

**Local network effects:
Specialised shipping in Bergen, 1960-1987**

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Abstract

One of the most important developments in the postwar shipping industry 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 – co-operation between individual companies, vertical integration and technological innovation – can explain Bergen's strong position within specialised shipping.

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 – characterising shipowners in a particular country. By comparing and contrasting these traits with those of shipowners in other countries, the ‘nature’ of a country’s shipping industry is identified.

At the other end of the spectrum, shipping company histories frequently eschew the general, looking instead solely at factors specific to the companies in question. While the former angle sometimes 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 such changes. The fleets owned by companies in the Norwegian port of Bergen are used to illustrate the developments.

The paper consists of three 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 merchant marine 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. Three factors that can explain the Bergen dominance within these segments – co-operation, vertical integration and technological innovation – are discussed.

¹ See for instance Lewis R. Fischer and Even Lange (eds.), “International Merchant Shipping in the Nineteenth and Twentieth Centuries: The Comparative Dimension”, *Research in Maritime History*, No. 37 (St. John’s, 2008 – forthcoming).

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 and bulk and general cargo carriers, plus a very 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.³ For instance, they owned more than 30 per cent of the chemical tanker fleet and more than 25 per cent of the vehicle carrier fleet by 1977.⁴ 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'.⁵ For the sake of simplicity, this paper focuses on ship types that did not exist in 1960, as well as vessels targeted at niches that were new and relatively small in 1960.⁶ In terms of 'the shipping matrix', we thus include three of the four

³ This structural transformation of the Norwegian fleet has been quantified in Stig Tenold, "So nice in niches – specialisation strategies in Norwegian shipping, 1960-1977," paper presented at the 5th International Conference of Maritime History, University of Greenwich, June 2008.

⁴ Calculations based on Lloyd's *Register 1977* (London, 1977), Table 2. At the time, around eight per cent of the world fleet was registered in Norway.

⁵ Indeed, it could be argued that the giant oil tankers are among the most specialised ships of all, as they can carry only one cargo and access a very limited number of ports.

⁶ 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.

segments; 'contract shipping', 'industry shipping' and 'specialised shipping'.⁷ The ships that are excluded, such as conventional tankers and bulk carriers, operate in the 'commodity segment'. This part of the shipping market 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'.⁸ 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.⁹ In this paper, the analytical framework draws upon Vernon's hypothesis, but with some modification.¹⁰

The new specialised segments within shipping developed on the basis of technological progress. In the initial 'entrepreneurial phase', these segments were commonly dominated by a limited number of pioneers. The first-mover companies were 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.¹¹ 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 established

⁷ See Peter Lorange, *Shipping company strategies – global management under turbulent conditions* (Oxford, 2005), 23-26 for a presentation of this matrix, which is commonly used to distinguish between shipping segments.

⁸ Raymond Vernon, "International investment and international trade in the product cycle," *Quarterly Journal of Economics*, Volume 80, No. 2 (1966), 190-207.

⁹ See Gunnar K. Sletmo, "Shipping's fourth wave: ship management and Vernon's trade cycles", *Maritime Policy and Management*, Volume 16, No. 4 (1989), 293-303 or Helen A. Thanopoulou, "The growth of fleets registered in the newly-emerging maritime countries and maritime crises", *Maritime Policy and Management*, Volume 22, No. 1 (1995), 51-62. 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.

¹⁰ Vernon, "International investment", 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 at the international level, and the transition between the latter two phases is vague.

¹¹ Vernon, "International investment", 193-194 specifically deals with innovations that substitute capital for labour.

owners 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.¹²

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 international trade and the location of production, is not directly applicable to shipping due to the global character of the industry. However, evidence from shipping niches may give an indication of the forces at play. Higher and more secure demand, as well as the existence of accepted standards, leads 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.¹³ 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 innovative 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' – customers and suppliers know what to expect – 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.¹⁴ 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.

¹² 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'.

¹³ 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.

¹⁴ 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; refer to Section III for examples.

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, from 1960 to 1977, can be seen as an ‘entrepreneurial phase’, when the specialised technologies were new and novel, and the early entrants had first-mover advantages. During the second phase – the decade after 1977 – the degree of innovation was more limited and certain technological standards had been established in most of the niches. While some of the pioneers managed to maintain substantial market shares, the maturation of the markets and the standardisation of the specialised technologies made it easier and less expensive for new participants to enter many segments.

