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**Specialisation strategies in Norwegian
shipping – a Vernon product cycle approach**

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Abstract

One of the most important developments in the postwar shipping industry from the 1960s onwards has been the introduction of specialised ship types that have gained market shares in the transport of a large number of cargoes. The share of specialised tonnage in the Norwegian fleet increased from less than one per cent in 1960 to more than thirty per cent by 1987.

This trend towards increased specialisation did not occur to the same extent in all maritime centres. Norwegian owners held a large share of the new ships, but even within Norway there were substantial differences. Specifically, a disproportionate share of the specialised Norwegian ships was owned by shipping companies in the city of Bergen. In 1977 Bergen companies owned around fourteen per cent of the aggregate Norwegian fleet, but almost half of the specialised tonnage. The Bergen presence was particularly strong in two segments; chemical tankers and open hatch bulk shipping.

After the introduction of a theoretical framework and a presentation of the increasing degree of specialisation within Norwegian shipping, the paper looks more closely at the Bergen participation in the two segments mentioned above. Through closer studies of the companies involved it becomes evident that three factors – cooperation between individual companies, vertical integration and technological innovation – can explain the strategic shifts.

Introduction

The most common unit of analysis in shipping history studies is ‘the national fleet’ – the Greek or Greek-owned fleet, the Norwegian or Norwegian-flagged fleet, etc.¹ Behind this generalisation lies the assumption that there are specific common traits – investment behaviour, market orientation and other business strategies – that characterise shipowners in a particular country. At the other end of the spectrum, shipping company histories frequently eschew the general, looking solely at factors specific to the companies in question. While the former angle dismisses heterogeneity, the latter perspective too often treats everything ‘outside’ the company as exogenous, in some cases even ignoring it altogether.² The aim of this paper is to use a combination of these ‘macro’ and ‘micro’ perspectives to gain new insights about structural transformations within shipping and the companies that initiate this change. The Norwegian merchant marine in general, and the fleets owned by companies in the port of Bergen in particular, are used to illustrate the developments.

The paper consists of four parts. The first section provides a theoretical framework in which the increased specialisation within shipping can be understood. The subsequent section is primarily empirical, and sketches the structural transformation of the Norwegian shipping industry from 1960 to 1987, with particular reference to the disproportionate share of the specialised fleet registered in Bergen. This period thus includes both the early phase of niche investments, from 1960 to 1977, and the maturation and standardisation of the specialised segments in the subsequent decade. The third section presents the two niches in which Bergen owners played particularly important roles – chemical tanker transports and open hatch bulk shipping. In the final part of the paper, three factors that can explain the Bergen dominance within these segments – cooperation, vertical integration and technological innovation – are analysed.

¹ See for instance Fischer & Lange (2008).

² These claims are of course more valid for ‘bad’ research, than for ‘good’ research. If done well, a presentation of a country’s shipping sector will analyse the degree of heterogeneity, while a history of a shipping company will aim at putting the company’s activities into a relevant context or framework.

I. Specialisation and the product life cycle

The postwar shipping market has been characterised by a substantial increase in the number and share of purpose-built vessels aimed at specialised segments of the market for seaborne transport. In 1960 the world fleet mainly consisted of tankers, bulk and general cargo carriers, plus a fairly limited number of specialised vessels such as for instance gas tankers. By the mid 1970s the share of specialised tonnage had increased dramatically. This reflects the fact that several cargoes that had previously been transported on conventional vessels could be shipped cheaper and more efficiently in specialised ships. Cases in point are cars and chemicals, which had traditionally been transported in general cargo vessels. During the 1960s purpose-built car carriers and chemical parcel tankers took over large portions of this trade, and by the middle of the 1970s general cargo ships hardly carried such cargoes at all.

The increasing specialisation within shipping can partly be explained by new technological opportunities, partly by trade growth that secured sufficient demand to warrant the introduction of purpose-built tonnage. Norwegian shipowners were at the forefront of the move towards specialised shipping, gaining substantial market shares in several of the new segments. A previous paper has quantified the structural transformation of their fleets, with particular emphasis on the increasingly important role of specialised ships.³ The proportion of ‘specialised ships’ in the Norwegian fleet, based on gross registered tonnage (grt) increased from 0.7 per cent in 1960, via 8.2 per cent in 1977, to around 32 per cent in 1987.

It is not easy to give a precise definition of ‘specialised ships’. For the sake of simplicity, this paper focuses on ship types that did not exist in 1960 and vessels targeted at niches that were relatively small in 1960.⁴ In terms of ‘the shipping matrix’, we thus include three segments; ‘contract shipping’, ‘industry shipping’ and ‘specialised shipping’.⁵ The ships that are excluded, such as conventional tankers and bulk carriers, operate in the ‘commodity

³ See Tenold (2009) for a presentation of this structural transformation.

⁴ The following ship types are characterised as specialised vessels; liquefied gas carriers, passenger and cruise ships, chemical tankers, car and vehicle carriers, supply ships, specialised service vessels, open hatch bulk carriers and LASH (Lighter Aboard Ship), container and Ro-Ro (roll on-roll off) vessels. The non-specialised ships include four types of vessels; conventional bulk carriers, general cargo ships, combination carriers and oil tankers.

⁵ See Lorange (2005:23-26) for a presentation of this matrix, which is commonly used to distinguish between shipping segments.

segment', which is characterised by insignificant barriers to entry and very limited potential for differentiation. The terms of competition consequently differ from the niches that are the focus of this paper.

One approach that can be used to describe the shift towards increased specialisation at the international level is the hypothesis that shipping segments can be characterised by a development similar to the one seen in a 'Vernon product life cycle'.⁶ This framework has previously been successfully applied to shipping, for instance to explain the shift of gravity from Traditional Maritime Nations (TMNs) to Flags of Convenience and open registers.⁷ In this paper, the analytical framework draws upon Vernon's hypothesis, but with some modification.⁸

The new specialised segments within shipping develop on the basis of technological progress. In the initial 'entrepreneurial phase', these segments are commonly dominated by a limited number of pioneers. The first-mover companies are typically based in TMNs. This reflects two elements. First, it is a result of the fact that development and introduction of innovations are risky and relatively costly. Within shipping, the new technologies are therefore unlikely to be introduced by countries with a comparative advantage in labour-intensive service provision.⁹ Second, good knowledge of the market and close ties to potential suppliers and customers are necessary to succeed with the introduction of new technologies. Again, this would favour shipowners in the TMNs. In the 'entrepreneurial phase', the existence of quasi-monopolies, product differentiation or 'captive markets' lead to a relatively high price of the new product or service.¹⁰

⁶ Vernon (1966).

