COLD CHAIN IN THE SHIPPING INDUSTRY: BULK VERSUS CONTAINER IN THE BANANA TRADE

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ABSTRACT

Since the last few decades the reefer transportation market has been increasing due to the constant demand growth. Despite the recent global crisis affecting households in terms of purchasing power, cold chain shipments still represent basic products for human consumption. Products such as flowers and pharmaceutics, traditionally transferred by air, are now shipped via sea due to the advantages given by new technologies on maritime transportation. Therefore, the reefer sector is currently one of the most promising markets of the overall shipping industry.

During the last twenty years the reefer shipping sector has been characterized by a gradual changing process, leading from specialised vessels to reefer containers. In fact, the reefer bulk fleet has experienced an irreversible decline, while the reefer container fleet has shown a continuous growth. Some evidences of this trend emerge from the strategic behaviour of global ocean carriers like Maersk Line and MSC. These players are gaining market power in cold chains by investing in services for reefer containers and also by offering the conditions to attract perishable cargo from the air industry.

This paper investigates the current major aspects shaping the reefer shipping industry in order to understand the economic drivers inducing competition between bulk and containers. Therefore, a twofold analysis has been developed. First, an overview of the reefer market, including the demand for refrigerated products and the supply of reefer capacity given both by containership fleet and by conventional reefer fleet. Second, a specific case of the banana trade has been carried out for knowing all service costs along the cold chain. The results reveal the market tendencies, focusing on the sources of competition for bulk vs. container.
Keywords: reefer, bulk, container, shipping industry, cold chain, banana trade, cost structure.

1 INTRODUCTION

Over the last twenty years, international trade of reefer products has increased continuously. As a consequence, shipments of perishable commodities via sea have expanded and changed: the volumes of reefer cargo carried by the specialised reefer fleet have been gradually eroded by the incoming competition of containership fleet.

New build orders for specialised bulk vessels are more and more scarce and very few contracts have been allocated to them during the last years. In contrast, the ordered containerships equipped with electrical slots for carrying reefer boxes are increasing. Even if the bulk reefer sector still exists holding an important share of demand, it is a fact that the percentage of refrigerated cargo recently moved in reefer containers is growing fast.

The massive growth of the reefer container fleet depends on many factors, mostly economic and technological. As containerships are increasing in size the relative portion of reefer plugs is increasing as well. This stems from the economies of scale in these vessels. Next to this technological innovations have been applied to both bulk vessels and reefer containers at a high pace. All this leads to a very intense competition between container operators and the reefer industry. The last one finds itself in a phase of stagnation because of this and is likely to lose further market share in the future.

Primarily, the historical development of the bulk reefer ships and containership fleets has been evaluated, as well as their associated capacity, particularly in recent years, when the massive increase in reefer capacity offered by the containerships has been one of the most relevant fleet trend in the shipping industry.
Secondly, a case study has been developed on the banana cold chain, which continues to be highly dependent upon specialised reefer ships, to compare the costs for transporting a pallet conditioned in a reefer container with the costs for transporting a pallet traditionally shipped in a bulk reefer vessel. Therefore an evaluation of the profits for each actor involved in the chain has been provided, to demonstrate how profitable the banana trade is.
Indeed, the main objective of this study is to analyse the principal factors supporting the massive development of the containerisation in the reefer shipping market. Moreover, it is aimed to investigate why the traditional reefer segment still represents a consistent share of this market, especially in the banana trade, even characterised by an almost irreversible decline.

In order to investigate the reefer shipping industry and its main dynamics, this paper has been divided into four sections. An overview of the reefer shipping market considering the leading operators and their fleet have been provided in section two. The third section is focused on the banana cold chain and a real case illustrates the costs for transporting a reefer container and a bulk reefer. Finally, in section four some conclusions are drawn on the complete analysis, mainly concerning economic aspects of trade-off bulk vs. container in the reefer shipping market.

2 REEFER SHIPPING MARKET

The market of reefer shipping has been shaped by the increase in the seaborne reefer trade from the demand side, and by the competition between the specialised reefer industry and the container from the supply side, especially in recent years. As soon as refrigerated flows grow, this competition increases and new technological solutions appear in the market. In order to analyse the characteristics of this market, a study has been developed on the actual demand of reefer shipping and the relative supply from maritime companies, including the changes in their overall fleet and the reefer capacity currently offered.

2.1 Definition of cold chain

A cold chain can be defined as the transportation of temperature sensitive products along a supply chain through thermal and refrigerated methods and the logistical planning to protect the integrity of these shipments (Rodrigue and Craig 2009). There is a segmentation of cold chains according to the several niche markets of reefer commodities around the world. Reefer foodstuff comprises “chilled” and “frozen” products that require different temperature level maintenance to guarantee their integrity during transportation via sea along the supply chain. Chilled commodities are mainly composed by fruit cargoes and require a temperature around 0°C or higher (i.e. bananas need 12-13°C), while frozen products need to be maintained at -18°C or even less and include primarily meat, seafood and dairy products.

