2) | 33.3 | 33.3 | 33.3 | 33.3 | 33.3 | 33.3 |
| Handling cost | 138.75 | 138.75 | 138.75 | 138.75 | 138.75 | 138.75 |
| Container maintenance and insurance | 18,75 | 18,75 | 18,75 | 18,75 | 18,75 | 18,75 |
| TOTAL ($) | 505 | 482 | 465 | 415 | 402 | 369 |

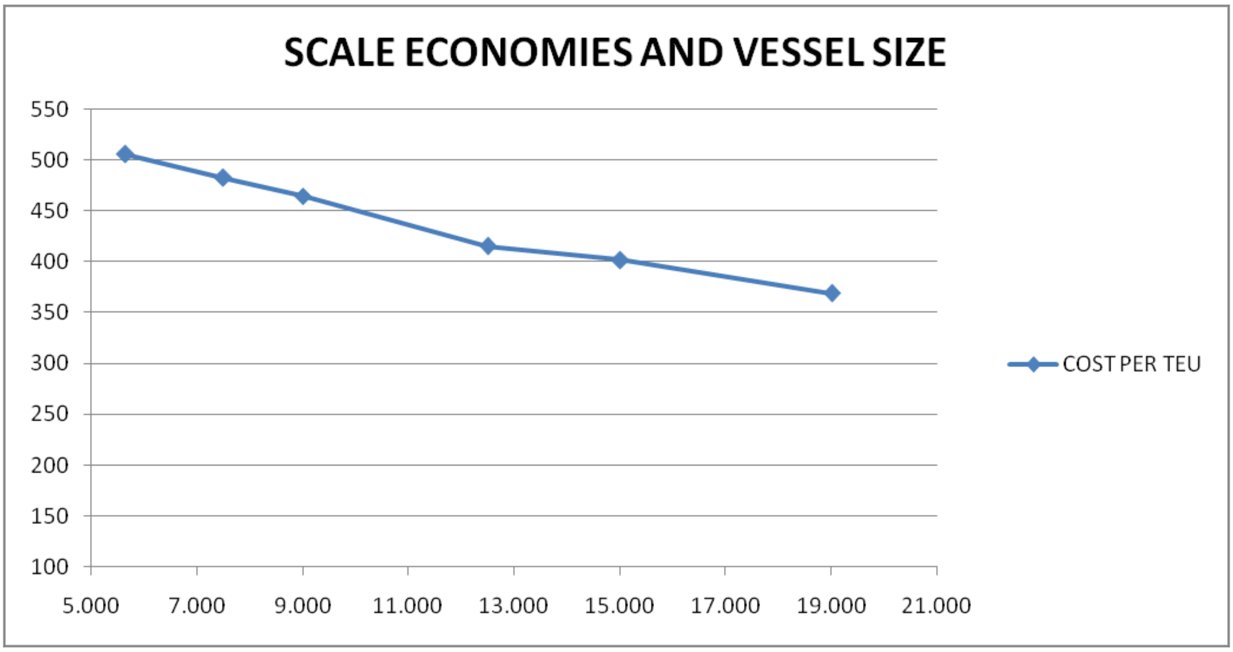
*Source: Own elaboration from OECD (2015), Stopford(2004) and Port Authority of Barcelona*

There is an evident decrease in the fixed costs of a vessel when the size of it is increased. In variable costs, the costs related with cargo and containers, there is not reduction and it is possible than this costs increase due to problems at port such as handling too many containers, the entrance of the ship and other operational difficulties. Port authority dues per TEU seem to decrease up to a point where get stagnated. This cost is discretional and depend on public authorities so it cannot be interpreted as a result of market forces or economic factors.

Bunkering costs also decrease with size. This can be interpreted as driven by two main forces; the first one is the decrease in average total cost as total capacity increases while the fuel consumption remains relatively stable because fuel consumption do not increase proportionally with total capacity of vessels. The second force is caused by gains in vessels efficiency and a better technological level of ships. As the biggest ships are also the newest there is an effect that is not related with economies of size but that seems to cause these economies. It would be interesting to try to correct this effect when analyzing economies of scale caused by megaships.

