Bulk reefer market economics in a product life cycle perspective

The paper analyses the market form of the bulk reefer segment and the industry's dynamics in a product life cycle perspective in view of the erosion of the former's market share from container shipping. The author discusses how reefer services' advertising and product differentiation classify this specialized bulk shipping market in monopolistic competition. The analysis draws from empirical evidence of advertising from the maritime press of the last decades, market developments and observed company strategies, while the overall classification of bulk reefers in this market form is based on Chamberlin's discussion of the traits that set this market structure apart. Reefer ship type and service developments are discussed next from a product-life cycle perspective pointing that the bulk sector of refrigerated transport has reached the declining end of its product life cycle curve. On that basis, a SWOT review points to few and bleak prospects for bulk reefer operators, which lay essentially outside the carriage of perishable produce in bulk; this, the analysis concludes, is in contrast to opportunities for further research for which this market segment provides ample opportunities.

1. Introduction: a chilling hypothesis?

The fate of bulk reefers in post-war shipping could be read in earlier post-war developments of world fleet statistics; it was confirmed around the millennium when the—terminal by then—relative decline of their share in world tonnage turned into an absolute one. Perhaps due to some form of forward thinking, research in bulk reefers has attracted a very small share of academic attention [1]. This, despite the detailed documentation of the segment by a variety of sources [2] and a number of directly observable market characteristics that point to its exemption from the blanket classification of main bulk markets in perfect competition.

By the end of the 20th century, developments in the intra-modal split of perishable produce had made obvious that bulk reefer shipping might not be able to continue to compete on the same basis as containers into the 21st [3]. Despite a rather general agreement of market sources and analysts on the future of the segment, there was still no noticeable academic interest in its future or in its market structure. This, despite the bulk reefers emerging as an interesting field for further exploration as the segment was apparently not imperfect enough to be classified as oligopolistic, or to escape volatility and recurrent overcapacity crises, but still not competitive enough [4] to be listed along examples of purely competitive traditional bulk markets such as bulk carriers. Reefer shipping could have attracted additional interest due to its

capability to make significant inroads into another specialized bulk shipping market carrying—durable these ones—consumer goods, that is, the car carrier market. The converse does not hold as no other ship category from within the bulk sector can effectively substitute for reefers due to the special requirements of the carriage of perishable produce by sea.

However, the industry's decline, as discussed in this paper in a product life cycle perspective, originated from outside bulk shipping *per se* as the flexibility, intermodality and speed of container reefer carriage [3, 5, 6] were becoming evident to all and—most critically—to shippers. The one-way substitutability between break-bulk and container traffic for the same type of cargo has been underlined at the end of the last decade, in 2009, by Sys [7] referring to a European Union document [8].

This paper is structured as follows. Section 2 reviews developments in bulk reefer shipping demand and supply in the period of rising intra-modal competition for the transport of refrigerated cargo. Section 3 attempts to define the nature of the market form of this theoretically neglected specialised segment on the basis of observable market form characteristics. The fourth section analyses the course of bulk reefer shipping to its current stage in a product life cycle perspective. Section 5 focuses on future prospects for bulk reefer operations in a SWOT context. Conclusions, in the final sixth section, point to multiple avenues open to research into the form and the course of this bulk segment, in contrast to the narrow range of options left to bulk reefer firms.

2. Bulk reefers: turning into a 'partial statistical loss'

The waning of the bulk reefer market in recent years is not entirely singular in post-war shipping. Over the past decades, significant declines of tonnage categories such as combination carriers—and for many years conventional liners [9]—were few, yet prominent. The new century added this of refrigerated bulk vessels (cf. Figure 1). As was the case earlier for conventional general cargo ships, the culprit for this development was competition from container shipping [10].

The rather dire market conditions in the segment until the early 2000s underpinned the inevitable decline of bulk reefers [11] that had come already under the pressure from container reefer services [3]. This brief alignment was to be interrupted as freight rates started their recovery in the early 2000s; by then, however, container capacity had increased close to half of the total reefer market [12]. Containers had claimed about 40% of the total trade before the

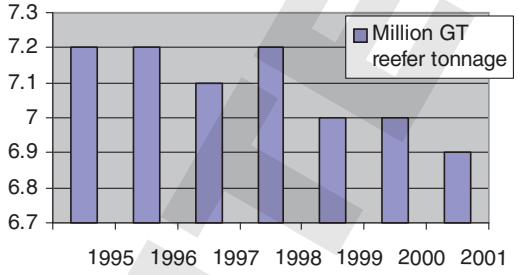

Figure 1. Reefer tonnage 1995–2001.
Source: Based on tonnage data in Lloyd's Register, *World Fleet Statistics*, annual [14].