⁷ See Sletmo (1989) or Thanopoulou (1995). The term TMNs may somewhat imprecisely be said to refer to the OECD-countries. Open register-ships still fly the TMN-flag, but special provisions apply.

⁸ Vernon (1966), dealing with manufacturing production, international trade and international investment, distinguishes between three phases; a new product, maturation and standardisation. Within shipping, it is difficult to clearly model the trade and investment effects, and the transition between the latter two phases is vague.

⁹ Vernon (1966: 193-194) specifically deals with innovations that substitute capital for labour.

¹⁰ Yet, as a result of increased efficiency, the price may be low relative to previous alternatives, using older technologies. As long as the new technology is not universally available, it may therefore be correct to use the term 'high profits' rather than 'high prices'. In some instances a combination of the two might occur; refer to the presentation of the chemical tanker market in Section III.

The second ‘maturing phase’ in Vernon’s product life cycle is associated with expanding markets and a higher degree of standardisation. Vernon’s approach, emphasising the role of trade and the location of production, is not directly applicable to shipping. However, evidence from shipping niches gives an indication of the forces at play. Higher and more secure demand and the emergence of accepted standards lead to increasing economies of scale. Within shipping, these can be manifest in two areas. First, there are economies of scale in supply – both with regard to individual vessels (larger ships) and individual companies or pools (larger fleets). Second, owners can reduce the cost of inputs through mass ordering of large series of identical ships. This will both lead to lower purchase costs per ship and enable cheaper and more flexible operation of the fleet.¹¹ As a result of these economies of scale, the early entrants are still able to command a ‘premium’ revenue-wise, despite the fact that the forces that gave an advantage in the ‘entrepreneurial phase’ are no longer as strong.

At the final ‘standardised’ stage, price becomes an increasingly important competitive parameter, and the ‘premium’ that the early entrants could previously enjoy is not as pronounced as before. In addition to becoming ‘standardised’, the technology now becomes more easily accessible. At this stage, older specialised ships become available in the second-hand market. This implies that parts of the niche have lost the technology- and capital-intensive character witnessed at the previous stages. Early entrants may still have some scope for further diversification, for instance through vertical integration or continuous innovation.¹² However, as price becomes the main competitive factor, focus on costs becomes essential. In this phase ‘flagging out’ to low labour-cost registries becomes a feature even in the case of ships operating in specialised segments.

II. Structural transformations in Norwegian shipping

In line with the ideas presented in the previous section, the analysis of the structural transformation of the Norwegian fleet distinguishes between two different periods. The first,

¹¹ For instance, with long series, ships can conveniently be replaced by identical tonnage. Moreover, the personnel will get more intimate knowledge of technological solutions and can more easily be transferred among vessels.

¹² However, it is not necessarily the case that the company is able to transfer the cost of the innovation to its customers to the same extent as before. One result of this may be ‘over-sophistication’ of the tonnage; again, refer to Section III for examples.

from 1960 to 1977, can be seen as a ‘pioneering’ or ‘formative’ phase, when the specialised technologies were new and novel, and the early entrants had first-mover advantages.¹³ During the second phase – the decade after 1977 – the degree of innovation was more limited and technological standards had been established in most of the niches. While some of the original participants maintained substantial market shares, the maturation of the market and standardisation of the specialised technology made it easier and less expensive for new participants to enter the market.

Table 1 shows that in the period from 1960 to 1977 the growing share of specialised ships primarily reflected a strong increase in the number and tonnage of such vessels.¹⁴ Other market segments saw slower growth, but only one type of vessels, the general cargo carriers, was characterised by absolute reduction. In the subsequent period, from 1977 to 1987 the increase to some extent reflected growth in the specialised fleet, which almost doubled over the period. However, the massive disinvestment in non-specialised types of shipping was in fact more important, leading to an even stronger increase in the proportion of specialised tonnage. Whilst the general cargo carriers continued their downward trend, the previous period’s expansion was replaced by substantial decline for tankers, dry bulk carriers and combination carriers as well. The term ‘change factor’ is used to denote the growth (if above one) or decline (if below one) of the tonnage from 1960 to 1977 and from 1977 to 1987.

Table 1. Structural transformation of the Norwegian fleet (1,000 grt), 1960-1987

Type	1960	<i>Change factor</i>	1977	<i>Change factor</i>	1987
Tankers	5,914	2.48	14,681	0.32	4,709
Dry bulk carriers	617	8.62	5,318	0.33	1,772
Combination carriers	145	26.15	3,792	0.58	2,201
General cargo	2,355	0.45	1,055	0.27	289
Specialised ships	64	34.58	2,205	1.9	4,128
All ships	9,095	2.98	27,051	0.48	13,098

¹³ This period is analysed in more detail in Tenold (2009).

¹⁴ The tables and figures in this paper are, unless otherwise stated, based on three purpose-built data sets consisting of all Norwegian ships above 5,000 grt. The data sets have been based on Det norske Veritas (1960), Det norske Veritas (1977) and Det norske Veritas (1987), but have been supplemented by other sources when necessary. The 1987 data set includes Norwegian-owned ships registered abroad. Due to the strict Norwegian flag regime before 1980, there is hardly any difference between the Norwegian-flagged and Norwegian-owned fleet in the first two data sets.

A closer analysis of the data on which Table 1 is based reveals that the driving force behind the change varied across segments and periods. In Table 2 the differences between the two periods have been decomposed into a ‘size effect’ and a ‘number effect’. The former is a result of growth or reduction in the average size of the ships in the various sub-groups, while the ‘number effect’ refers to changes in the number of the various vessel types. The data are shown as percentages of the level in 1960 and 1977 respectively. For instance, the average size of the Norwegian tankers increased by 478 per cent from 1960 to 1977, while the number of tankers declined by 57 per cent.