Capital and operating costs, jointly with bunkering, are the main factors behind the reduction in the cost per TEU analyzed here. Capital and operating costs reduction can be mainly understood as fixed costs of a vessel when it is built and operated. The marginal cost increasing of building a bigger ship is not as big as the marginal cost reduction of increasing its capacity, this is due to mechanical and ship engineering factors and because of the way the ships are built. Analyzing operating costs we can see that operating a bigger ship does not need a proportional increase in the crew, the same happens with stores or lubricants. An ambiguous effect could take place with insurance costs. A bigger vessel surely means a higher risk premium but if it is compensate by the increasing capacity effect is not sure. However, what is clear is that as well as average capital cost, average operating costs decreases as total capacity increases.

The following graph shows this effect:




*Source: Own elaboration from OECD (2015), Stopford(2004) and Port Authority of Barcelona*

Cost per TEU reduction is clear in the previous graph, as commonly is said by investigators on maritime transport, when ship size increases, cost per TEU decreases. What it is not so obvious is the reduction in the slope of the function when capacity increases. Literature has emphasized that the most important effect of scale economies took place when sips passed from 3.000 TEUs to 5.000, this segment has not been analysed so it can be the reason behind this apparent contradiction. What seems clear from this analysis point of view is that it is not always true that the scale economies effect tends to disappear when the ship increases too much, the cost function is not a continuous function that has a regular and stable behaviour, it depends on multiple and dynamic effects so it is possible that the point where the marginal cost reduction tends to zero has been postponed by technological changes or gains in port terminals efficiency.

Slot issues and capacity analysis has not been introduced yet so it is also a possible reason to expect the slope of the function not to decrease. The main reason argued by previous literature is that economies of scale tend to disappear due to operating difficulties as well as capital and port costs increases. Capital costs have been found to decrease and port costs seem to be constant or to depend on exogenous factors. The next step in this analysis is to introduce slot and operating variables.

In order to introduce utilization variables and to link vessel costs with carrier's costs a new function has been defined transforming the initial one. The main step here is to redefine the variable "Quantity" as the multiplication of "Ship size" and "% of Utilization". When a ship is carried with merchandise in a port it is not commonly carried with all its capacity.

The percentage of utilization varies with different factors and one of these factors is probably the ship size, as discussed before. The more interesting variable in this analysis is however if shipping liners are acting jointly as a strategic alliance or are acting independently. One of the reasons that carriers have argued to form alliances is that acting together they would be able to offer more services to stakeholders, to increase the frequency, the quality of the vessel and to reduce the slot price increasing the percentage of utilization of the vessels. It can be understood that if it is needed in the industry to operate large ships and as the average ship size increases it is every time more difficult to full this ships. Strategic alliances could be an efficient way to maintain or even increase the utilization of ships, reducing costs.

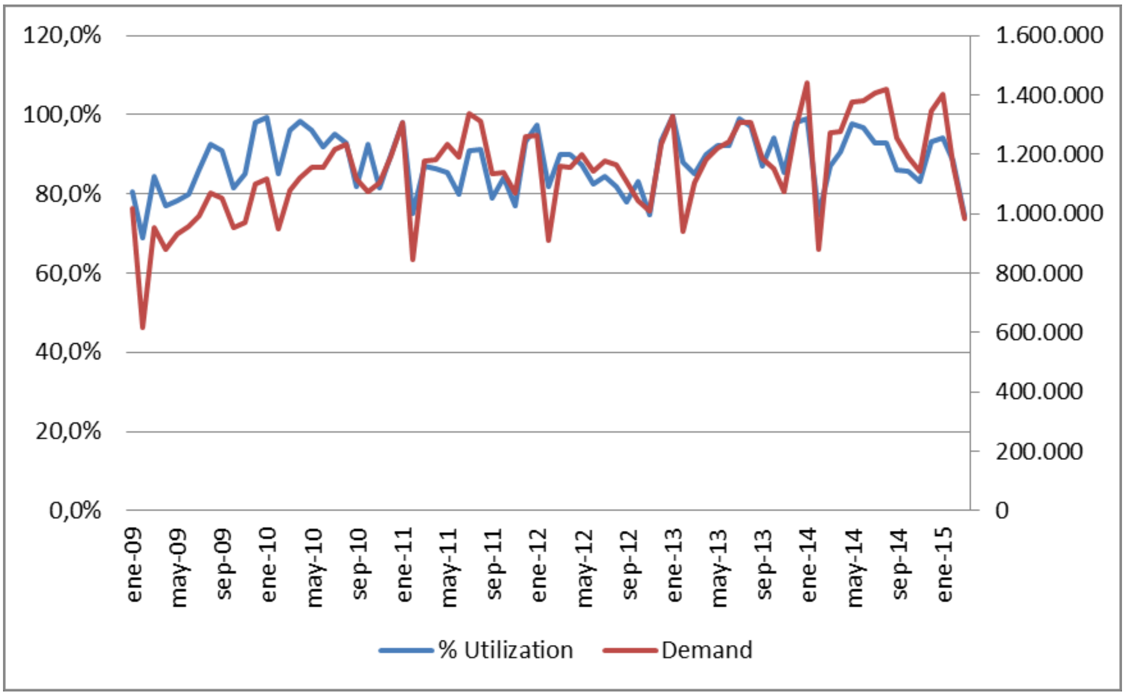
The redefined cost function, now introducing a link with strategic alliances and beginning to abandon the ship point of view is the following:

$$\frac{CT(U,Ss)}{U \times Ss} = \frac{Op(Ss) \times Tt}{U \times Ss} + \frac{K(Ss) \times Tt}{U \times Ss} + \frac{\left(P(U,Ss) \times U \times Ss + P(Ss)\right) \times 2}{U \times Ss} + \frac{2Hc + Z + M}{Sc} + \frac{B(Ss,U)}{U \times Ss}$$

This new function, that redefines the variable “Quantity” and introduces a link between operating issues and average total costs, so introduces by first time carriers in the cost function, is only the first step in order to analyze the possible gains in efficiency derived from de settlement of strategic alliances.

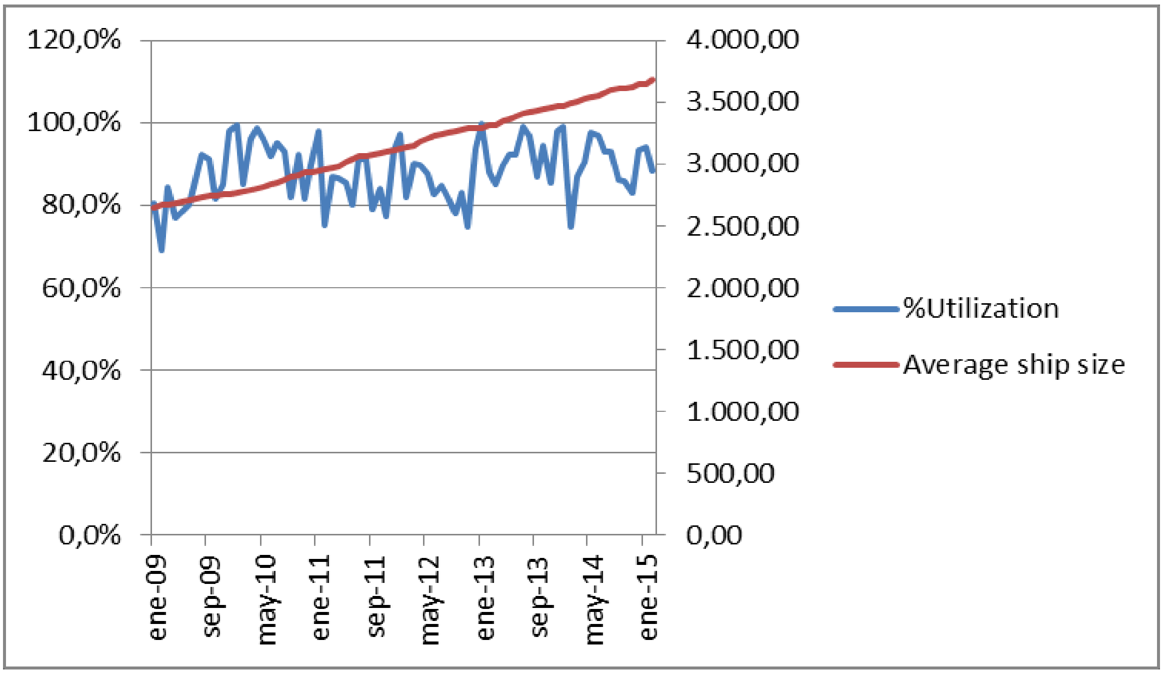
The following step is to test the hypothesis that forming an alliance means an operating advantage so the average utilization of ships increases as agreements among carriers take place. To test this hypothesis an OLS model has been estimated introducing the variable “average % of utilization in the market” and to model it with different variables that are understood to explain its variability. These variables are the average ship size in the market which is supposed to affect negatively the utilization percentage, a market demand variable and the number of operators acting in the industry. The last variable is the core of the analysis. When an alliance is formed the number of operators decrease so if it is true that strategic alliances mean operating benefits and economies of scale the relationship between the two variables would be negative. When an alliance is formed the number of operators in the industry decreases and the average vessel utilization in the market increases, this is the main hypothesis to be tested in this research.