middle of the 1990s [5]. If it were not for the resilient banana bulk reefer stronghold [13], which still [15] accounted for almost a third of the bulk reefer trade and for less than 10% in container ones [16] in 2004, the threshold of 50% of the total seaborne reefer trade—still held by conventional reefers even until the middle of the present decade [17]—would have been crossed well before the end of the 1990s. The marginal decrease of 0.9% in reefer hold capacity at the turn of the century was overcompensated, not by the small increase in reefer container capacity on board conventional reefers themselves, but by a 22 times higher increase in the reefer capacity of container vessels [18]. With the rise of liner container shipping even in the sea transport of bananas [19], it did not take long for bulk reefers to loose the trade's majority. Before the end of the first decade of the new century, the balance tipped with just over half of the trade already captured by containers [20].

The trigger for these developments related to the split between the two main ways of sea-carriage can hardly be sought on the demand side. On the contrary, reefer demand dynamics proved to be positive outliers among favourably moving world figures. Since the 1980s, reefer trades kept outstripping the total seaborne trade growth significantly for many years [5], rising much faster than world population or world GDP per capita. In the first part of the current decade, reefer trades increased by over 14%—surpassing between 2000 and 2004 the increase of the fast growing world population—supported by the faster growing GDP per capita, one of the trade's main drivers [3, 6, 21].

Despite demand developments, the decline of bulk reefer capacity was to become firmly established at precisely this period (cf. Figure 2) unlike the impressive growth of the world tonnage which at the start of the second decade of the current century was still increasing at a very high rate as record orders—placed earlier—had by then entered the fleet in service [22]. This was hardly what had happened to reefer capacity that had been declining since the year the financial and shipping crisis broke out, namely 2008, at the highest rate since the late 1990s [23]. While new consumer strata from emerging fast-growing regions were adding to sources of demand fulfilling earlier predictions [6], the bulk tonnage carrying perishable product was itself

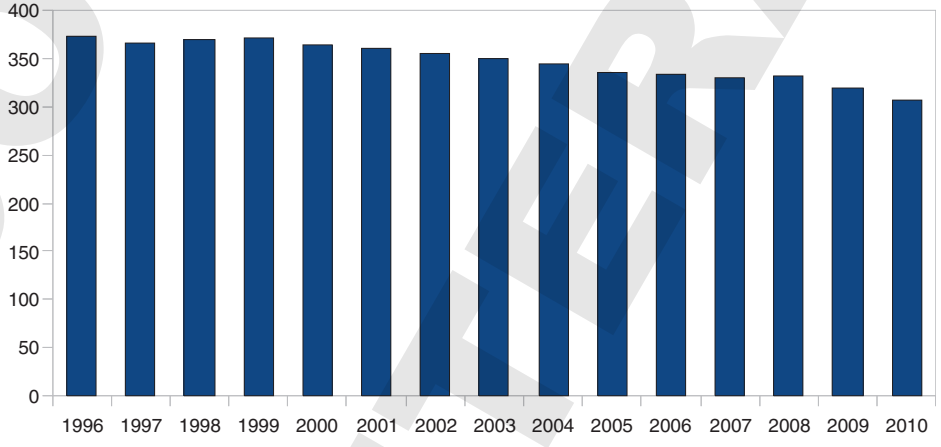

Figure 2. Bulk reefer fleet capacity in million cubic feet 1996–2010.
Source: Based on capacity data (end of year and start of the year for 2010) in Clarkson Research (2010): *Shipping Review and Outlook*, Spring 2010, 117, Table 32 [19].

perishing and not in a temporary way. This could not be attributed to any persistent dismal state of the market as world shipping conditions after 2003 had translated into either record-breaking or profitable rates throughout various market segments; bulk reefers were no exception [24]. The blame for the bulk reefer's industry's decline has to be sought in developments that—making bulk reefer shipping obsolete—were pushing this tonnage category to the end of its trajectory. Unlike freight rate cycles, product life cycles do not include obligatorily a recovery phase [25].

In this context, the range of remaining prospects for the service and of competitive options open to market participants have to be evaluated in relation to the structure of this specialised segment. However—unlike the detailed reefer market coverage by analysts and consultancy reports—the academic literature has yet to provide a verdict on the market form of a type of cargo specific sea-transport whose origins [26] precede even tankers. While perennial freight rate volatility and recurring overcapacity would point towards a perfectly competitive market form, directly observable market characteristics and research findings, such as those in [13], have been pointing to the need for discussing this market's structure keeping less than 'perfect'—if less competitive in nature—options open, focusing on the main traits where theoretical foundations and evidence from the segment itself jointly point, as shown in Figure 2.