The proportion of specialised ships in the Norwegian fleet increased from less than one per cent in 1960 to more than eight per cent by 1977, as previously mentioned. Table 1 shows that in the period from 1960 to 1977 the growing share of specialised ships in the Norwegian merchant marine primarily reflected a strong increase in the number and tonnage of such vessels.¹⁵ 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 increasing share of specialised ships in the Norwegian fleet partly reflected expansion within the niche segments. The specialised tonnage 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’ illustrates the growth (if above one) or decline (if below one) of the various categories of tonnage from 1960 to 1977 and from 1977 to 1987.

¹⁵ All 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, *Register over norske, svenske, danske, finske og islandske skip* (Oslo, 1960), Det norske Veritas, *Register of Norwegian, Swedish, Danish, Finnish and Icelandic ships and of other ships classed with Det norske Veritas* (Oslo, 1977) and Det norske Veritas, *Register Book* (Oslo, 1987), but supplemented by other sources when necessary. The 1987 data set includes most 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.

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

Type	1960 (1,000 grt)	Change factor	1977 (1,000 grt)	Change factor	1987 (1,000 grt)
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

A closer analysis of the data on reveals that the driving force behind the transformation 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 'size effect' is a result of growth or reduction in the average size of the ships in the various sub-groups, reflecting increasing economies of scale at the ship level. The 'number effect' refers to changes in the number of vessels in the different categories. The data are shown as percentages of the levels in 1960 and 1977 respectively. For instance, the average size of the Norwegian tankers increased from around 12,500 grt in 1960 to more than 72,000 grt in 1977 – giving an increase in average size of 478 per cent from 1960 to 1977. However, over the same period the number of tankers declined by 57 per cent, from 473 to 203.

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 enormous 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. 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.¹⁶

¹⁶ The substantial Norwegian disinvestment can be explained by the effects of the shipping crisis on Norwegian shipowners; see Stig Tenold, "Tankers in trouble – Norwegian shipping and the crisis of the 1970s and 1980s", *Research in Maritime History*, No. 32 (St. John's, 2006) for an analysis of this watershed in Norwegian and international shipping.

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 been 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 among the categories, 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 managed to neutralise their labour cost disadvantage through investments in larger and larger ships. 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.

Table 2 shows that from 1977 to 1987 the specialised markets were the only ones that still managed to attract new Norwegian investments. Lack of technological innovation – in particular the abrupt halt in the growth of average ship size – made it practically impossible for Norwegian owners to compensate for their labour cost disadvantage in the ‘commodity segments’. However, within the specialised niches, the competence of Norwegian personnel made it possible to generate revenues despite relatively high labour costs.¹⁷ As long as the technology was relatively expensive and not fully standardised, the payment of higher wages for the ‘human capital’ of Norwegian seafarers could be justified.

Within the specialised niches, the driving force of the expansion 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. 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.

¹⁷ Nevertheless, the importance of this effect was likely to diminish in time; see Thanopoulou, “The growth of fleets”.

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

Type	Fleet (1,000 grt)		Size effect	Number effect
	1977	1987		
Chemical tankers	686	960	11.5 %	27.3 %
Open hatch	506	915	27.7 %	41.7 %
Liquefied gas	360	1,064	51.2 %	95.7 %
Passenger/ cruise	278	427	25.6 %	22.2 %
Vehicle carriers	161	360	60.0 %	40.0 %
Ro-ro	72	272	-12.4 %	333.3 %

The strong increase in average size of gas and vehicle carriers after 1977 to some extent reflects new technological possibilities. This implies that while these niches had reached the ‘standardisation’ phase in a technological sense, there were still possibilities related to increasing economies of scale at the ship level.

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. 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, Bergen owners 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.¹⁸ First, a higher proportion of Bergen’s companies might have chosen a

¹⁸ This refers to simple reasons at the ‘numerical’ level. The more fundamental explanations of the deviating behaviour of Bergen shipowners will be discussed in Section III.

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’.¹⁹ 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. 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.

Figure 1. Specialisation: shares of companies and of the specialised companies’ fleets (per cent), 1977 and 1987