Table 2. The basis for the structural transformation – all ships (per cent), 1960-1987

Type	1960-1977		1977-1987	
	Size effect	Number effect	Size effect	Number effect
Tankers	478 %	-57 %	-3%	-67 %
Dry bulk carriers	138 %	262 %	0%	-67 %
Combination carriers	305 %	544 %	-22 %	-26 %
General cargo	19 %	-62 %	46 %	-81 %
Specialised ships	31 %	2540 %	27 %	48 %
All ships	261 %	-18 %	- 12 %	- 45 %

Table 2 illustrates the importance of the growing average size of ships in the period 1960-1977, a growth that was – in the case of Norway – reversed in the following period.¹⁵ However, the main reason for the strong reduction of the non-specialised tonnage from 1977 to 1987 was a massive decline in the number of such ships in the Norwegian fleet. In 1977 the Norwegian fleet had consisted of 132 specialised vessels and 582 conventional ships. Ten years later the number of specialised vessels had increased to 195, while the number of non-specialised ships had more than halved, to 200 vessels. Consequently, measured by the number of ships, the specialised tonnage made up almost half of the Norwegian fleet in 1987. However, due to differences in average size, the ships made up slightly less than a third of the total gross registered tonnage.

The structural shifts illustrated in Table 2 reflect the changing dynamics in the market for seaborne transport. In the period from 1960 to 1977 Norwegian owners had to some extent

¹⁵ This can be explained by the effects of the shipping crisis on Norwegian owners; see Tenold (2006b) for an analysis of this watershed in Norwegian and international shipping.

managed to neutralise their labour cost disadvantage through investments in larger and larger ships. The average Norwegian tanker increased from approximately 12,500 grt in 1960 to more than 70,000 grt by 1977. As the mammoth tanker and bulk carriers were particularly hard hit by the shipping crisis, new investments in non-specialised tonnage practically dried up. With the market in crisis, cash-strapped Norwegian owners were forced to sell or transfer even the largest ships to low-cost flags.

From 1977 to 1987 the specialised markets were the only ones that still managed to attract Norwegian investments. However, even within these niches, the driving force behind the growth differed among various ship types. As seen from Table 3, increases in average size were the most important factor behind the growth of the vehicle carrier and cruise fleets, while a reduction in the average size of Ro-Ro vessels was more than neutralised by a considerable increase in the number of such ships.

Table 3. The basis for the structural transformation – specialised ships (per cent), 1977-1987

Type	Fleet 1987 (1,000 grt)	Size effect	Number effect
Liquefied gas	1,064	51.2 %	95.7 %
Open hatch	915	27.7 %	41.7 %
Chemical tankers	960	11.5 %	27.3 %
Passenger/ cruise	427	25.6 %	22.2 %
Vehicle carriers	360	60.0 %	40.0 %
Ro-ro	272	-12.4 %	333.3 %

Due to the limited amount of specialised tonnage in Norway in 1960 a similar exercise would have been pointless for the period 1960 to 1977. The strong increase in average size of gas and vehicle carriers after 1977 to some extent reflects new technological possibilities, which indicates that these niches had not yet reached the ‘standardisation’ phase to the same extent as the other specialised segments.

The preceding analysis has illustrated the empirical side of the structural transformation of the Norwegian fleet. However, a number of interesting questions are lurking behind these numbers. Were there any specific patterns in the specialisation, based on for instance geography? What characterised the strategies of the companies that engaged in

the new segments? To which extent is it possible to identify the stages of the Vernon cycle within the individual niches?

Previous research has indicated that there were indeed substantial regional variations in the degree of specialisation.¹⁶ Bergen, Norway's second largest city and a long-standing maritime centre, held around 13 per cent of the total Norwegian fleet in 1977, but almost 44 per cent of the specialised tonnage, as seen in Table 4. Moreover, the investments of Bergen shipowners were heavily concentrated within two niches – open hatch bulk shipping and chemical tanker transports.

Table 4. Bergen's share of the fleet and sub-segments (per cent), 1960, 1977 and 1987

Bergen's share of the Norwegian:	1960	1977	1987
- fleet	12.1	13.4	12.8
- specialised fleet	-	43.9	26.5
- open hatch bulk carrier fleet	-	85.6	60.4
- chemical tanker fleet	-	69.6	50.6

There are three possible reasons that the share of specialised tonnage was higher in Bergen than in other parts of the country. First, a higher share of Bergen's companies might have chosen a specialisation strategy. Second, the companies that had chosen to invest in specialised ships might have had a more dedicated approach to this strategy – a higher 'specialisation ratio'.¹⁷ Finally, both of these forces might have been at play. A closer look at the data indicates that the third explanation is the correct one.

¹⁶ See Tenold (2009).

¹⁷ The 'specialisation ratio' is calculated as the specialised ships' share of all tonnage owned by the company. When looking at more than one company, the average of individual 'specialisation ratios' would give misleading results, as differences in the size of companies would not be taken into account. In these instances, the 'specialisation ratio' refers to the specialised fleets as proportion of all tonnage owned by companies that had invested in such ships.