Beyond the food commodities usually imported there is a significant range concerning other reefer cargoes. Every type of commodity requiring special thought, equipment and care may be transported in a reefer container, from the Hermitage paintings to Italian wine, from Japanese bonsai to Italian ski equipment. One the most profitable segment is the pharmaceutical one: about 20 billion dollars is the value of medicines requiring reefer transportation (Health Distribution Management Association, in Rodrigue and Craig 2009).

2.2 Seaborne trade of refrigerated commodities

In the last twenty years a strong increase has been seen in the seaborne trade of perishable goods, which represents a consistent part of the international reefer trade (more than 60%)[1].
The historical development of the world reefer trade (Fig. 2.1), has shown a moderate growth of volumes from 1961 until 1985, with a 3,9% annual average growth rate.
After the mid-1980’s, an untypical rapid increase in volumes took place, probably as a consequence of the new reefer markets’ prosperity (particularly Russia and East Asia) and of the progressive containerisation of many refrigerated commodities. Indeed, more than 7 000 TEU containerships appeared on the market in the 1990’s, with 700-1 000 TEU of capacity dedicated to reefer containers.

[1] Source: Drewry, 2006.

During the latest ten years, the volumes of reefer trade have shown a further increase, growing from 90 million tonnes in 1998 to the current 156 million tonnes (Drewry 2009).

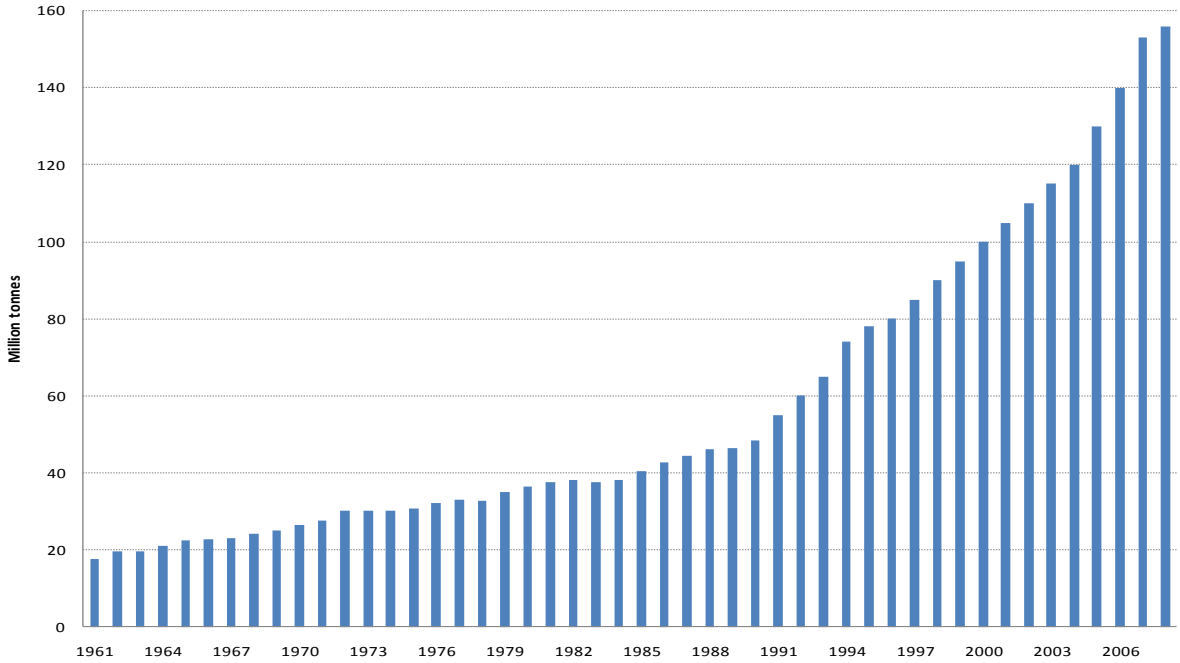

***Figure 2.1** – Historical evolution of the world reefer trade*

Source: authors' own elaboration from Nomadic Shipping ASA (2000) and Drewry (2009)

The products comprised in the reefer demand have a strong correlation with world output, and depend on the rising level of consumption of perishable goods in mature markets located in West Europe and North America, and also on the socio-economic development of many emergent markets - China, East Europe, India and Russia - some of the main importers of reefer commodities in recent years. Exogenous factors such as climate diseases or economic recession have affected the imported volumes but only for short periods.