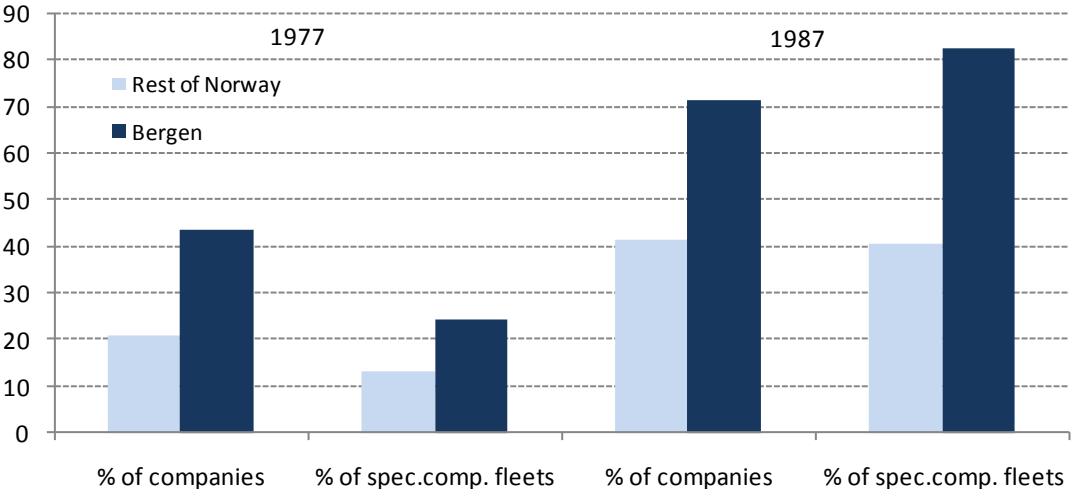


Figure 1 shows that both factors were significant in 1977 as well as in 1987. In the latter year, ten out of the fourteen Bergen-based shipping companies had invested in specialised ships, and the niche tonnage made up more than eighty per cent of these companies’ fleets.²⁰ Specialised tonnage made up more than 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 61.8 per cent and 26.6 per cent respectively.²¹

Differences in cost structures – in particular the high Norwegian manning costs – could contribute to an explanation of the disproportionate share of specialised vessels in the Norwegian

¹⁹ The ‘specialisation ratio’ is the specialised ships’ share of all tonnage owned by a 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 be ignored. In such instances, the ‘specialisation ratio’ refers to the specialised fleets as proportion of all tonnage owned by companies that had invested in such ships.

²⁰ It is worth noting that there were ten specialised companies in Bergen both in 1977 and in 1987. However, the number of companies that had not invested in specialised tonnage declined from thirteen to four.

²¹ The reason for the deviation between these figures and those calculated on the basis of the proportion of specialised companies and their ‘specialisation ratio’, is the higher propensity of large companies to invest in specialised tonnage.

fleet. However, this can not explain the observed regional differences. In order to understand the high investments in specialised tonnage in Bergen, it is necessary to look into the dynamism of the city's shipping sector in more detail. However, 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 towards increased specialisation.

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 – accounted for more than 90 per cent of the specialised shipping investments 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.

Chemical tanker transports

The transport of chemicals in purpose-built tankers was one of the fastest growing niches in the period 1960 to 1987.²² 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.²³ 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 1987.²⁴ 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 –

²² For a more thorough introduction to this market, see Hugh Murphy & Stig Tenold, "Strategies, market concentration and hegemony in chemical parcel tanker shipping, 1960-1985," *Business History*, Vol. 50 (3), 291-309.

²³ The most obvious example of this is that chemical tankers may trade in the oil products market when demand for chemical transport is low, and oil products tankers may carry some 'benign' chemical cargoes when demand is high.

²⁴ Based on data from Clarkson, *The Tanker Register*, 1964 (London, 1964), Clarkson, *The Tanker Register*, 1977 (London, 1977) and HP Drewry, *Liquid Chemicals* (London, 1989), 42.

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.

The Bergen-based Odfjell group had been among the pioneers of the chemical tanker industry in the 1960s. After entering the market with smaller ships, the company invested in larger and larger tonnage, utilising the new possibilities in ship construction.²⁵ By the mid 1970s the Odfjell group controlled almost a quarter of the world's transport capacity in the sophisticated end of the chemical tanker market.²⁶ These ships had been classified to allow the transport of all kinds of chemical cargoes, even the most corrosive, explosive, inflammable and toxic liquids.

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. In addition to the Bergen-based 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.

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 one of the problems of having a lower limit of 5,000 grt for the ships included in the database. To the extent that new technologies are first introduced on smaller ships, this specialisation is not recorded until the ships reach a certain threshold size.

²⁶ Chemical tankers are classified according to the different chemicals they can transport. The sophisticated end of the market comprises ships that can accept even the most hazardous chemicals. The other end of the spectre consists of relatively simple chemical tankers, often with coated tanks, that can only accept a limited number of more 'benign' chemicals.