3. The reefer market form: monopolistic competition?

The reefer market could be easily mistaken to be more or less identical to the traditional bulk markets; interestingly, the reefer segment is not always discussed or reported separately from dry bulk developments. However, many of its main characteristics translate clearly into a departure from perfectly competitive markets where main bulk markets are usually classified in the maritime economics' literature [27]. It was the observation of initially advertising and then of product differentiation by the author in the early 1990s that had led to viewing the bulk reefer market as a potential candidate for classification under monopolistic competition [4]. That was, however, more of an intuitive hypothesis than the result of a thorough comparison of observed market characteristics with the archetype of monopolistic competition—or of any other market form—in shipping and any conclusions could only have been tentative. After all, the term monopolistic competition, qualified as a 'paradoxical expression' by none less than Chamberlin [28:347], has not always been used to describe a distinguishable type of imperfect market structure as the one assumed in more recent decades; clearer distinctions emerged in the industrial organization literature along the way [29].

In (apparently) the more generic sense, which allowed for any degree of departure from perfect competition [28], the term has been used sporadically in the cargo shipping literature to qualify markets as diverse as tankers or liners while it has been used in relation to 'process and product innovation' [30] in the discussion of the structure of the boat yard industry. As a more theoretical discussion of market form distinctions and definitions would be beyond the scope of the paper—or rational ambition—the discussion that follows focuses on observable evidence of a departure of this market from purely competitive characteristics.

On the one hand, assuming pure monopoly as the prevailing market form in bulk reefers is automatically excluded through the presence of a much greater number of firms; on the other hand, assuming perfect competition for this market would—by

sheer observation of prevailing market traits—soon lead to a conclusion along the summary of Sraffa's argumentation against the perfect competition hypothesis: that 'behavioural descriptions implied at that hypothesis were at variance with the known facts' [31]. Proceeding again by exclusion, one can easily accept that the reefer market cannot be deemed as one where the market of the individual seller is completely merged with these of its rivals [32:69] and become assimilated thus to pure competition. Any product homogeneity can be equally dismissed just by taking into account the various types of reefer vessels and technologies co-existing in the bulk reefer market over the last three decades and the ensuing *variety* of service.

However, the problem is more complex than simply excluding the possibility of bulk reefers being a purely competitive market with a homogeneous product. What is required, according to Chamberlin—the author most associated with the definition of this market form—is a positive identification of this market as one where there is a degree of separation from the rivals' markets sales through (a) *price*, (b) *advertising* and (c) *the nature of the product* [32:71]; the three are not independent as the essence of successful product differentiation, apart from increasing sales, must be equally to create a *different perception* of the product in order to be able to achieve *some* discretion over *price*.

3.1. *Price and price volatility in the reefer trades*

Although not necessarily critical for identifying monopolistic competition as the form of the bulk reefer market, the first question that arises is whether differences in prices resulting from differentiated reefer services exist in this market in earnest. Reefer market reports continue to use a common price in US dollar cents per cubic feet per 30 days to follow market developments. The small print, however, of market reports and detailed analyses [33] indicate that there has been clear differentiation between rates achieved by break-bulk reefers, modern container friendly reefers and conventional pallet-friendly reefers. This is not just a recent trend. A comparison of time-charter rates in the 1990s for modern vessels and traditional break-bulk ships shows a marked difference despite their close correlation (cf. Figure 3). Around the millennium, pioneering research using data for converted and pure pallet vessels had revealed that vessel characteristics are statistically significant confirming the existence of a fragmented price structure in the reefer market [13]. The ability of larger, geared, container friendly tonnage to attract premium time-charter rates was already underlined in market reports [3], while the premium for container-friendly

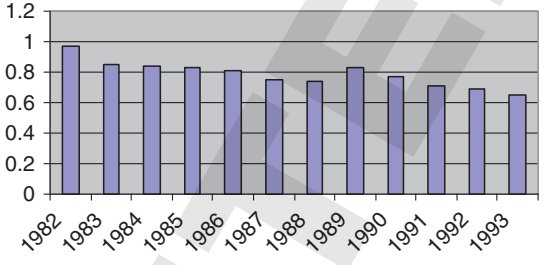

Figure 3. Break-bulk reefer rates/modern pallet friendly reefers.
Source: Ratio calculated from A/S Klaveness chartering data for 12 month time charter rates as in Drewry (1997: 212), [5].

bulk reefer vessels had been assimilated in mid-1998s to a similar pattern during the period of the shift towards pallet-friendly tonnage in the 1980s [34].