The sea transportation of food has continued to grow in correlation with international trade. In 2002, an estimated 1200 billion dollars worth of food was transported by a fleet of 400 000 refrigerated containers (Gac 2002).
Concerning the actual composition of the seaborne trade of perishable products, the largest individual commodity in terms of tonnage is represented by banana. Fruit and vegetables account for almost 60% of all reefer cargo, while seafood is the category with the most rapid growth in recent years (Garratt and Teodoro 2008).
The increase of reefer commodities traded via sea across the decade 1994-2004, illustrated (Fig. 2.2), reveals that the commodities with the highest rate of annual growth are meat, fish and exotic fruits, while bananas, citrus and deciduous fruits have risen slightly from a volume perspective.

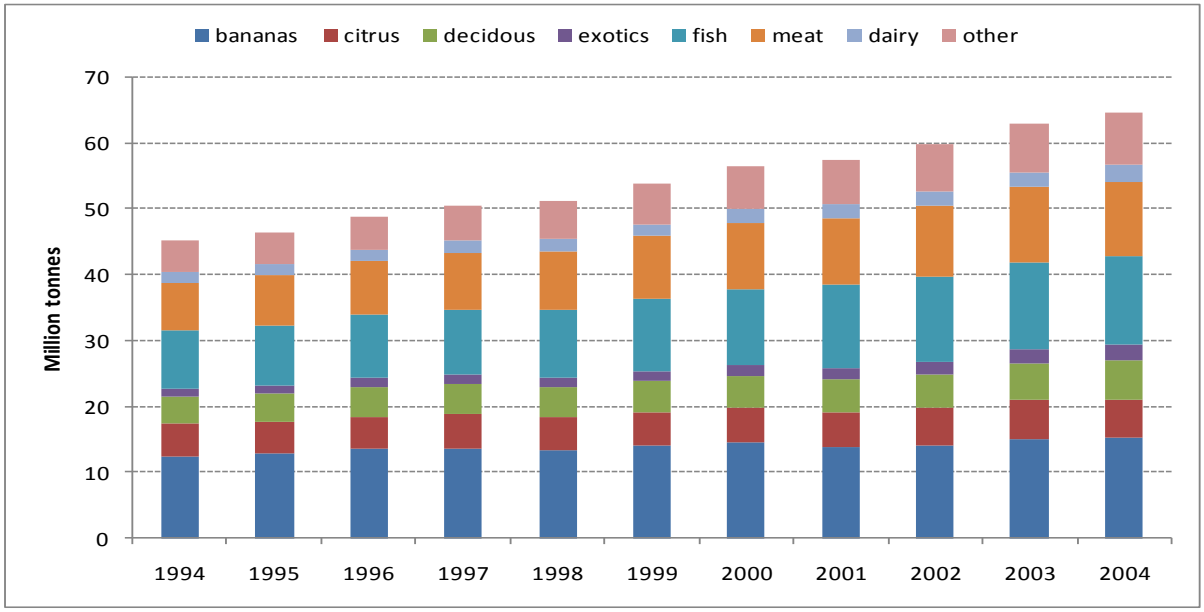

***Figure 2.2** – The main commodities in the seaborne reefer trade*

Source: authors' own elaboration from Drewry (2006)

The sea transportation of reefer cargoes is a practice established for a long time. Initially, it started from the need of transporting food between European countries and their colonies. In the second half of 19th century, many shipments of frozen meat were imported from Paraguay to France, and also from Australia to Great Britain (James at al. 2006). Another case of temperature controlled shipments was related to the seaborne trade of bananas in 1901 (Dellacasa 1987).

But the real expansion in the reefer trade via sea is linked with the globalisation, the expansion from international trade and the economic growth of many developed countries whose consumption are increasingly based on imported food. Therefore, a cold chain shipping industry has been developed to feed distant markets with a wide variety of perishable products.

2.3 Decline of bulk reefer fleet vs development of containerised fleet

The progressive decline of the bulk reefer market, which was particularly under the pressure from the newer container reefer services in the 1990's (Drewry 1999 and 2006), is evident from the analysis of the fleet from 1980 onwards.

A decreasing trend regards both the number of specialised ships and their capacity. The highest number of ships has been reached in 1994 (1.487 vessels); then the fleet has started to decrease. The actual bulk reefer fleet amounts to almost 1.190 ships, among which the majority (790) is characterized by a total capacity higher than 100 000 Cubic Feet.

The total capacity offered has been shaped by the same negative trend, with the highest peak in 1994 (395 million of Cubic Feet) followed by a steady decline continuing until now (Fig. 2.3).