The following graphs show the relation among de different independent variables introduced in the model and the Utilization variable:



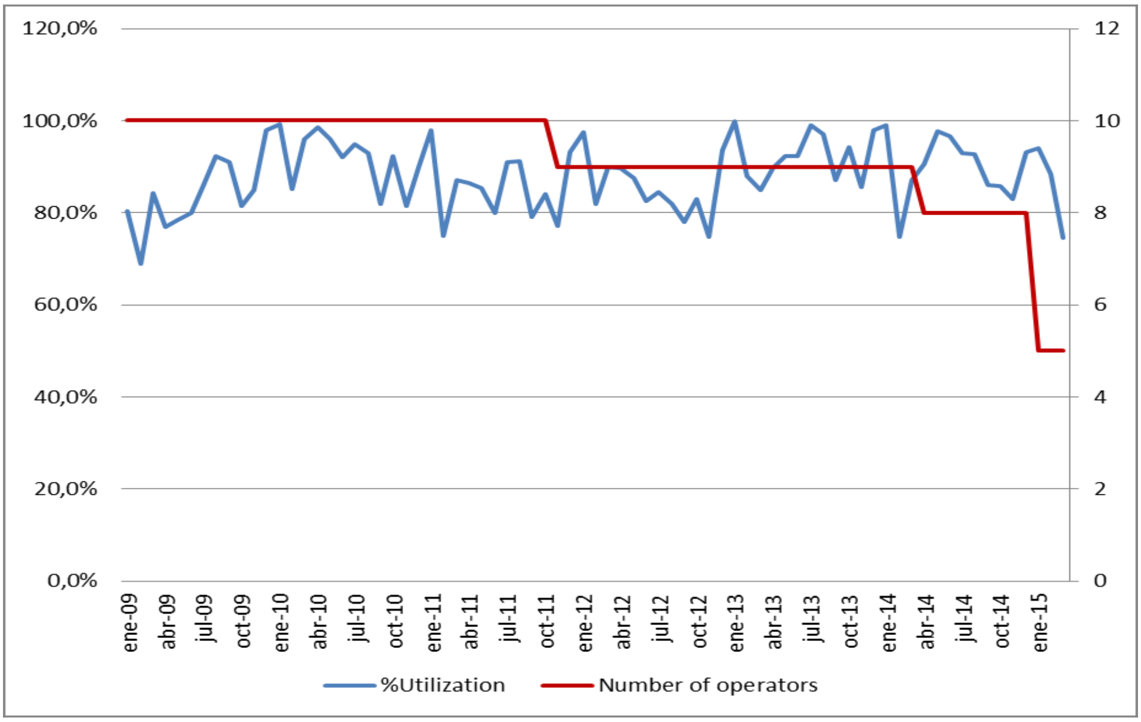

*Source: Own elaboration from Alphaliner's monthly monitor data*

It is clear the relationship between the two variables plotted in this graph, it is also interesting to see the seasonal component of the demand for shipping liner's services, which also affects the utilization rate and which is mainly caused by the paralysation of the Chinese economy at the first months of each year, coinciding with the "Chinese new year". It can also be seen that the correlation between the two variables is increasing with time so it seems possible that supply is increasing its ability and flexibility to match the demand.




*Source: Own elaboration from Alphaliner's monthly monitor data*

The average ship size follows an increasing pattern through time, it does not seem to have a close relation with the variable analysed.




*Source: Own elaboration from Alphaliner's monthly monitor data*

The core variable of this analysis, the number of operators in the industry, seems to be quite uncorrelated with the utilization level, it is true that after the October 2011, when G6 is formed, the average utilization does never fall below the 70% but it does not seem enough to consider for the moment that one variable is causal of the other, much more analysis is still needed and the OLS estimation is needed in order to introduce light to this relation.