While any degree of price differences would be fully compatible with the paper's main hypothesis, the level of observed price volatility in bulk reefer shipping may seem much more difficult to reconcile with habitual examples of monopolistic competition market structure, such as for example restaurants. However, there is no real contradiction between the periods of low rates that plighted the reefer market since the 1980s [32] and some degree of deviation of this market from purely competitive conditions as there is no contradiction between zero profitability and monopolistic competition either [35]. The derived character of demand [36] exposes all bulk vessels—and reefers—to the possibility of shocks of multiple potential origins [37]; in the case of the bulk reefer market, volatility may be exacerbated due to the trade's idiosyncratic seasonality [38].

Purely competitive markets are also un-concentrated. Although not having crossed the 40% threshold, considered usually critical for market concentration by various regulatory authorities, the C_4 concentration ratio in bulk reefers, was calculated for the late 1990s (before the post-millennium merging trend) at 26.8% [39] falling well above the range of respective ratios for traditional bulk markets at the time. Moreover, that level was higher than the respective one for liner shipping even at later dates [40]. Still, concentration ratios are not straightforward in this market as leading operators have been—since long—either managing/leading/owning (in any combination) [41] pools of bulk reefers. Pools in themselves may seem incompatible with pure competition; one of the major reasons they are created is to take advantage of economies of scale through their critical mass [42]. Shipping pools, however, have been functioning within clearly competitive segments of the bulk industry [43] for many decades [44]. The confirmation of a departure of this market from purely competitive structures requires additional confirmation that firms in bulk reefer shipping have—or at least consider as efficient—additional possibilities to influence sales and (or) sustain profitability. Advertising is one such commercial weapon for company survival and growth and is definitely not consistent with pure competition [28:347].

3.2. *Advertising of reefer bulk services*

In the early 1990s, with the ISM (International Safety management Code) being still a distant prospect and with the quality focus only sketching itself in the horizon, cargo shipping services advertisements in the specialised maritime press could only be found for 'the usual suspects': liner services and—sparingly—by firms operating highly sophisticated tonnage such as LPGs (auxiliary vessels, ship management and other services to shipping notwithstanding). The use of advertising by reefer operators already before the mid-1990s, was a far cry from the typical perfectly competitive traditional bulk shipping market where any type of charterer-oriented marketing remained a contradiction in terms; it was also to be considered as 'necessarily excluded from a theory of pure competition' [28:348]. Although it could be argued rightfully that indications for the use of advertising should be sought in the shipper-related press as much as in the shipowning/managing one, boundaries may not be considered as so clear cut. Indeed, the origins of the present paper lay in the early 1990s encounter of its author with two advertisements by leading bulk reefer operators in the specialised shipping press. Initial hypotheses were confirmed through a systematic recording, in the early part of the summer of 2008, of total

advertisements included in all 1993 and 2006 issues of *Lloyd's Shipping Economist* [45], in a number of available 1998 issues of other shipping publications such as *Lloyd's Ship Manager* [34], *Lloyd's List* [46] and in about two thirds of *Fairplay* weekly issues [47] of the year 2000 as well as in various summer 2008 issues of [46], *Seatrade* [48], *Shipping Outlook* [49], both issues and supplements [50]. Advertisements of tanker companies or even of dry bulk carrier companies do see the light in maritime publications quite often, among increased in recent years shipping finance and listed company advertisements, and some had advertised already in the previous decade. However, in the latter case there was—as a rule—no customer orientated *advertising intent* in them as their mission was to make the company's details known for crewing purposes. Reefer advertising has not proliferated tremendously over recent years with press or web advertising by container lines—mainly—and listed large reefer operators adding to the list; however, the efforts to differentiate the service in real terms have, as discussed in the next paragraph.