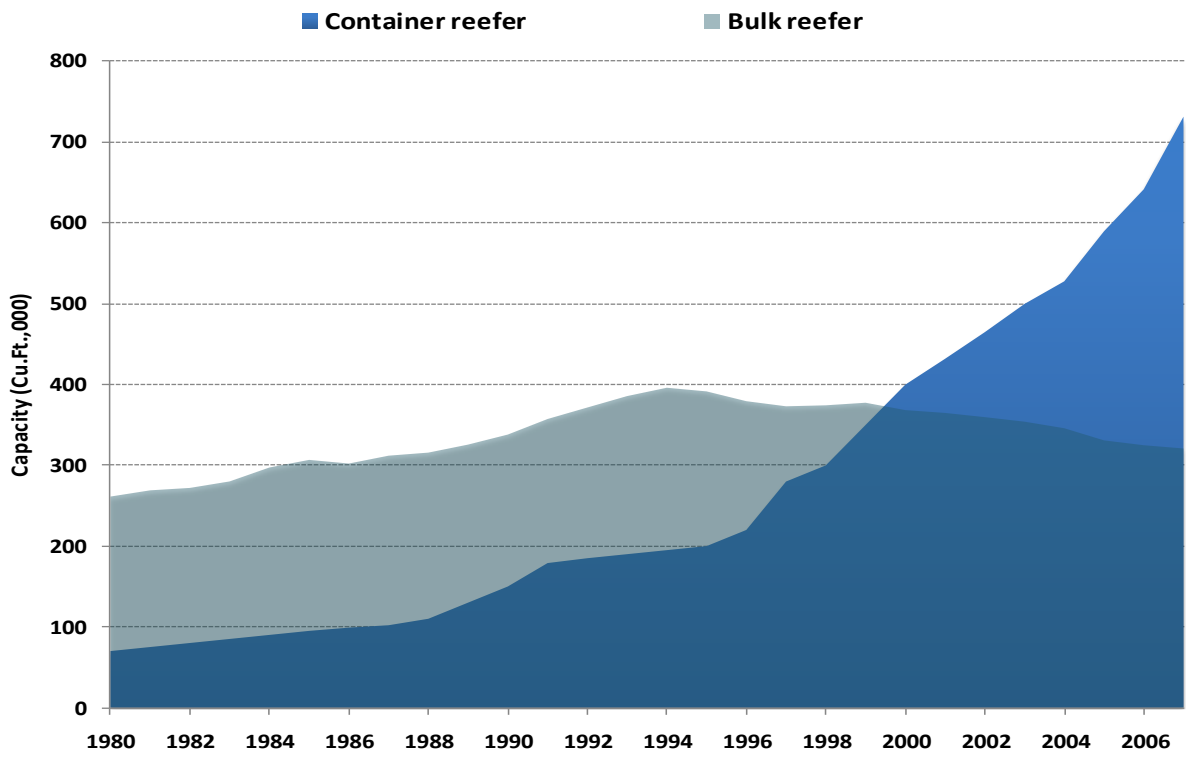

***Figure 2.3** – Reefer capacity by bulk ships and containerships*

Source: authors' own elaboration from Drewry (2006) and Containerisation International (2009)

In contrast, the containerised fleet has shown an extraordinary increase in reefer capacity since 1980. The actual container fleet includes 4.600 containerships with a total capacity of 11,4 million TEU, whose 15,8% is dedicated to reefer (about 1,8 million TEU, accounting for 80 per cent of total reefer capacity)[2].

Massive amounts of reefer capacity have been provided by global shipping lines, among which Maersk Line has the leadership. Its new containerships have the capability of transporting approximately 20-25% of their shipments in reefer containers.

Maersk offers more than 50% of 40' High Cube reefer containers available on the market; each reefer container has a microprocessor for monitoring the temperature while en route.

The mega containerships, namely Emma Maersk and the other seven PS Series vessels of 14 500 TEU, are equipped with 1 286 electrical plugs equivalent to 20% of their total capacity, proving that the number of reefer plugs increases, in absolute terms, in relation to the size growth and to the fleet age.

2.4 Transport solutions: bulk reefer versus container

Within reefer seaborne trade a clear trend is emerging in recent years: the specialised reefer fleet has been reducing and, on the contrary, the container fleet has been equipped with a growing number of plugs for reefer containers.

As a consequence the modal split between bulk reefers and containers has experienced a gradual change since 2004. Currently, the container solution has become dominant. This

[2] Source: Containerisation International 2009, "World trade set to rise".

trend is confirmed by economic forecasting; it is predicted that in 2015 the container share of maritime reefer trade will raise approximately to 65%[3].

Considering the reaction of the main reefer segments to containerisation, the modal split for each reefer commodity is different (Fig. 2.4). There are goods like meat, fish and dairy products which are growingly conditioned in reefer containers. Conversely, most of fruit shipments (typically high-volume, homogenous and/or highly seasonal such as bananas, citrus and deciduous fruits) are still transported by specialised reefer fleet.
Indeed, the bulk reefer ships still retain a 45% share (about 80 million tonnes[4]) of the maritime reefer trade, although the incremental containerisation in reefer market and the reduction of its capacity share in the present decade.