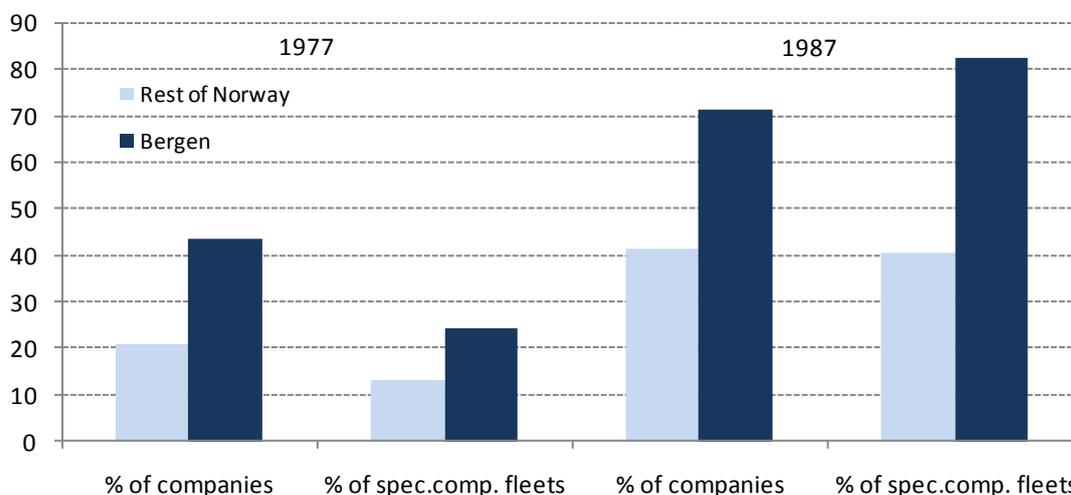
Figure 1. Specialisation: shares of companies and specialisation ratio, 1977 and 1987

Figure 1 shows that a higher share of the Bergen companies had chosen to invest in specialised ships *and* the specialisation ratio was higher among these companies than among specialised companies in other parts of Norway. This was evident as early as 1977, and the differences were significant in 1987 as well. In the latter year, ten out of the fourteen Bergen-based shipping companies had invested in specialised ships, and the niche tonnage made up more than eighty per cent of these companies' fleets.¹⁸ Specialised tonnage made up 26 per cent of the Bergen fleet in 1977, relative to 5.3 per cent for the rest of the country. By 1987 the comparable figures were 66.1 per cent and 27 per cent respectively.

While it is evident that Bergen may be a very good starting point for an analysis of specialised shipping, the high degree of specialisation and the concentration on two specific niches imply that 'general' conclusions about the forces at play should not be drawn from this example. Nevertheless, the two segments can shed some light upon the processes that characterised the development of the two largest specialised niches.

III. The Bergen niches

The specialisation of Bergen owners was more 'focussed' than what we observe for the rest of the country. Two niches – chemical tanker transport and open hatch bulk shipping –

¹⁸ It is worth noting that there were ten specialised companies in Bergen in 1977 and 1987. However, the number of non-specialised companies declined from thirteen to four.

accounted for more than 90% of the specialised shipping investments of Bergen shipowners both in 1977 and 1987. Moreover, the Bergen owners – and locally-based ship equipment producers – played an important role in the technological development of both niches. In this sense, the Bergen shipping milieu can be seen as having many of the properties that Michael Porter used to characterise ‘clusters’.¹⁹

Chemical tanker transports

The transport of chemicals in purpose-built tankers was one of the fastest growing niches in the period 1960 to 1987.²⁰ It is difficult to give a precise definition of the size of the chemical tanker fleet, mainly due to borderline vessels that switch between markets depending on demand and supply.²¹ However, according to data from brokers, the amount of chemical tanker tonnage in the international market increased from around 700,000 dead weight tons (dwt) in 1964, via 4.5 million in the mid 1970s, to more than 11 million dwt by 1987.²² This gives a trend growth of around 14 per cent over the period – substantially stronger than the five per cent seen for the world fleet as a whole.

Before 1960, the limited amounts of chemicals that were transported internationally were usually carried in steel drums or carboys on conventional ships. During the 1960s parcel tankers – purpose-built ships that could transport different chemical products in bulk – took over this trade. The bulk transport concept led to a substantial reduction of transport costs, a fact that, together with the strong growth in chemical use and production capacity, led to high growth in the internationally traded volume of chemicals.

¹⁹ There are two reasons that the ‘cluster’ approach presented in Porter (1990) has not been explicitly used in this paper. The first is the fact that the shipping companies’ role as the core of the Norwegian maritime cluster is disputed; see Midelfart Knarvik & Steen (1999). The second reason is that the notion of a ‘Norwegian maritime cluster’ has been at the centre of a heavily politicised debate within Norway; see Fougner (2006). This does not mean that we doubt the strategic and economic importance of the linkages between companies in the Norwegian maritime industry. Rather, one of our main explanations of the Norwegian success within shipping niches relates to such relationships.

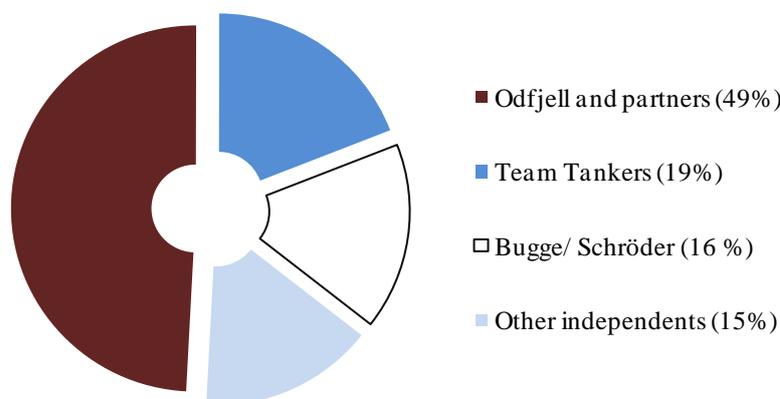
²⁰ For a more thorough introduction to this market, see Murphy & Tenold (2008).

²¹ The most obvious example of this is that chemical tankers may trade in the oil product market when demand for chemical transport is low, and oil product tankers may carry some ‘benign’ chemical cargoes when demand is high.

²² Based on data from Clarkson (1964), Clarkson (1977) and Drewry (1989:42).

In the mid 1970s, Norwegian shipowners played important roles in the seaborne transport of chemicals. Indeed, more than a third of the chemical tanker fleet was registered in Norway in 1977, according to data from Lloyd's.²³ Twelve Norwegian companies had invested in chemical tankers above 5,000 grt, implying that this was the niche in which the highest number of companies participated. The main centre was Bergen, with more than two thirds of the tonnage.