It is also possible that forming a strategic alliance does not affect the other variables immediately; it is really probable that a specific period of time is needed for alliances to begin working correctly and to affect the market. To begin to operate jointly with a company with which there was no relation before is a difficult and long process so it seems reasonable that the effects of a decrease in the number of operators do not appear until a period of time has passed. To show and test this effect lagged variables of “Number of operators” have been introduced in the analysis.

Lagged variables up to 24 periods have been introduced and the apparently more significant were the 1 lag observation, this is one month lagged variable and the one year lagged variable, this is 12 observations lag. This is why the variables regressed against “Average % of Utilization” are the 1 and 12 lagged variables of “Number of operators”

The OLS estimation following the next function has been estimated in order to assess the effects of changes in the independent variables to the dependent variable, the average rate of ship’s capacity utilization:

$$U_{i,t} = \alpha_t + \beta_1 N_{t-1} + \beta_2 N_{t-12} + \beta_3 Ss_t + \beta_4 D_t + \varepsilon_{i,t}$$

The result of the OLS estimation using monthly data from Alphaliner maritime consultancy and covering the time period from January 2009 to March 2015 is as follows:

Modelo 1: estimaciones MCO utilizando las 63 observaciones 2010:01-2015:03

Variable dependiente: Utilization

| *Variable* | *Coeficiente* | *Desv. típica* | *Estadístico t* | *valor p* | |
|---|---|---|---|---|---|
| *Const* | *2,57296* | *0,377548* | *6,8149* | *<0,00001* | *** |
| *Demand* | *4,21644e-07* | *4,2753e-08* | *9,8623* | *<0,00001* | *** |
| *Number_of_o_1* | *-0,0227662* | *0,00927259* | *-2,4552* | *0,01710* | ** |
| *Number_of__12* | *-0,103567* | *0,0202169* | *-5,1228* | *<0,00001* | *** |
| *Average_ship_si* | *-0,000305885* | *5,16627e-05* | *-5,9208* | *<0,00001* | *** |

*Media de la var. dependiente = 0,888429*
*Desviación típica de la var. dependiente. = 0,0695819*
*Suma de cuadrados de los residuos = 0,0962354*
*Desviación típica de los residuos = 0,0407337*
*$R^2$ = 0,679409*
*$R^2$ corregido = 0,6573*
*Estadístico F (4, 58) = 30,729 (valor p < 0,00001)*
*Estadístico de Durbin-Watson = 1,59401*
*Coef. de autocorr. de primer orden. = 0,175734*
*Log-verosimilitud = 114,856*
*Criterio de información de Akaike = -219,712*
*Criterio de información Bayesiano de Schwarz = -208,996*
*Criterio de Hannan-Quinn = -215,497*

Analysing the principal indicators, all variables are significant at a 5% confidence level, the model explains a 68% of the variability of the dependent variable, twelve observations among 75 are loosed due to the introduction of a twelve periods lagged variable and there seems to not exist multicollinearity among the dependent variables.

Error term seem to be also no auto-correlated so the estimation seems to pass the main tests.

The first variable to be analysed is “Demand”. This variable is highly correlated with the dependent variable, it is significant at a 1% level and it is probably the variable that explains the majority of the variability of the utilization rate. It has been introduced in order to create a correct model because it seems clear that demand in a market is the main driver of the utilization rate in that market. If there is a drop in the effective demand and supply remains constant the utilization of the ships will decrease.

The main hypothesis tested in this regression is whether the parameter of the variable “Number of operators” is significant or not and it appears to be really significant, at a 1% level of confidence for the 12 periods lag. For the 1 month lag it is statistically significant at a 5% level of confidences so the null hypothesis that says that the effect of a change in the number of operators has no effect to the average utilization level of the industry 1 and 12 months later is rejected at a 5% confidence level.

This result introduces some light and confirms the initial assumption demonstrating that, at least from a statistical point of view, the process of alliances among different carriers has an effect to the total utilization level of the ships. The argument introduced previously that alliances would take some time to operate correctly, mainly due to difficulties in implementing the joint process, to introduce an effective communication between both parts and to adapt the behaviour of two or more completely different carriers, has been also confirmed. The two lagged variables tested were the more significant and they appear both to be significant. This result is coherent with common sense, it seems logical from an economic point of view that rigidities of different kinds, such as informational rigidities or inefficiencies at a contractual level, in addition to the rigidities in the process of implementing, of even designing, an operational plan for a really complex market would let the strategic alliances to need a more or less long period to acquire a good enough level of know how in order to produce gains in efficiency an operational benefits to the industry.