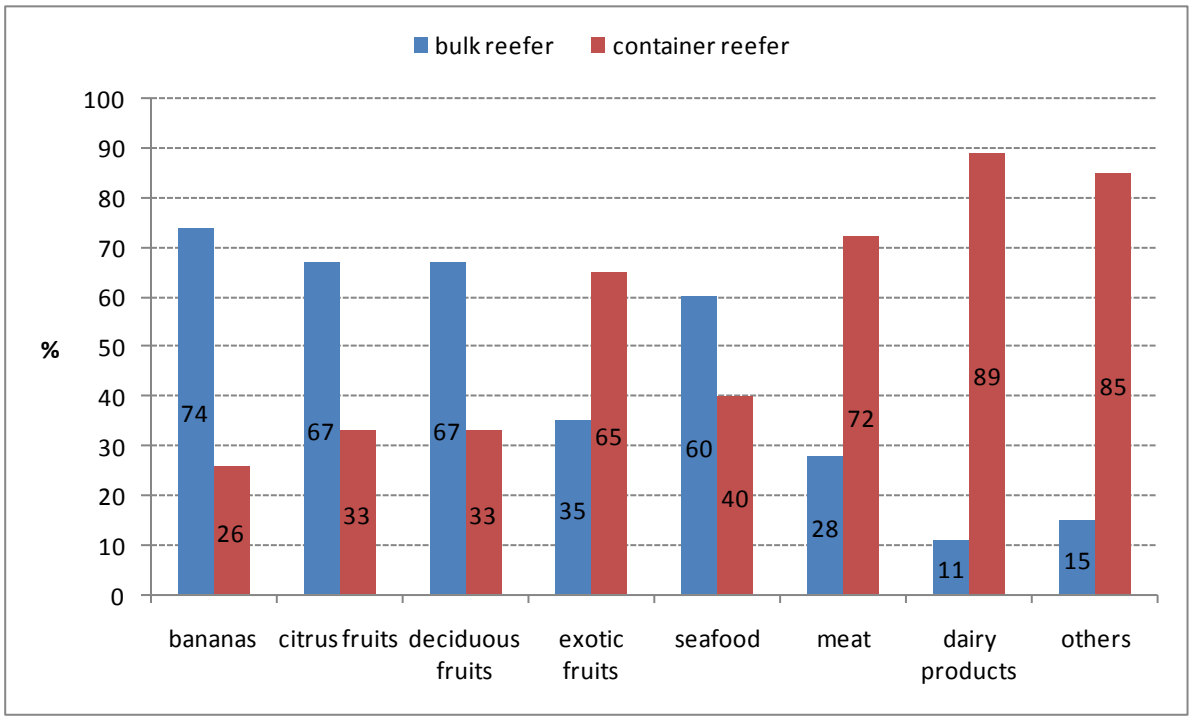

***Figure 2.4** – Reefer seaborne trade by commodity and mode*

Source: authors' own elaboration from Drewry (2006) and Fairplay database (various years)

According to some literature sources[5] the conventional fleet is progressively declining but will continue to exist by retaining more than 30% of the global reefer trade in 2015.
This has been possible primarily because of resilient banana bulk reefer stronghold (Mehta 2000 in Thanopoulou 2009), so that bananas currently represent almost a third of the overall bulk reefer trade. In fact the whole reefer capacity provided by the container fleet is not sufficient to cover the global demand for banana as well as for other categories of fruit coming from the southern hemisphere, especially during production peaks.

[3] Source: Containerisation International, 2008.

[4] Source: Drewry Shipping Consultants in Bright 2009.

[5] Penfold 2000, Bright 2009 and Drewry 2009.

Besides exporting bananas, the traditional reefer fleet will continue to be employed in the South Africa-Europe route for exporting citrus fruits, largely because not all African ports are properly equipped for accommodating new containerships.
Furthermore, the container supply chain is often congested due to the bottlenecks in many European hub ports that compromise the ocean carriers' schedule reliability. For this reason, most of claims in reefer shipping market have been caused by delay in transits (Bright 2009). On the contrary, specialised reefer fleet traditionally offers port-to-port services that are faster, without transit times in hubs.
Finally, the design of specialised reefer ships has been improved during the last decades, through the introduction of more cargo-friendly vessels (with capacity for reefer containers on deck) and of new techniques for preserving cargo on board (Thanopoulou 2009).

By the start of the 21th century the rapid development of container shipping has determined a progressive decline in the refrigerated bulk vessels as well as in the case of reduction in conventional liner cargo fleet in past years (Wild 1996). In 1994 containers claimed about 40% of the total trade (Drewry 1997) and their share has continued to rise in the 1990s.
The incremental containerisation of the reefer trades is based on the following elements:

- investment in innovative technologies, such as the introduction of the reefer integral container[6] and the controlled atmosphere (CA) systems[7];
- the growth in containerships' size with a proportional increase of reefer plugs;
- the competitive advantage of a reefer container moved at a lower cost than the equivalent capacity in a specialised reefer (Bright 2009);
- a substantial increase in the range of refrigerated commodities which can be shipped in smaller quantities with specific temperature and humidity requirements (i.e. pharmaceutical products) instead of use more expensive air freight transportation;
- the worldwide connectivity and logistics offered by the global container shipping lines, having the network and the resources to transport cargoes to any part of the world;
- a decrease in risk of cargo damage and deterioration (and consequently minor insurance costs) due to the constant monitoring of the temperature and humidity of the shipments, both at the terminals and on board the vessels[8].