3.3. *Product differentiation*

The acid test to ascertain whether the bulk reefer market fits the archetype of monopolistic competition cannot be other than the degree in which the markets for each seller are isolated in any measure through product differentiation, making the selection of sellers by buyers a question of preference not of chance [32:69]. Controlled atmosphere (CA) has been a good example of a 'competitive edge' some of the largest operators in the market tried to establish at around the time of the introduction of container friendly vessels, following the initial differentiation of reefer services between traditional break-bulk tonnage and pallet-friendly vessel. There have been also more than one CA systems [51] providing evidence of a wider spectrum of further service differentiation and constituting a *variety* of the service destined to appeal to large customers supplying retail outlets although the impact of the latter on re-shaping the refrigerated transport chain does not seem as significant as once anticipated [24]. Product differentiation has to be seen, however, mainly in the light of the succession of types of reefer vessels and even of types of reefer services provided, as emphatically underlined by the spectacular inroads of containers into refrigerated maritime transport. Only in such a light, the critical issue of the value of cross elasticities of demand [52] for the different types of service can provide a final positive answer on the nature of the market's structure and not one merely by exclusion; this is assuming, of course, that the bulk reefer market will not disappear too soon into the diving part of its product cycle bell curve, as discussed in the following.

4. Refrigerated transport by sea in a product cycle perspective

The rapid *replacement* of conventional break-bulk tonnage by pallet friendly capacity indicates that product differentiation should be viewed within a 'product life cycle' (PLC) analysis context as the concept is reviewed in [53, 54], although the usual caveats of level of product aggregation [55] apply here as well. In this discussion, break-bulk, pallet-friendly, and container-friendly bulk reefer vessels will be considered as three distinct product/service forms. The course over the typical PLC bell-shaped form of the curve—prevailing among a larger variety [55] —and including introduction, growth, maturity and decline as four distinct phases, can

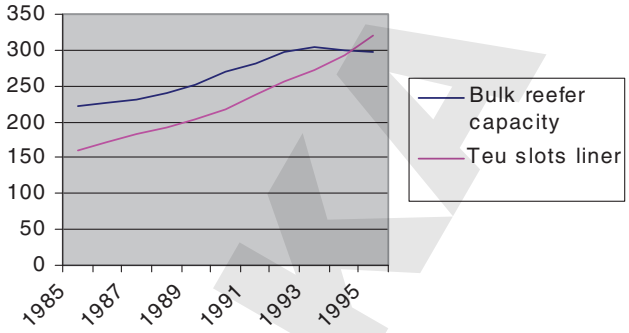

Figure 4. World reefer and Container reefer capacity 1985–1995.
Source: A/S Klaveness reefer data in million cubic feet and Drewry/*Containerisation International* data on total reefer slots for container vessels in Drewry (1999) [3].

clearly be traced in the history of the bulk reefer industry. The latter went through a long phase of growth of traditional vessels, the first attempts dating back to the late 1870s [38]. Introduction and growth of reefer vessel types have been accompanied by the passage of previous types of vessel/service from maturity to decline as traditional vessel types became technologically and commercially obsolete [56].

The process could be tentatively considered as a rather accelerating one as has been observed for other markets [57]. The conversions of old 'break-bulk' vessels to 'pallet-friendly' ones in 1990s indicated that 'pallet-friendly' vessels were quick to replace any remaining break-bulk vessels that continued to decrease. Soon after, 'container-friendliness'—rather than 'pallet-friendliness'—of *bulk* reefers replaced the previous type in defining modern reefer capacity *as well as* a new 'product' or rather service. In this respect, the intersecting courses of the three 'product' forms can be distinguished as depicted in Figure 5; capacity trends are used as a proxy for the sales usually measured on the vertical axis in a PCL context.

When the analysis goes up one level embracing product *class* [55] instead of *form*—in this case substituting bulk reefer *vessel types* with *modes* of refrigerated transport by sea—a picture of a whole type of bulk reefer service having stepped into the downward sloping part of its own bell curve clearly emerges (cf. Figure 6).

The incursion of container vessels in the reefer market could not have been better timed for container shipping or worse timed for bulk reefer owners. By the late 1990s, as major reefer operators set off to offer improved quality of service through controlled atmosphere and the provision of on-shore logistics to maintain a competitive edge, container shipping encroached further on the market share of reefer bulk vessels. Despite a *prima facie* impression that bulk reefers could have a cost advantage over refrigerated containers, reefer containers had achieved through scale at least comparable costs [58] expected to decline further in the late 1990s [44]. In any case, reefer container shipping was differentiated enough as a separate *class of* service to allow itself not to be concerned by bulk reefer pricing [24 : 18]. The increasing pressure from container lines incited reefer operators to introduce container-friendly vessels capable of transporting large volumes of cargo on deck [59]. Although the use of below deck capacity is also mentioned nowadays in conjunction with the possibility for carrying chilled cargo in containers, any such