Figure 2. Leading Norwegian chemical tanker owners, based on grt, 1977



The Odfjell group was by far the leading Norwegian chemical tanker operator, as shown in Figure 2. Together with their partners, Odfjell held an international market share of more than 25 per cent in the sophisticated end of the chemical tanker market.²⁴ These ships had been classified to allow the transport of all kinds of chemical cargoes, even the most corrosive, explosive, inflammable and toxic.

The basis for Odfjell's position was twofold. First, it reflected the fact that the Odfjell group from the beginning of the 1960s onwards channelled practically all of their ship investments into the chemical tanker sector. Second, it reflected a strategy of cooperation, where Odfjell handled the commercial operation of ships owned by other companies. In fact,

²³ Lloyd's (1977), Table 2. The other niche with really high Norwegian participation was vehicle carriers, where around a quarter of the world fleet was registered in Norway. At the time, the Norwegian share of the world fleet was around seven per cent.

²⁴ Chemical tankers are classified according to the chemicals they can transport. The sophisticated end of the market includes ships that can accept all kinds of chemicals, while the 'simple' chemical tankers can only accept a relatively low number of less hazardous chemicals.

almost half of the tonnage that Odfjell operated commercially was nominally owned by two other shipowners – the Bergen-based Westfal-Larsen & Co. AS and Christian Haaland of Haugesund. Odfjell had entered the market for transport of chemicals with relatively small ships, but increasing demand and new technical possibilities paved the way for larger vessels.²⁵ Through a combination of strategic cooperation, innovative technological solutions and vertical integration, the company managed to gain and defend a substantial market share.

As indicated above, the chemical tanker fleet grew massively in the period from 1960 to 1987. In 1960 the few existing ‘dedicated’ chemical tankers – a fleet that hardly surpassed 100,000 grt – were either relatively small, relatively simple (i.e. dedicated to one or two products) or owned by large multinational chemical producers such as Dow and Union Carbide. However, as the multinationals decided to outsource the seaborne transport of their chemicals, some operators – primarily Norwegian and British owners – managed to gain substantial positions in this rapidly growing market. A 1973 report from the shipping consultants H.P. Drewry claimed that “Scandinavian interests have almost monopolized the ownership pattern for [chemical] parcel tankers.”²⁶ In addition to the Odfjell group, Stolt-Nielsen, a company controlled by a US-based Norwegian expatriate, the Norwegian-British partnership ANCO and the British Athel Line were the dominant players.²⁷

By the mid 1970s Athel and ANCO, after first having merged with each other, merged with Panocean, a new contender owned by the British shipping giants P&O and Ocean. The three main participants – Odfjell, Stolt-Nielsen and Panocean Anco – then held an aggregate market share of almost 80 per cent in the intercontinental market, but much less than this in the regional markets. This substantial degree of concentration indicates that the kind of ‘quasi-monopoly’ suggested by Vernon still applied in the market at this stage – at least for the large sophisticated vessels that operated on intercontinental routes.

²⁵ This illustrates the point made before, that the lower limit of 5,000 grt for the ships included in the database may result in neglect of the ‘really pioneering’ period of specialisation, in which the waters are tested with small vessels.

²⁶ Drewry (1973:5).

²⁷ Murphy and Tenold (2008).

From the late 1970s onwards, a number of changes occurred in the market. In particular, the chemical tanker technology had now become ‘standardised’ – to follow Vernon’s vernacular – and a number of new agents entered the market. Specifically, a substantial number of relatively small Japanese vessels – built by Japanese shipyards that needed orders – contributed to a doubling of chemical tanker supply between 1980 and 1987. Through a combination of mergers and buy-outs, the main operators managed to still control most of the sophisticated tonnage that performed the long-haul voyages. However, the terms of the competition had irrevocably changed and profits were squeezed.

Three factors contributed to the ‘maturation’ and ‘standardisation’ of chemical tanker shipping. The first was the introduction of an International Maritime Organisation-endorsed Code regulating the transport of chemical cargoes in bulk. To allow the transport of a given chemical, ships had to comply with specific standards regarding for instance tank, pump system and pipeline construction. This implied that reputation and established relations to charterers became less important, reducing one of the advantages of the pioneers. The second factor leading to standardisation was the thresholds reached with regard to the technology. There was less room for innovation as the technological solutions pioneered by the early entrants – including the deepwell-pumps produced by the Bergen-based manufacturer Frank Mohn AS – had become relatively commonplace. Finally, by the early 1980s a well-functioning market for second-hand chemical tankers had appeared, substantially reducing barriers to entry. As can be expected from the Vernon framework, this led to the diffusion of the technology from countries with comparative advantage in high technology, capital-intensive shipping, to countries with labour cost advantages.²⁸

In the early days of chemical shipping, a combination of strategic cooperation, innovative technological solutions and vertical integration had enabled Odfjell and their Bergen compatriots to gain and defend a substantial market share.²⁹ The strategic cooperation refers to the operation of ships, owned by different owners, on a pool basis. Odfjell cooperated with other Bergen shipowners, investing in identical ships and operating these commercially as one entity. This secured a fleet that was big enough to offer a comprehensive

²⁸ See Thanopoulou (1995).

²⁹ See Thowsen & Tenold (2008:275-355) or, for a more concise presentation, Tenold (2006a).

world-wide service. The company would not have been able to attain a fleet of this size on its own due to financial limitations. The most important pool partner was Westfal-Larsen & Co. AS, which in the late 1960s and early 1970s more or less matched Odfjell's investments on a ship-by-ship basis.³⁰ Odfjell also operated a series of smaller chemical tankers that were fully or partly owned by seven minor shipowners.

The most important technological innovation was the introduction of versatile, stainless steel tanks, as opposed to the less expensive coated tanks that had previously been used. The high-quality stainless steel tanks enlarged the market, by allowing safe bulk transport of a number of new chemicals. Odfjell and their Bergen partners had a virtual monopoly on this technology during the 1960s and early 1970s. Even as late as mid-1978, Odfjell's stainless steel capacity was around 30% larger than their two most important competitors put together. However, in the 1980s most owners invested in stainless steel capacity, leading to an 'over-sophistication' of the tonnage. This expensive technology to some extent became the norm, even for chemicals that could have been safely transported in traditional coated tanks. The fact that a technological innovation that had previously been limited to the pioneers became common, illustrates that the sector had reached the 'standardisation' phase of Vernon's framework.