Furthermore, in recent years the tonnage in excess and the consequent reduction in freight rate in the container market has led many container operators to invest in other niche segments more profitable, like the reefer one, entering in competition with specialised reefer carriers on traditional reefer routes South-North and even with air cargo operators (i.e. providing specialised equipment for transporting cut flowers and live seafood from Japan)[9].

[6] This type of refrigerated container has an integral refrigeration unit for controlling the temperature inside the container. When transported by ship, integral units have to be connected to the on-board power supply system.

[7] CA is particularly useful for moving climate-sensitive produce such as bananas, by slowing down their ripening process and extending the shelf life of the perishable products.

[8] This constant controlling is possible because the reefer container has a microprocessor that monitors the temperature while in route, also when the container is unplugged during port operations (Maersk Line 2009).

[9] According to Penfold 2000 and Stopford 2000.

3 THE CASE OF BANANAS COLD CHAIN

The present section aims to reveal the competition scheme between reefer containers and reefer bulk. Among the commodities' specific markets, perhaps the most important one is the banana trade, as it represents almost a third of the overall bulk reefer trade, and also the volume of container tonnage employed in this trade is growing.
As such, a case study has been developed considering the market interactions between demand and supply in order to analyse the complex structure of the cold chain of bananas. The analysis provides the cost-disaggregation of this commodity when transported by a container against the same shipped on bulk vessels including the profits for the stakeholders at each level of the chain.

3.1 Economic actors

The trade of bananas has been attaining its increase of the demand along the time until being the most consumed reefer commodity over the world and therefore, the most transported by seaborne trade (Stopford 2009).

Bananas are very delicate fruits as their temperature should be maintained between 13,6 and 16 Celsius degrees all along the transportation chain since the aim is to avoid them freezing or maturating previously. Hence, this cold chain need to be managed with extreme care by all the suppliers involved at each function, from the production until their arrival to the supermarkets.

It is possible to distinguish four main functions constituting the bananas cold chain:

1. production,
2. logistics and transportation,
3. taxation and
4. retail.

All of them can be identified as commercial or physical agents[10]. The commercial functions concern the mutation of the goods' ownership while the physical functions relate to the physical transformation and the cargo movement.

Regarding the typology of actors, on the demand side, the owners ask for services (producers, importers and exporters) whose business is the trade itself while on the supply side, the cargo intermediaries provide those services (forwarders, carriers, shipping companies, etc.) whose business are mainly logistics and transportation. For this reason, logistics services represent a cost for the owners while for the providers the logistics services represent their revenues.

The presence of economic actors is very different from country to country, at the several stages of the complex banana cold chain. The producers can be small independent growers

[10] Following a classification proposed by Van Der Lugt and Veenstra in 2001.

(mainly in the Caribbean countries and Ecuador), national companies (in Ecuador and Colombia) or multinational companies (in Central America). Then bananas are transported through independent reefer carriers (specialised or containerised) or by reefer fleets owned by the same multinationals. After their unloading in the importing countries, bananas may move through importers before their arrival to retail outlets in order to be sold at consumers.

Despite the heterogeneity of actors, the international banana market has an oligopolistic nature, due to the presence of a few major transnational companies which tend to dominate the overall international trade, by controlling several or all of the stages of the bananas cold chain[11].

In order to reveal the economic interests of every stakeholder involved in the banana cold chain, an economic analysis on the revenues that every actor obtains has been developed for the banana cold chain between Costa Rica and Italy. The cost of production (Costa Rica), transport and logistics, taxation, distribution and retail (Italy) were calculated in Euros (2010).

However, the unique category that changes according to the distance is of course the transportation and logistics. For this category the distance estimated was in km. All the values were obtained through interviews to logistics-providers tailored for this study.

The contribution of the costs to the average price of one kg of bananas at the super market in Italy is shown in table 3.1. The actors involved in the banana cold chain have very different economic benefits in terms of revenues.

Function	Actors or agents	Revenue (€/Kg)	Revenue (in %)
PRODUCTION	Plantation owner and labourer, exporter (consignor) and importer (consignee)	**0,42**	**22%**
LOGISTICS AND TRANSPORTATION	Carrier, terminal operator, forwarder, shipping company	**0,29**	**15%**
TAXATION	Customs	**0,44**	**23%**
DISTRIBUTION AND RETAIL	Retailer and wholesaler	**0,76**	**40%**
AVERAGE PRICE 1 KG BANANAS IN MILAN[12]		**1,91**	**100%**

***Table 3.1** – Actors involved in bananas cold chain by function and revenue*

Source: expert-interviews in Arduino 2010

[11] The major multinational banana companies at present are Dole Food Company, Chiquita Brands International, Fresh Del Monte Produce, Fyffes (the leader European fresh products' distributor) and Noboa Corporations.