The coefficient of 1 month lagged variable of "Number of operators" is (-0,023), this is coherent with the initial assumptions as a reduction of the operators would mean an increase in the utilization level. Specifically a strategic alliance among two carriers, this is the case of the last alliance done, the 2M alliance formed by Maersk and MSC, would mean a reduction of one in the number of operators and an increase of the 2,3% of the utilization level the next month.

Analysing the coefficient of the one year lagged variable it is founded to be more significant than the one month lag and even the coefficient of the variable is higher so the largest effect on utilization of a decrease in the number of operators seems to appear when a period on twelve months have passed. The coefficient is (- 0,103), so after a period on an year the settlement of a two members alliance would mean an increase of a 10,3% in the average ship utilization level of the industry. If we add the two effects, because the first effect is also acting when the twelve months effect happens, the total result is an increase of the utilization level of 12,6%. This is a really big number so strategic alliances would be really justified in terms of increasing the operational efficiency of maritime transport.

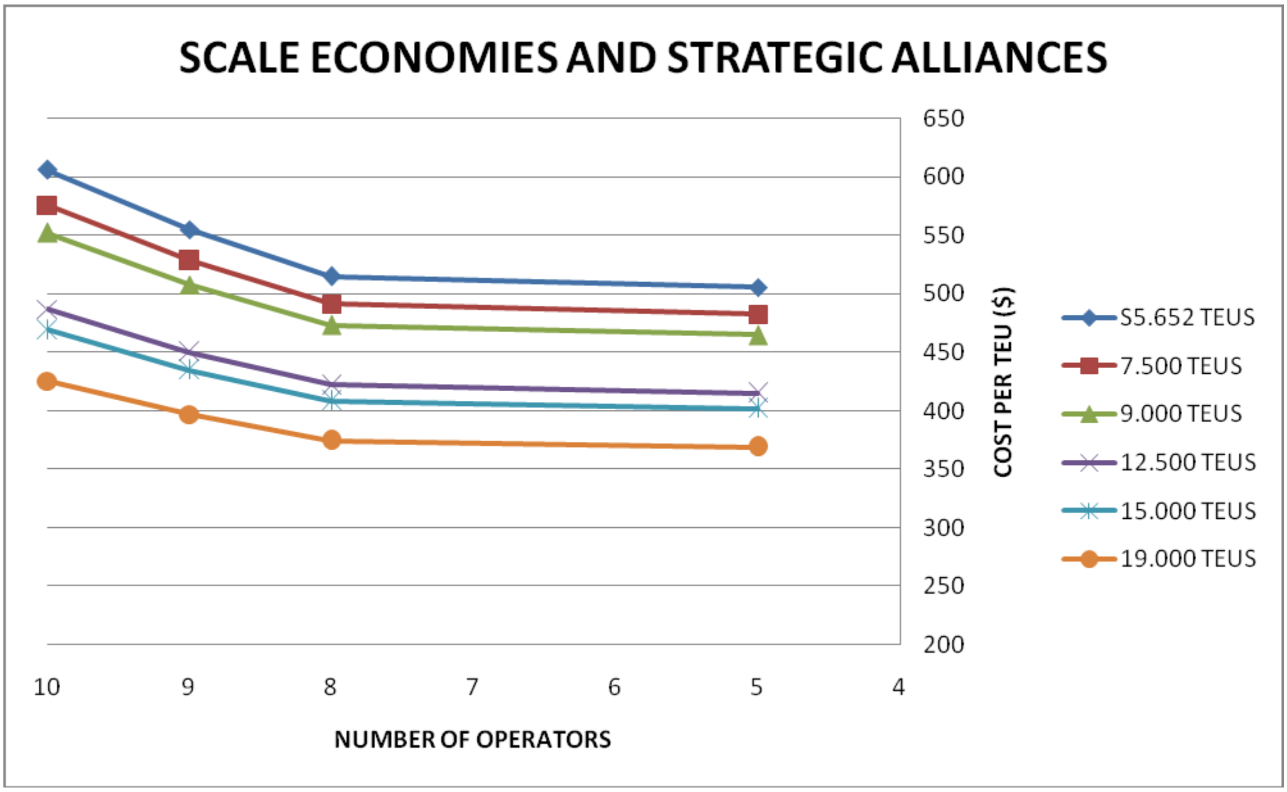
The second variable to be analysed is the average size of the vessels operating in the industry. This average size has been increasing constantly during the observed period driven by the introduction of megaships in the industry. A megaship, as previously explained, introduces economies of scale in the industry, so it causes gains of efficiency but, on the other hand, it may introduce operational problems. The variable "Average ship size" is significant at a 1% confidence level so it there is a clear relationship between the introduction of megaships and the utilization of these ships, the coefficient is negative so introducing new and larger ships in the transport sector causes the difficulty to full these ships to increase, this is represented in the model by the utilization of the vessels decreasing. The coefficient of the variable is (-0,0003) so an increase of 1.000 TEUs by the average ship of the industry would mean a decrease of the utilization average of the 30%. This is a really high value and an increase of 1.000 TEUs in the ships average seems to be a realistic assumption. Upon the period analysed this variable has increase from 2.649,5 on January, 2009 to 3.687,4 on March 2015.