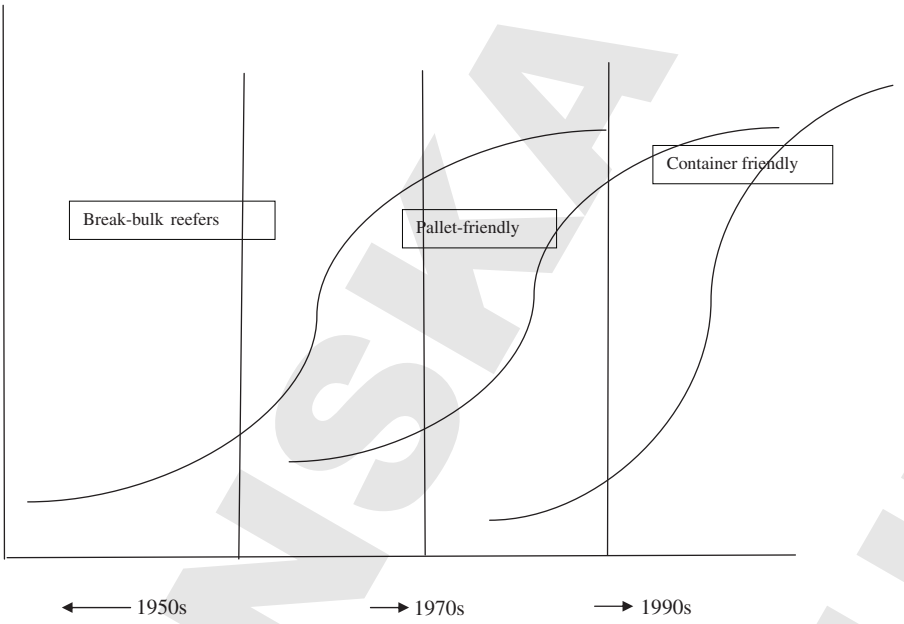

Figure 5. Bulk reefer ships in a product life cycle perspective.
Note: Curves are only figurative in representing capacity changes.
Source: On the basis of data and dates in Mitropoulos (1980) [60], Drewry reports, especially Drewry (1999) [3], Stopford (1997) [61], Wijnost and Waals (1999) [38], Lauritzen News (2007) [62], Day (1981) [53], Rink and Swan (1979) [55], Volk (2002) [63] and Figure 4.

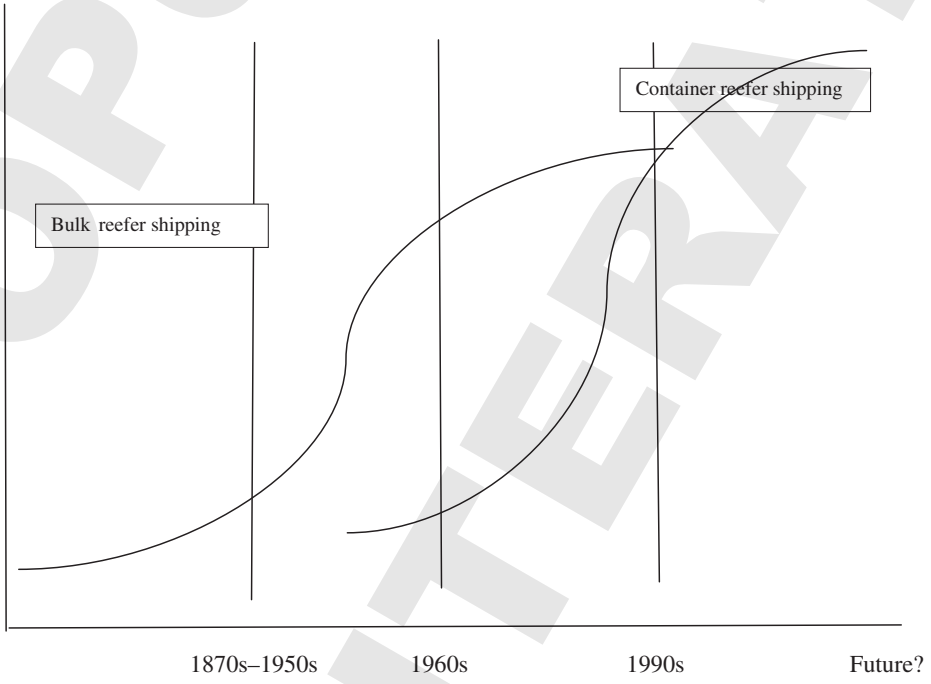

Figure 6. Reefer shipping in an adapted product life cycle perspective.
Note: Curves are indicative only.
Source: As Figure 5.

extended use of the 'box' [60] in the future would prove a self-defeating or rather 'self-negating' exercise for bulk reefer shipping.