[12] Source: www.osservatorioprezzi.it, consulted in January 2010.

The first three functions composing the cold chain - production, logistics (including transportation) and taxation - allow the actors to obtain a revenue between 15% and 23% each, while the distribution and retail turns out to be the most profitable with revenues reaching 40 per cent of the final price[13]. In fact, the retail organisations are the leaders in terms of commercial power, stating that the other markets or functions are hardly competing for the rest of the shares.

It is important to underline the weakness of the basic production on the overall composition of costs as it represents only the 3,3 per cent while only the retailer organisation obtain more than 40 per cent of the cost involved. With regards on transportation a fourth of the costs are allocated to this activity involving forwarders, ocean carriers, terminal operators and road hauliers. In order to reveal the economic interests of freight agents, a detailed analysis has also been carried out only for this market or function.

3.2 Reefer transportation of bananas

From the production sites (mostly located near plantations in South-Central America), the boxes of bananas are transferred to the loading port chosen by the shipper[14]. In the chosen port, the boxes are consolidated into pallets that are loaded directly inside a bulk ship or in reefer containers. All these activities are performed by a terminal operator. In the phase of maritime transportation, the responsible actor is a global ocean carrier who performs a transoceanic route. At the port of destination there is the unloading of the vessel and the further road haulage towards the retailers' infrastructures (reefer warehouses and platforms).

Considering the reefer transportation of banana shipments from Costa Rica to the Italian port of Vado Ligure, the total transportation cost has been calculated for a pallet of bananas in order to compare the shares of each logistician and transport agent. As well, the calculations were made for both, inside a container reefer and in a bulk reefer vessel.

The costs include the loading and unloading, the maritime transportation from Costa Rica to Vado, and the road haulage from Vado to Milan (about 180 km).

[13] The calculation was based on the following hypothesis: one kg of bananas transported from Costa Rica to Italy (port of Vado Ligure), until the final market of Milano. One reefer container *High Cube* 40' with 20 pallets (1.000 kg each) has been used; the importation duty is €176 /ton. Source: expert-interviews.

[14] Who can be the exporter or the importer, it depends on the INCOTERMS adopted (see Carrillo Murillo and Liedtke, 2007).