With regard to vertical integration, the Odfjell group invested in tank terminals in various locations. In addition to enabling a more efficient use of their fleet, the terminals improved the service offered to charterers.³¹ Another example of vertical integration was the company's establishment of an in-house brokerage. By taking over the marketing and chartering of the vessels in the pool, Odfjell managed to increase operational efficiency and maintain their close linkages to the most important customers. This became particularly important as international regulations and the fact that ships operated by different owners became more and more similar, reduced the scope for technological diversification.

³⁰ By 1977 Westfal-Larsen contributed approximately 40% of the tonnage in the pool. However, the focus on Odfjell is warranted by the fact that this company had been the original pioneer, owned the onshore facilities and was responsible for the commercial operation of all ships employed in the pool.

³¹ The other major owners took similar steps, while smaller new chemical tanker operators did not have the capacity to offer onshore storage as part of the transport assignment.

While technological innovation and vertical integration played a particularly important role in the case of Odfjell, cooperation was an important ingredient for most of the other Norwegian chemical tanker operators as well. Three Bergen companies – Det Bergenske Dampskipsselskap, Finn Engelsen and Rolf Wigand – participated in the *Team Tankers* pool, which operated in the less sophisticated part of the chemical tanker market. The companies transported relatively benign chemical cargoes that were lifted in larger volumes. Outside Bergen, companies such as Iver Bugge and Ole Schröder had a history of participation with British interests in the Athel-ANCO partnership, while Ruud-Pedersen operated a number of chemical tankers that were chartered to Associated Octel to carry lead antiknock compounds.³²

The chemical tanker industry provides a good illustration of the trend towards specialisation in shipping. The niche expanded on the basis of a combination of new technological possibilities and rapidly growing trade. High barriers to entry and the limited spread of their sophisticated technology implied that Odfjell and their Bergen compatriots could still reap the benefits of their first-mover advantage during the 1970s. As the market matured, however, the Bergen owners' position was weakened. Just like Norway's position in the international market for chemical transports was diluted, Bergen's share of the Norwegian chemical tanker fleet declined.

The share of the world's chemical tanker fleet registered in Norway declined from more than 35% in 1977 to less than five per cent by 1987.³³ However, if we take into account Norwegian-owned chemical tankers registered abroad, the decline is lower, to around 28% of the market. Despite this reduction, the number of Norwegian companies with chemical tankers in their fleets increased from 12 in 1977 to 16 by 1987. Nine of these 16 companies had entered the segment between 1977 and 1987, while five companies – including the three participants in the *Team Tankers* pool – exited the market.³⁴ The most successful of the newcomers, and the only one of the new companies based in Bergen, was JO Tankers. The

³² Confer Figure 2.

³³ Calculations based on Lloyd's (1977), Lloyd's (1987), Det norske Veritas (1977) and Det norske Veritas (1987). Over the same period, the share of the world fleet registered in Norway declined from 7% to 1.6%.

³⁴ Despite the exit of the original participants, the *Team Tankers* pool continued with other participants.

company was a spin-off from Odfjell, established as the assets of the Odfjell group were divided between two branches of the family. By 1984 the offshoot had “moved into the big three of the chemicals trade in volume of business and tonnage”³⁵

Open hatch bulk transports

In a similar vein to their pioneering roles in the chemical tanker industry, owners from Bergen played major roles in the evolution of the open hatch bulk carrier segment.³⁶ The technological basis was similar in the two niches; “[t]he progressive ‘bulking’ of cargoes results mainly from increases in volumes on particular routes to levels that justify full shiploads of single cargoes and the employment of larger and more efficient ships, and investment in specialised handling and storage.”³⁷ In the chemical tanker industry, the introduction of several tank subdivisions with separate pumps and pipelines enabled the transport of chemicals in bulk. With regard to the open hatch bulk carriers, improvements in cargo handling and storage were of particular importance. Specifically, the introduction of larger, more flexible hatch covers and movable gantry cranes gave the ships a competitive advantage in the transport of the so-called ‘neo-bulk’ commodities.³⁸ Among the most important neo-bulk commodities were forest products, steel and cement.

While Bergen-based shipowners were reluctant to invest in conventional bulk carriers, they managed to carve out a niche within open hatch bulk shipping.³⁹ Indeed, the vessel type was in many ways a local innovation, developed in cooperation between Star Shipping and Sverre Munck AS, a Bergen-based manufacturer of cranes.⁴⁰ The antecedents of Star Shipping were originally established in the early 1960s by Per F. Waaler. The son of an

³⁵ Quote from *Fairplay* (1984).

³⁶ The open hatch bulk carriers do not figure as a separate type of ship in macro statistics such as for instance those presented by Lloyd’s and Veritas, but are lumped in with other types of bulk carriers. In order to identify open hatch bulk carriers in the database, information on the breadth of the hatch covers and the crane equipment, which distinguish them from conventional bulk ships, has been used.

³⁷ Drewry (1982:1).

³⁸ The term ‘neo-bulk’ refers to shipments of commodities that require specialised shipping and port handling. Neo-bulk commodities are differentiated from break-bulk cargoes (less uniform and more difficult to load and unload) and bulk cargoes (homogeneous cargoes that are shipped in loose condition).

³⁹ See Fon (1995) for an analysis of the emergence of dry bulk shipping as a defined segment..

⁴⁰ See Bakka (2001). The technology was a refinement of a concept originally developed in cooperation between the US pulp and paper company Crown Zellerback and a shipowner in eastern Norway.