There are two main forces operating nowadays in the maritime transport industry; the first one is the creation of strategic alliances among the different carriers which used to compete in the past, the second is the order, and effective construction, of megaships that are near to surpass the line of the 20.000 TEUs barrier, line that was seen impossible to cross not long time ago. These two forces have opposite effects on the core variable of this analysis so it seems reasonable than the two processes are truly correlated and cannot be understood separately. On the one hand we have the delivery of every time bigger vessels in order to achieve economies of scale and reduce cost per TEU, but this process has negative effects from an operational point of view, to solve this and to try to avoid these negative effects carriers have begun a process of strategic alliances, of reduction of the number of operators in the industry, that has increased the average rate of containership utilization in the industry.

Understanding the formation of strategic alliances as the reduction of number of operators in the industry means a decrease in the number of operators. Remaining constant all other variables so the total output of the industry being the same, a decrease in the number of operators means an increase in the average output by operator. This is the principal reasoning in this investigation. Strategic alliances have been proved to increase the utilization rate of ships and the utilization of a ship is clearly one of the main drivers of the cost per TEU function. The first table of costs was represented assuming a 100% level of utilization, so the final step is to remove that hypothesis and to substitute the variable “Utilization” with the model estimated previously.

If variable “Demand” is kept constant at an 8.000 level and “average ship size” is fixed at a 3.500 point the effect of the reduction of the number of operators, this is the formation of strategic alliances, can be estimated.

The next graph shows cost per TEU function by different vessel sizes and different number of operators in the industry:




*Source: Own elaboration from Stopford (2004), OECD (2015), Port Authority of Barcelona and Alphaliner's consultancy*

Analysing this graph it seems clear than strategic alliances have an effect in the average total cost representative function of the maritime transport sector, it can be understood as setting up higher rate of utilization of the ships or as allowing the operators to full the new megaships they are introducing in the market. What seems clear is that the process of introducing new and larger ships, jointly with the establishment of operational synergies and agreements among operators with the creation of strategic alliances is making the liner shipping industry much more efficient.

# Conclusions

Strategic alliances have been one of the principal factors of the evolution of the maritime transport sector since the first agreements that resulted in the Grand Alliance and the New World Alliance in 1996. This form of horizontal integration has its particularities, advantages and disadvantages; it is an agreement to operate containerships jointly, to schedule the routes and frequencies and to share slots and equipments without losing the juridical independence, so without merging. This introduces implicit instability in the agreement in addition to incentives to break the deal and act against the common good of the alliance. Is for that reason that the consolidation of that form of cooperation has been slow and knowhow has been achieved during a difficult process, some alliances have failed and operators have broken the agreement, others have been forbidden by public authorities.

However strategic alliances are consolidated nowadays, the creation of the G6 alliance on 2011 and the formation of Ocean 3 and 2M in January 2015 confirmed the pattern in the industry and actually alliances are seen as the best way of horizontal integration in order to gain efficiency and reduce costs.

To operate mega-ships is also the reason that has consolidated strategic agreements; the average size of vessels has increased constantly and every time bigger ships are being delivered to companies, surpassing the barrier of 20.000 TEUs. This increasing in containerships capacity has come in parallel with the phenomena analysed and both are clearly correlated, operating a mega-ship is an adventure in which it is difficult to succeed, it means losing flexibility, concentrating the cargo with the increase in costs that this means and needing an absurdly huge critical mass in order to obtain a reasonable level of capacity utilization.