The accelerating competition from the container trades—combined with the impact of poor markets in the late 1990s—can also be considered to be at the origin of the post-millennium merging trend inaugurated in 2000 [64]; this was followed by further consolidation involving important players in the reefer market [65]. Indeed, the potential for taking advantage of 'economies of scale [. . .] and the development of more complex transportation services' [66, 2000] were among the main reasons put forward in the case of the first post-millennium merger that set the scene for more consolidation as the decade progressed [67]. There is scarcely a possibility, however, for the increasing consolidation proving ultimately a real problem for charterers. What can be considered as key, in keeping the bulk reefer market form away from the oligopolistic end of the monopolistic competition spectrum, is mainly the strong existence of substitutes in the form of container vessels and hence the prevalence of a *renewed* freedom to entry. In any case, shortly before the—ominous eventually in a PLC context—exit in 2007 of an industry pioneer from reefer shipping after a century in the market [62], the top four reefer fleets operated 37% of the capacity in cubic feet and 44% if only vessels over 100,000 cubic feet are retained [68]. However, in view of the decline of the bulk reefer fleet, consolidation has obviously limited power to counter trends or threats that bulk reefer operators face in a fast-changing environment; their margin for strategic responses is not greater either, but needs to be assessed, nevertheless. In a systematic manner.

5. Competing in modern bulk reefer shipping: threats without opportunities?

In the purely competitive traditional shipping markets [69,70], companies have traditionally little defensive arsenal in their disposal in lean periods; they are essentially limited surviving—and preparing for—these periods pursuing a least-cost strategy with a focus on fixed-cost minimisation [71] and on the all important cash flow [61]. Reefer market firms have over time capitalised on what has been proposed as the first bulk shipping competitiveness factor [71, 72], that is, that of *specialisation in the context of demand developments*, by introducing vessel types better adapted to growing types of cargoes. Firms have also capitalised on the second factor of competitiveness, this *of the level of quality of service* both by the introduction of more stowage-friendly vessels and by the introduction of new techniques for preserving cargo on board. The idiosyncratic nature of perishable produce as a cargo without necessarily identical properties but a large variety of both the latter and of required conditions [73] for its transport, creates an analogous variety of risks [74]. Increasingly, however, the competitive potential of differentiation pursued by individual operators—consistently with the suggested departure of the reefer market from pure competition earlier in the paper—has been hampered by the aggressive entry of container shipping in the trades. The latter form of service became an overriding force, undermining the competitive potential of the entire bulk reefer industry especially as container lines have also introduced customer orientated new concepts.

As bulk reefer services pass as a class of service from maturity to decline, the range of alternative strategies for participant firms seems to have narrowed further. Any remaining opportunities for bulk reefer operators in a SWOT context—within the usual limitations of a SWOT approach [75]—originating eventually from demand

Strengths	Weaknesses
(Experience)	Minimum size of shipment dictated by vessels
Tailor-made services	Lack of flexibility
Evolution of the service provided	Speed of transit and transhipment Stagnant terminal handling systems
Ties with shippers	
Opportunities	**Threats**
Demographic trends	Container shipping (flexible, quick, integrated)
Economic growth	Logistical experience of shippers

Figure 7. A SWOT review of bulk reefers.
Source: Various Wild G.P Ltd. and Drewry reports *Lloyd's Shipping Economist* [45], comments from industry executives and author's estimates.

factors (cf. Figure 7) must be seen equally in perspective. The overall positive demand trends have confirmed previous forecasts made more than a decade ago [6]. While the reefer trade has been described traditionally as a north–south one—easily contrasted with the east–west direction of container trades—the expression that would best convey reefer trade flows may be exactly the inverse; south–north describes quite accurately the direction that the trade has been following in servicing current origins and destinations [24]. As the growth of the GDP per capita continued to be impressive to the North of the equatorial divide for many years—disregarding any current east–west differentials—total trade prospects have been solid to excellent for long, although the downturn of the world economy at the end of this first decade of the 21st century has put these—be that temporarily—in perspective. Total trade by the middle of the second decade of the 21st century is estimated to be near the 110 million mark [76]. However, despite these favourable prospects, it is unlikely that bulk reefer shipping may return on the basis of future world economic growth to any previous stage in a PLC perspective claiming market shares back; it is equally—if not more—improbable that, cyclical trends notwithstanding, it can be seriously revived in terms of absolute growth. Only some revolutionary innovation would allow bulk reefer operators out of the strategic impasse that the quadrants of Figure 7 signpost.