From the late 1970s onwards, a number of changes occurred in the market. In particular, the chemical tanker technology had now become 'standardized' – 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 to secure employment – contributed to a doubling of chemical tanker supply between 1980 and 1987. Through a combination of mergers and buy-outs, the main operators maintained control of a large part of the sophisticated tonnage that performed the long-haul voyages. However, several newcomers managed to build up substantial fleets, so the terms of the competition had irrevocably changed and profits were squeezed.

Two 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, the ship 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. 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 had become relatively commonplace. Moreover, 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.²⁷

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.²⁸ 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 world-wide service – financial limitations imply that the company would not have been able to attain a fleet of this size on its own. The most important pool

²⁷ Confer Thanopoulou, "The growth of fleets".

²⁸ For an introduction to Odfjell's strategy in the 1960s and early 1970s, see Atle Thowsen & Stig Tenold, *Odfjell*, 275-355 or, for a more concise presentation, Stig Tenold, "Steaming ahead with stainless steel – Odfjell's entry and expansion in the chemical tanker market, 1960-74", *The International Journal of Maritime History*, Vol. XVIII, No. 1, June 2006, 179-198.

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.²⁹

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 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 per cent larger than their two most important competitors put together.³⁰

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 cement the ties to the most important customers.

During the 1960s and 1970s Bergen became the leading international centre for chemical tanker transports. In addition to the companies involved in the Odfjell system, three Bergen companies – Det Bergenske Dampskipsselskap, Finn Engelsen and Rolf Wigand – participated in a pool operating in the less sophisticated part of the chemical tanker market. The companies transported relatively benign chemical cargoes that were lifted in larger volumes.

The chemical tanker industry provides an 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 Bergen owners 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

²⁹ By 1977 Westfal-Larsen contributed approximately forty per cent 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.

³⁰ However, in the 1980s this focus on high-quality stainless steel tanks as a competitive parameter led to an 'over-sophistication' of the tonnage – this expensive technology to some extent became the norm, even for some chemicals that could have been safely transported in traditional coated tanks.

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.

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 chemical tanker fleet registered in Norway declined from more than 35 per cent in 1977 to less than five per cent by 1987.³² However, if we take into account Norwegian-owned chemical tankers registered abroad, the decline is lower, to around 28 per cent 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 entered the segment between 1977 and 1987, while five companies – including the three participants in the Team Tankers pool – exited the market.³³

Open hatch bulk transports

Like their pioneering roles in the chemical tanker industry, Bergen owners provided the centre of gravity in the open hatch bulk carrier segment. However, while parcel tankers that could carry chemicals in bulk represented a completely new technological regime, open hatch bulk carriers should be regarded as a major improvement of already existing standards.³⁴ Nevertheless, from an innovation and technology point of view, the open hatch bulk market undoubtedly warrants inclusion as one of the emerging specialised segments.

The fundamental principles were 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.”³⁵ In the chemical tanker industry, the ‘bulking’ was achieved through the introduction of many tanks with separate pumps and pipelines. For the open hatch bulk

³² Calculations based on Lloyd's *Register 1977* (London, 1977), Tables 1 and 2 and Lloyd's *Statistical Tables 1987* (London, 1987), Tables 1 and 2. Over the same period the share of the world fleet registered in Norway declined from seven to 1.6 per cent.

³³ Only one of the nine newcomers – J.O. Odfjell – was based in Bergen. However, this company, which managed to gain a substantial market share and was undoubtedly the most successful of the new companies, was established as a result of the division of the Odfjell assets between two branches of the family. Despite the exit of the original participants, the Team Tankers pool continued with other participants.

³⁴ Consequently, 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.

³⁵ H.P. Drewry, “Changes in ‘Neo-Bulk’ Trade, Transport and Handling, *An Economic Study*, No. 99, (London, 1982), 1.

carriers, the latter element – improvements in cargo handling and storage – was particularly important. The vessels were built with larger, more flexible hatch covers and movable gantry cranes, giving the ships a competitive advantage in the transport of the so-called ‘neo-bulk’ commodities.³⁶ The most important cargoes were forest products, steel and cement.³⁷

While Bergen-based shipowners were reluctant to invest in conventional bulk carriers, they managed to carve out a niche within open hatch bulk shipping.³⁸ Indeed, the vessel type was in many ways developed locally, based on cooperation between Star Shipping and Sverre Munck AS, a Bergen-based manufacturer of cranes.³⁹ The open hatch bulk concept had originally been introduced in the early 1960s by Per F. Waaler. However, Waaler, the archetypal entrepreneur, lacked investment funds and approached several of the ‘established’ Bergen shipowning families with an invitation to participate in the building up of an open hatch bulk carrier fleet. A number of owners, including the previously mentioned Westfal-Larsen & Co. AS, joined the partnership in the mid 1960s. Vessels owned by the different participants were operated in a pool under the Star Shipping banner. By 1977 Star Shipping controlled approximately 45 per cent of the Norwegian open hatch bulk carrier fleet. Their main competitor – with 40 per cent of the fleet – was the Bergen-based Gearbulk pool.