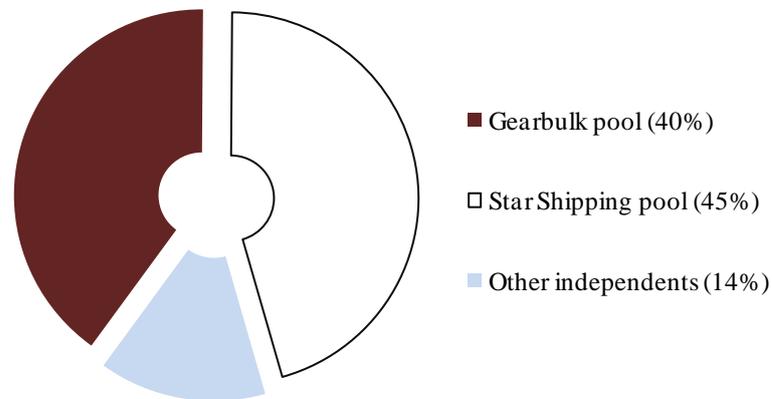
academic, he pioneered the open hatch concept, but due to lack of funds “cooperation was a necessity.”⁴¹ Investments started to escalate when several of the ‘established’ Bergen shipowning families, including Westfal-Larsen, entered the partnership in the middle of the 1960s. In fact, Westfal-Larsen signed a pool agreement with Star Shipping in February 1963 – some 14 months before the company entered into a similar agreement with Odfjell about chemical tankers

By the late 1960s, the backbone of Star Shipping’s fleet was a series of six purpose-built vessels – the so-called “C-class” – delivered from Kockums yard in Sweden. However, the company continuously upgraded its fleet, introducing newer and more flexible versions of the open hatch bulk concept in subsequent deliveries. In order to secure a “critical mass” of vessels, newbuilding contracts were at times resold to other owners, and Star Shipping took the ships back on timecharter contracts with purchase options. Furthermore, in 1970 the Star Shipping partners admitted a third member – Fred Olsen & Co – into the fold. This led to more capital available for investment and also secured a partner with substantial experience from the liner industry. The latter element became important as Star increasingly relied on regular services between specific ports. In particular, containers became important to fill transport capacity on the return leg of forest product transport assignments.

Although the open-hatch bulk carriers were legally owned by different interests, they were operated in a pool under the Star Shipping banner. By 1977 Star Shipping controlled approximately 45% of the Norwegian open hatch bulk carrier fleet. Their main competitor – with 40% of the fleet – was the Bergen-based Gearbulk pool, as seen from Figure 3. Gearbulk had been established by Kristian Gerhard Jebsen, who came from a family with long traditions within shipping. He established Gearbulk on the basis of a pool agreement between his own newly formed company, the Bergen owner J. Ludwig Mowinckels Rederi and two foreign companies – the French Louis Dreyfus & Cie of Paris and Buries Markes Ltd., a British subsidiary of Dreyfus. The companies expanded their open hatch investments rapidly in the first half of the 1970s.

⁴¹ Nilsen (2001:565).

Figure 3. Norwegian owners of open hatch bulk carriers, based on grt, 1977



Efficiency in loading and unloading gave the open hatch bulk ships a competitive advantage in the ‘neo-bulk’ market, and the land-sea interface was seen as an integral part of the business concept. Consequently, both Star Shipping and Gearbulk established a widespread network of personnel in foreign ports, and Star Shipping even invested in a purpose-built terminal for forest products in British Columbia. This on-shore element, coupled with the need for considerable investments in order to acquire a sufficiently large fleet, led to relatively high barriers to entry in the segment. The “C-class” ships delivered to Star Shipping from Sweden in the late 1960s represented the definite breakthrough for the open hatch bulk concept. Subsequently, the concept was refined, but without radical innovations of the type first introduced by Waaler. The ship size was increased substantially with the introduction of the “D-class” ships in the mid 1970s. Star Shipping continued to order identical ships in batches – the “F-class” and “G-class” ships delivered in the mid 1980s provided further refinement of an already successful concept.

Despite continually investing in new capacity, Star Shipping and Gearbulk’s dominance of the open hatch bulk carrier market, with control of more than 85% of the Norwegian fleet in 1977, was reduced in the following decade. Only two Norwegian companies outside Bergen owned open hatch bulk carriers in 1977. However, one of these, Leif Høegh & Co. AS of Oslo, expanded rapidly on the back of a long-term contract with the forest product giant Weyerhaeuser. A well-diversified company – with interests in three of the specialised segments – Høegh entered the open hatch niche in the mid 1970s, but controlled

approximately a quarter of the Norwegian fleet of such vessels by 1987. Four other companies entered the segment between 1977 and 1987, but two of these were welcomed into the Star Shipping pool as minor participants.⁴² Despite increased competition, the position of the original entrepreneurs is still strong; Gearbulk and Star Shipping both remain among the top three of the world's largest open hatch bulk carrier operators.

Network effects in Bergen shipping & Vernon's cycle

There is a long tradition focussing on regional 'networks' as an integral component of the shipping environment.⁴³ In a recent contribution, Boyce has pointed out that close networks can "facilitate the execution of an innovative strategy." An important element here is the "bonds of trust".⁴⁴ An illustration from the drive towards specialisation in Bergen is the pool agreement between Odfjell and Westfal-Larsen – a one page document that lay the foundation for a partnership lasting almost a quarter of a century.⁴⁵ According to Boyce, such levels of trust, combined with shared cognitive patterns, tend to "promote commitment, resource mobilisation, and co-operation."⁴⁶

This type of network effects were undoubtedly at play in the Bergen shipping community, and this can explain the city's drive towards specialisation and the leading role within two of the niches. Specifically, the technological solutions devised by Odfjell and Waaler provided Bergen with a head start within two rapidly growing niches and gave first-mover advantages at the 'entrepreneurial' stage of Vernon's product life cycle. Indeed, Odfjell's innovations within chemicals shipping and Waaler's new concepts in the transport of neo-bulk commodities were pioneering efforts. However, the entrepreneurs' limited financial clout led to cooperation with other local shipowners.⁴⁷ The symbiosis is self-evident:

⁴² Star Shipping's reduced share of the Norwegian-owned open hatch bulk fleet was to some extent neutralised by the company's operation of foreign-registered ships on long-term contracts.

⁴³ See for instance Boyce (1995) or Harlaftis & Theotokas (2004).

⁴⁴ Boyce (2007:48).

⁴⁵ Thowsen & Tenold (2006:324).

⁴⁶ Boyce (2007:48).