It could be argued that a number of companies could position themselves as operators of older units purchased at lower prices. Prices for 10-year-old vessels had doubled (or halved) within 24 months or so in the past. However, operators may have limited potential anymore for pursuing investment strategies that have proved popular—and successful—in main markets as tankers in the past [77] as obsolescence of old break-bulk tonnage is limiting access to main trades. Any resort to older vessels must take into account that, while reefers have already adjusted to changes in the list of allowed refrigerants [5], future measures could impact on vessel prospects along with preferences of quality-conscious shippers selling to large consumer markets.

A lower average cost can be achieved by exploiting economies of scale through increasing the vessel size. However, parcel sizes and shore-logistics are essentially the

factors that dictate the vessel size but are difficult to dictate to shippers; additionally, the provision of integrated logistics solutions is one of the main strengths container shipping built upon in recent decades. The main threat for bulk reefer shipping originates precisely from the perception by its customers of the many advantages of reefer containers: flexibility—considered, however, by bulk reefer operators as a main strength of their own [24:20]—along with speed and easier integration into the entire transport chain [78].

In a SWOT context, bulk reefer operators are left essentially with their longer exposure to the idiosyncratic demands of the transport as their main remaining strength. Nevertheless, it has been too long already since container shipping made significant inroads into this market for any global container operator to be considered as still struggling with learning curves; on the contrary, the capture of the majority of the trade by liner shipping has provided the companies operating in the latter with the advantage of the leader between the two types of sea-carriage of perishable produce. Any remaining significant strength of the bulk reefer segment may lay in the potential for forging ties with shippers whose forward vertical integration—despite expansion through the latter being observed in the past [79]—has seemed without momentum. However, successive periods of overcapacity over the last 15 years have ideally combined with the reassuring rise of reefer container operations to curb any shipper concerns which would otherwise force them massively into buyer–supplier alliances for fear of lack of capacity; by the same token, any other remaining strengths in Figure 7 can be put, along with *experience*, in brackets as well as in perspective.

6. Conclusions: competing elsewhere still researching here?

The analysis that preceded suggested that, on the basis of the foundations of monopolistic competition [32], the bulk reefer market seems to satisfy two criteria for inclusion in this market form: of product differentiation and of advertising, shipper preferences being influenced by the quality of service provided, as perceived either on an objective basis or on a subjective one through advertising. While large operators in reefer shipping have been leading or managing large pools of reefers, the market structure has been kept towards the more competitive end of the spectrum of imperfect competition through mainly the strong existence of substitutes in the form of container vessels and hence through the increasing prevalence of a *renewed* freedom to entry. Evidence of any market power based on price deviations from marginal cost is necessary to validate the conclusions of this theoretical discussion. Assessing the specific market structure of this segment on the basis of its essential traits was one of the two key areas in which the paper aimed to contribute. Research is equally needed to verify the extent of product differentiation; this can be approached either by measuring related cross elasticities or by further investigating the potential origins of transport price differentials as these may be found reflected in charter data. The scope for extending the research with regard to adapting related concepts such as, for instance, the concept of variety or of experience goods to the idiosyncracies of shipping seems equally large. However, assessing the market form in the context of a changed economic and technological environment within which the cold chain operates would be incomplete and misleading in terms of the potential for a survival strategy of bulk reefer operators. Any future flourishing of a—belated anymore—interest in the market's structure can hardly contribute to address the

main issue for bulk reefer firms, that is the prospects of this market in a product-cycle perspective. Applying the concept within a shipping segment and assessing where bulk reefers and the bulk reefer service concept find themselves at this stage on the cycle is the other key area where the paper aimed to contribute. Further research into the product-life cycle concept and its application on the reefer market is equally—if not promising—at least necessary as the process is underlying the modal decline of reefer shipping. While further consolidation might be the only strategic move left to bulk reefer operators, it cannot automatically be effective if the penetration of the trade by container lines continues at high rates. The main strategy option available to bulk reefer firms seems limited to the—classic anymore—approach of *focus* as suggested by Porter [80] within which differentiation or cost leadership can be selected according to the nature of buyers. Limiting the target area on the demand side might allow individual operators to provide tailor-made logistics solutions to customers locking-in demand long term by creating eventually switching costs. Viewing the carriage of seaborne cargo from an international supply chain perspective with the specific requirements of the cold chain [19, 76, 79] is essential in this regard. Market moves seem to suggest that any less focused alternatives may lie outside the proper bulk reefer market [81]. As—even amidst the last longer phase of shipping market prosperity—bulk reefers proved unable to reach back to any ascending parts of their PLC curve, shipping economists may be left with few other alternatives than to agree.