Economies of scale, that result of a strategic alliance among different maritime carriers, have been tested during this investigation and alliances have been confirmed as a good way to increase ship capacity utilization and to reduce average total costs.

The main force behind this fact is the increase in ships capacity utilization due to the operational synergies that acting jointly as an alliance provides.

It is not the same loading a mega-ship of 20.000 TEUs alone, with the difficulties is terms of slot chartering and inland transportation that this has that doing this together with one or two different carriers. It is also probable that carriers are simply unable to catch enough critical mass acting alone. If total production that needs to be transported at a determinate day remains relatively stable it is simply impossible that all the carriers that used to do that service continue doing it with double sized vessels. It is true that competition may cause some carriers to stop doing that service up to the point where there is enough critique mass to full the ship of one or two carriers but this is a long and hard process, supply is really slow to adjust to demand in the vessel transport sector and strategic alliances seem to be the best way to undertake that process and to adjust operational capacity in order to avoid a hard crisis that could have hit the industry.

Liner shipping alliances are supposed to be implemented gradually so it is logical that the effect on efficiency and other variables is found once some time has passed. This period of time has been founded to be a year, once twelve months have passed the agreement is fully operative and effects on average utilization are completed. These effects have been founded to be of about 13% of previous utilization level by settling an agreement between two big carriers; this is a really large number that shows the good results of that way of horizontal integration when introducing operational gains.

The increase in vessel size has also been founded as crucial to understand the operational efficiency of the industry so the average utilization level of ships capacity. As ships capacity increases it is every time more difficult to load them, the critical mass needed to achieve a sufficient level of utilization to ensure sustainability and profitability is larger and it needs to be concentrated in peaks of cargo, thing difficult to achieve by the exporting and the importing industry and the transport operators, both inland and maritime.

An increase of 1.000 TEUs in the average vessel size reduces average vessel loading by a 30%, this is a really important figure and illustrates why the process of alliances have had such a good effect in terms of operational efficiency. If those ships were operated without the advantages that acting together introduces average utilization would have dropped intensively causing tremendous looses to carriers and maybe a huge crisis in the industry which could have damaged all stakeholders, from ports to shippers, in addition to inland logistics operators and obviously the final costumers. Average utilization level has kept constant or even increased so strategic alliances are confirmed as a success.

These two processes, the building of mega-ships and the establishment of alliances have appeared together and have been interacting during the last decade, they are closely correlated and one cannot be understood without the other. If mega-ships were not built strategic alliances would not be needed to maintain the level of utilization in the market, which was relatively high before, and if strategic alliances were not formed it is simply impossible that mega-ships were operated correctly, fact that would have let the industry to a hard reorganizational period and probably the same level of concentration in the industry. This establishes a link with the main theory that has ruled the literature about shipping liners and the main regulations of the sector.

That theory explains that it is impossible that the service of transporting containers by ship from one extreme of the world to the other and obtain profits in an industry where there are a big number of operators. The fixed costs and the operational difficulties are too large so there would exist an "empty core" in a game with many agents. This has been probably exacerbated by the apparition of mega-ships so the number of operators in the market needed to provide a core to the game may have decreased, this could be one explanation to the process of strategic alliances in liner shipping.

Whether the previous theory is true or not it is clear that the combined process of mega-ship operating and jointly acting has introduced gains in efficiency so the economies of scale in the carriers industry seem to be clear. This cost reduction does not mean increases in the consumer surplus, lower freight rates or increases in the total welfare of the economy. It is possible than cost reduction goes to the supplier surplus due to the capacity that concentration of the industry gives to the agents to collude and fix monopoly prices. If this happens the situation described during this investigation may simply suppose a transfer of costs from maritime operators to inland operators and final consumers. If the reduction of costs is not transferred to the final price that would mean that all costs of the reorganization process, investments that ports are doing and the process of adaptation of inland transport operators, as well as the bad services and uncertainty produced during the process of settling the alliance, are assumed by agents that do not form part of the maritime industry, by the whole population. That would mean a clear transfer of resources from a part of the population to an organized sector, an externality and a clear inefficiency.

Studying all that is out of the scope of my final degree investigation but, and due to the clear importance that the maritime transport sector has for a healthy, competitive and sustainable economy, as well as for the welfare of the population, it would be really interesting to go further with this investigation and assess the effects of liner shipping alliances on total welfare.

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