⁴⁷ As the Gearbulk case shows, there were also partnerships with interests that were clearly not locally based. However, the local participants were by far the most important, and there is little doubt that geographical proximity and already existing relations between the companies facilitated the cooperation.

the original entrepreneurs got access to the tonnage necessary to build up sufficient economies of scale, while the companies invited into the projects were given access to profitable investment opportunities.

As the markets reached the ‘maturation’ stage, the Bergen shipowners to some extent managed to maintain their strong position in the market, despite increasing challenges to their position. However, from 1977 to 1987, as the technology had become fully standardised and more easily accessible, they were unable to retain their substantial market shares. Moreover, at this stage of the product life cycle, the Norwegian participants were subject to increasing competition from foreign shipowners, reflecting the fact that the technology was no longer exclusive and price had become the main competitive factor.

One indicator of the standardisation of the specialised markets is the declining share of the world’s specialised fleet registered in Norway. Among the most important newcomers were Asians, Greeks and shipowners operating vessels flying Flags of Convenience. As Thanopoulou found; “[n]ations at a less advanced stage of development enter the maritime industry producing services that have reached the stage of a more or less ‘standardized’ product following Vernon’s product cycle.”⁴⁸ While we do not have detailed data for all segments, Table 5 illustrates the declining trend in several of the specialised markets. However, if we take into account Norwegian-owned ships registered abroad there was a small increase in the Norwegian-controlled share of the gas carrier fleet.

*Table 5. Norway’s share of the world fleet and important niches, 1977 and 1987*⁴⁹

Norway’s share of the world fleet of:	1977	1987	1987 (int.)
Chemical tankers	35.6	4.1	28.1
Liquefied gas carriers	10.0	7.6	10.9
Vehicle carriers	25.1	0.35	8.1
World fleet	7.1	1.6	3.3

⁴⁸ Thanopoulou (1995:51).

⁴⁹ Calculations based on Lloyd’s (1977) and Lloyd’s (1987), Tables 1 and 2, as well as Det norske Veritas (1977) and Det norske Veritas (1987). The rightmost column refers to Norwegian-owned ships, rather than vessels registered in Norway.

An alternative way of illustrating the move from the ‘entrepreneurial’ to the ‘maturation’/ ‘standardisation’ stages is to look at the concentration of the market. At the ‘entrepreneurial’ stage, with quasi-monopolies and limited diffusion of the specialised technology, concentration is likely to be high. As the market matures and the technology becomes standardised and more easily accessible, in particular through the establishment of second-hand markets for specialised ships, the degree of concentration is likely to decline.

While data limitations make an estimation of concentration difficult at the aggregate international level, the databases enable us to gauge the changes in market shares among Norwegian owners. A useful tool in analysing market concentration is the Herfindahl-Hirschman index (HHI). The HHI is based on the relative shares of all firms in the market, which are squared and summed up, in order to increase the weight given to larger firms. Table 6 is calculated on the basis of the various companies’ or pools’ shares of the Norwegian fleet. One company owning all tonnage in a segment would give an index of 10,000 (a market share of 100% squared), a duopoly with two equally large companies would give an index of $(50^2 + 50^2)$ 5,000, while ten companies, each with a market share of 10%, would give an index of $(10^2 * 10)$ 1,000. The US Department of Justice and the Federal Trade Commission (1997, p. 15) considers an HHI between 1,000 and 1,800 as a moderately concentrated market, and a market with an HHI above 1,800 to be concentrated.

Table 6. The Herfindahl-Hirschman index for specialised segments, 1977 and 1987

Segment	HHI		HHI with pools		Number of companies	
	1977	1987	1977	1987	1977	1987
Chemical tankers	1,419	1,189	3,040	2,325	12	16
Open hatch	2,085	1,398	3,819	2,780	6	10
Liquefied gas	1,499	2,544			11	13
Vehicle carriers	3,267	1,615	5,288	3,698	5	8

As the calculations in Table 6 are based only on Norwegian data, the figures should not be interpreted as an indication of concentration at the international level. Moreover, we are not interested in the level of concentration *per se*, but the development from 1977 to 1987. While

the data do not *prove* that concentration was reduced and competition was improved internationally, it illustrates the increasing diffusion of the specialised technologies within Norway and the reduced role of the pioneers.⁵⁰

The number of participants increased in all specialised segments. The HHI declined as expected, with the exception of the gas tanker market, which saw increased concentration within Norway. This was the result of one dominant company – Sig. Bergesen dy & Co. – which entered the market after 1977, but by 1987 had managed to build up a market share of almost 45%. With substantial experience as a crude oil tanker operator, Bergesen used their links to the oil company Total when gaining their strong position in the liquefied gas segment.⁵¹ Thus, although concentration within this segment developed in the opposite way of what one would expect given Vernon’s framework, it illustrates the increasingly easy access to the technology and the limited ‘protection’ of the original pioneers.

Future research

This paper has discussed the trends towards increasing specialisation of the international merchant marine, with a particular emphasis on how a Vernon product life cycle framework can be used to analyse the development of the various segments. Changes in competitive advantage as the niches moved from the ‘entrepreneurial’ stage, via ‘maturation’, to the ‘standardised’ stage are reflected in technology diffusion and changes in ownership. Moreover, the degree of concentration changes as the pioneers’ ability to protect their ‘quasi-monopolies’ is weakened.

The Norwegian city of Bergen has provided examples of the forces at play in the period when the new technology is introduced. Through cooperation, innovation, and vertical integration, Bergen shipowners managed to gain substantial market shares in two of the new segments. The cooperation was necessary to gain the sufficient ‘critical mass’ to utilise economies of scale. However, the benefits from innovation and vertical integration declined

⁵⁰ For the sake of argument; if there were several small foreign competitors in 1977, but only one foreign competitor in 1987, the international indices could move in the opposite direction from that seen in Table 6. However, given our knowledge of what happened in other countries – even without numerical *evidence* – it is clear that this was not the case.

⁵¹ Lorange (2005: 84)

as the technology became more widespread – ‘standardisation’ in Vernon’s scheme. This led to increased competition both internationally and within Norway. By 1987 the specialised vessels were no longer as unique as they had been ten – let alone twenty – years before.

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