Gearbulk had been established by Kristian Gerhard Jebsen, who came from a shipping clan with long traditions, but who had broken with the family company in the late 1960s. He went on to establish 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 – Louis Dreyfus & Cie of Paris and the latter’s British subsidiary Buries Markes Ltd. The companies expanded their open hatch investments rapidly in the first half of the 1970s.

As efficiency in loading and unloading provided the economic rationale for the open hatch bulk ships, the land-sea interface was paid much more attention than by owners operating in other segments. Gearbulk therefore established a substantial network of personnel in foreign ports, and

³⁶ 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).

³⁷ Open hatch bulk carriers were also suited to the transport containers and vehicles, often as a means to generating revenues on the return leg of for instance forest products trades.

³⁸ See Anders Martin Fon, *En stormakt i tørrbulk* [A major dry bulk nation], PhD-dissertation, Norwegian School of Economics and Business Administration (Bergen, 1995).

³⁹ 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.

Star Shipping even invested in a purpose-built terminal for forest products in British Columbia. This, coupled with the need for substantial investments in order to acquire a sufficiently large fleet, led to high barriers to entry in the segment.

Star Shipping and Gearbulk's dominance of the open hatch bulk carrier market, with control of more than 85 per cent 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 did not enter the open hatch niche until 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.

Network effects in Bergen shipping & Vernon's cycle

There is little doubt that substantial network effects were at play in the Bergen shipping community, and that this can explain the city's drive towards specialisation and leading role within two of the niches.

The development of new specialised market segments provides first-mover advantages at the 'entrepreneurial' stage of Vernon's product life cycle. Odfjell's innovations within chemicals shipping and Waaler's new concepts in the transport of neo-bulk commodities were pioneering efforts. However, the limited financial clout of these participants led to cooperation with other local shipowners.⁴⁰ The synergy is self-evident: 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 'maturity' stage, the Bergen shipowners partly maintained their strong position in the market, despite increasing challenges to their position. By this time, the economies of scale that the pools had obtained still played an important role. 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 the Norwegian participants were

⁴⁰ 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.

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.

The most obvious 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.”⁴¹ 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 proportion of the gas carrier fleet.⁴²

Table 5. Bergen’s share of the fleet and sub-segments (per cent), 1960, 1977 and 1987

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

An alternative way of illustrating the move from the ‘entrepreneurial’ to the ‘standardised’ stage 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 technology becomes standardised and more easily accessible, in particular through the establishment of second-hand markets for specialised ships, the concentration is likely to decline.

While an estimation of concentration is difficult at the aggregate international level, the databases enable us to gauge the changes in market shares within Norway. 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 5 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 per cent squared), a duopoly with two equally large companies would give an

⁴¹ Thanopoulou, “The growth of fleets”, 51.

⁴² Calculations based on Lloyd’s *Register 1977* (London, 1977), Tables 1 and 2 and Lloyd’s *Statistical Tables 1987* (London, 1987), Tables 1 and 2. The rightmost column refers to Norwegian-owned ships, rather than vessels registered in Norway.

index of $(50^2 + 50^2)$ 5,000, while ten companies, each with a market share of ten per cent, would give an index of $(10^2 * 10)$ 1,000. The US Department of Justice 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.⁴³

Table 5. 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 5 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, but how it develops 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.⁴⁴

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 per cent. Thus, although concentration to develop 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.

Conclusion

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

⁴³ US Department of Justice and the Federal Trade Commission, *Horizontal Merger Guidelines*. (Washington DC, 1997), 15.

⁴⁴ For the sake of argument; if there were several small foreign competitors in 1977, but only one foreign competitor in 1987, the international indices would move in the opposite direction from that seen in Table 4. However, given our knowledge of what happened in other countries – even without numerical *evidence* – it is evident that this was not the case.

analyse the development of the various segments. Changes in competitive advantage as the niches move from the 'entrepreneurial' stage to the 'standardised' staged are reflected in technology diffusion and changes in ownership. Moreover, the degree of concentration is changed, and the pioneers' ability to protect their 'quasi-monopolies' disappears.

The Norwegian port 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 as the technology became more widespread. By 1987 the specialised vessels were no longer as special as they had been ten years before.