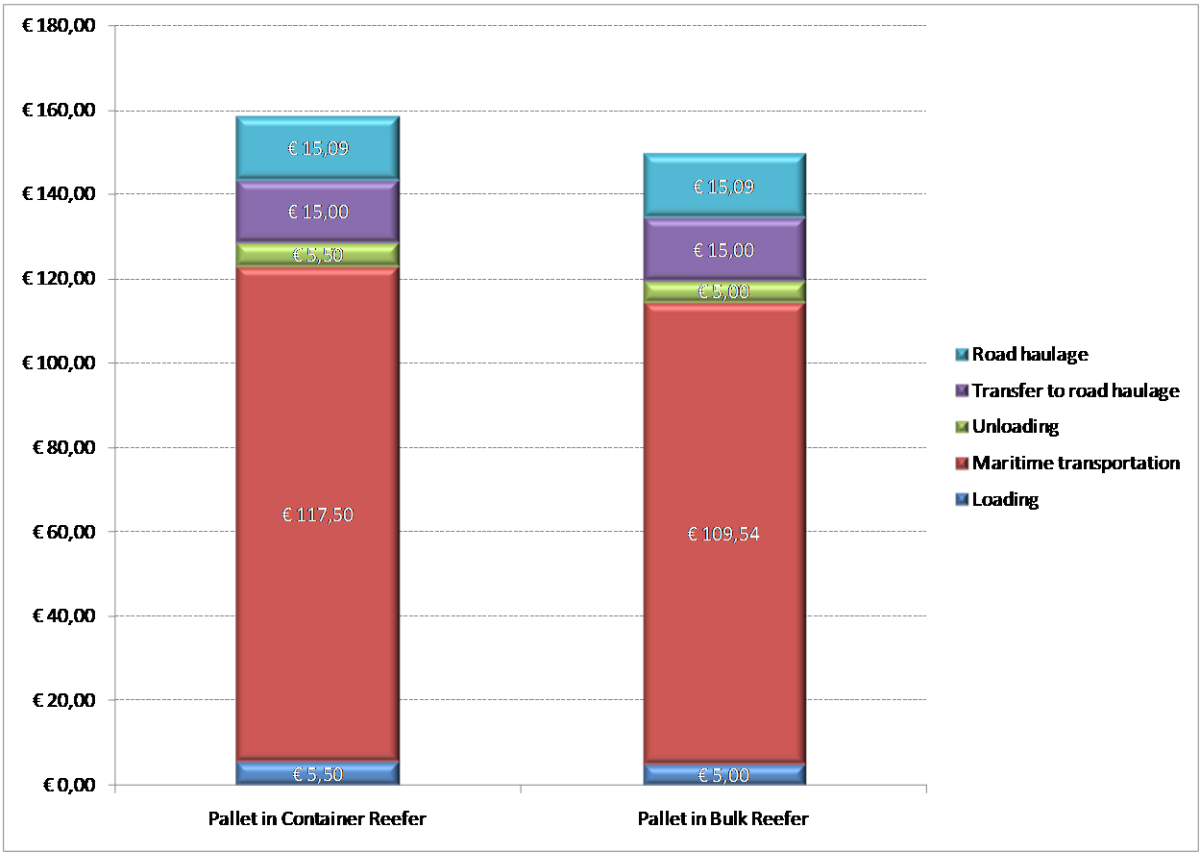

***Figure 3.1** – The transportation cost per pallet by container and bulk*

Source: expert-interviews in Arduino 2010.

The results show the low difference between the bulk reefer and the reefer container (the delta is 10€ only, as illustrated in Fig. 3.1). The leader in cost terms is allocated to the bulk vessels. However, unloading commodities from a bulk ship usually takes several days (3-4), while the containers can be unloaded in a maximum of 24h. Therefore, the real advantage in terms of non-monetary costs (time, flexibility, reliability) is allocated to the container.

Even more, the reefer container has the advantage of the black boxes in order to determine the guilty of freezing or previous maturation and the cargo is protected safe and easier for handling. However, if considering the savings between bulk or container, the transport performed by bulk can attain more than 200 Euros per container quantity if considering that every container can carry 20 pallets.

4 CONCLUSIONS

Reefer containerisation has shown a strong increase in the latest years as it represents a relative recent market where global ocean carrier are highly investing. On the contrary the bulk reefer market has entered its maturity phase with a declining fleet in number of conventional ships and in their capacity. However, the academic literature has not provided a definitive verdict on the ultimate stage of the bulk reefer market.

One of the major aspects shaping the reefer shipping industry is the historical and current competition between bulk and container, characterised by a relative stasis and decline of the first and the growing market share of the latter in recent years.
In literature have been identified many factors leading to the massive predominance of containerisation in reefer trade. There are mainly advantages in term of innovative technologies developed by global ocean shipping lines, applied both to reefer containers and to new mega containerships equipped with reefer plugs; and also economic advantages of reefer containers in terms of reduced cargo damage.

Despite the above considerations on the container growth, the share of reefer trade depending upon bulk remains significant, and some experts (R. Bright and other consultants of Containerisation International and Drewry Shipping Consultants) have estimated that this share will be maintained at least in the short-medium term, and there is no way that global shipping lines may control the whole maritime reefer business. In particular, there are some reefer segments, namely bananas, citrus and deciduous fruits, that are mainly shipped in traditional reefer ships.

A real case has been developed for proving that the total cost for transportation of bananas by reefer container has approximately the same amount of the total cost for transportation by bulk reefer. It has been proved there is not a real economic advantage for using bulk reefer in spite of containers in case of bananas transportation.
One of the main reasons for still using bulk in this segment can be found in the typology of actors managing the banana cold chain; that is why this type of chain is generally under strict control of very few multinationals (Dole, Fresh Del Monte, Chiquita, Noboa, Fyffes). They are directly involved in many functions of the chain, from production to transportation until retail. This is possible for high-volume and homogenous commodities such as bananas and other fruits, that allow to fulfil the conventional ships owned or operated by multinationals.
Therefore, this paper is willing to demonstrate that the bulk reefer business is still surviving and competing with container in some fruit segments not for economic reasons but as a consequence of the presence of vertical integrated actors operating bulk reefer ships and having control over their supply chain.

Given the previous discussion, for our concern the competition between bulk reefer operators and container shipping companies shows different aspects according to the reefer cargo categories, leading to a strong and increasing market segmentation.
In case of high quantities of bananas and other mass fruits, the competition bulk vs container is not a “tout-court” competition. It may be better considered a certain “coexistence” as the two shipping modes can operate side-by-side for satisfying the reefer demand peaks in the southern hemisphere fruit trades. For instance, the 5 500 reefer containers of bananas leaving from Guayaquil every week could not be transported only in containerships, but necessitate also the capacity on deck provided by the specialised reefer ships.
However, the competition of container versus bulk is becoming stronger for other refrigerated commodities like meat and dairy products, and even for high-value products in small quantities or with specific temperature and humidity requirements (typically pharmaceutical

products from United States, cut flowers from Holland, highly perishable vegetables and fruits like blueberry from Chile or asparagus from México) which have to be necessarily shipped in containerships.

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