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FLEXIBILITY VS. SPECIALISATION IN RO-RO SHIPPING IN THE SOUTH BALTIC SEA

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Abstract. The trade-off between flexibility and specialisation implies delicate tasks for transport system designers and marketing managers. The outcome of their efforts ranges from highly specialised solutions for a restricted number of users and types of cargoes to very open systems for common use adapted to accommodate a wide variety of transport demands. The purpose of this article is to adapt theories on openness and trade-offs, characterise a selection of flexible and specialised European short sea shipping concepts and analyse how substantial changes in the future character of the competition with road and rail can affect the development of ro-ro shipping in the South Baltic Sea. A matrix with commercial openness and technological openness on the axes is used for categorising sub-segments in the empirical context of the South Baltic Sea. Foreseeable changes in key cost and competition parameters until 2020 are taken into account in discussing potential scenarios. A plausible outcome for the ferry/ro-ro shipping segment is that a branch with slow services for unaccompanied freight will be diverted from the current homogenous market offerings. During the study, the Swedish Orient Line launched a service with these characteristics, which is analysed in a case study.

Keywords: flexibility, freight, openness, passenger, short sea shipping, trade-off, specialisation.

1. Introduction

Over the years, shipping has developed in phases where the main features of ships, the operational principles, the surrounding systems and the market offer have either been designed for a wide scope of transport demands or optimised to suit narrow demand characteristics. This has been well analysed in the scientific literature (see, e.g., Douet, 1999) and shipping textbooks (see, e.g., Stopford, 2009). One way of interpreting the development is to see a flexible shipping concept being applied; after the transport market has been stimulated up to levels where it makes sense to divert parts to more specialised concepts, an actor will observe the process happening and capture that emerging specialised shipping market. The flexible market offer must then be adjusted to the new mix of demand patterns, hence operating under a new compromise, until a new part is diverted. Evident examples of diversion are bulk shipping and high-speed passenger ferries. The reverse is also viable, when the underlying demand changes or specialised concepts fail in the market and then merge into a flexible concept.

The trade-off between flexibility and specialisation implies delicate tasks for transport system designers and marketing managers alike. The outcome of their efforts ranges from highly specialised solutions for a restricted number of users and types of cargoes to very open systems for common use adapted to accommodate a wide variety of transport demands. One particular type of compromise between transport demands is passenger and freight transport that occurs in the same vehicle or vessel. Another is containerised transport systems, where a strictly standardised cargo containment technology allows for a wide range of commodities to be transported with technologically specialised vehicles and vessels.

The degree of specialisation obviously affects the ability of the transport system to utilise economies of scale and scope. This certainly applies to European short sea shipping (SSS) in firm competitions with road and rail alternatives, with very different inherent properties regarding the size of vehicles, spatial reach and dependency on economies of scale. This also relates to the parameters of speed and costs of the competing transport modes as used by Lingaitiene (2008) in her model for selecting transport modes. Also the traditions and abilities to manage customer interfaces differ between the modes. Hence, the design of short sea shipping systems critically depends on adaptation to the contextual competitive situation.

The purpose of this article is to adapt theory on commercial and technological openness and analyse how substantial changes in the future character of the competition with road and rail can affect the development of ro-ro shipping in the South Baltic Sea (SBS).

This research thus adheres to the findings of Jarzemskiene (2007), whose literature review identifies the fact that most of the intermodality related research addresses container ports and railway scheduling, and finds a lack of scientific research on intermodality, including the use of semi-trailers. Maksimavicius (2004) has also identified the urgency of further research on roll-on-roll-off (ro-ro) shipping in a systems context.

Nevertheless, research on intermodal transport chains, including a maritime leg, and hinterland transport and dryport research in particular (Jarzemskis and Vasiliauskas, 2007), has also recently been expanded to include semi-trailers (Woxenius and Bergqvist, 2011). The research also corresponds to the need for more research on the sizes of ships used in the Baltic Sea in order to understand the nature of the transit flows in the region as stated by Paulauskas and Lukauskas (2003).

The analytical framework rests on a matrix with commercial and technological openness on the axes introduced by Sjöstedt *et al.*, (1994) for analysing intermodal freight transport systems.

The research was performed in two stages. The first stage was a desktop study done during the spring 2010, in which the ro-ro category was analysed and divided into sub-segments in the empirical context of the SBS. Foreseeable changes in key cost and competition parameters until 2020 were taken into account in discussing plausible scenarios. In the second stage, the main scenario was empirically illustrated in the context of a service introduced by Swedish Orient Line (SOL) in September 2010. The case study data was gathered through structured and in-depth interviews with SOL's CEO and the former CEO of Port of Trelleborg in February 2011.

After the general introduction, the theoretical concepts of openness and trade-offs are introduced in a European SSS context. The next section narrows the focus to ro-ro shipping in the SBS and looks ahead with the characterisation of current SSS segments and an analysis of the effects of changes in costs, demand characteristics and competition with other modes. A hypothesis is that parts of the ferry/ro-ro shipping in the SBS will continue to be operated as they are currently if emission-cleaning technologies are used and niches with relatively fast passenger ferries and slow and energy-efficient freight services will be created. Such a freight service is analysed in the case study context before conclusions are drawn.

2. Commercial and technological openness

The choice between flexibility and specialisation facing designers of transport systems is obviously not a single and binary one, but rather includes a number of decisions on the values of system parameters on somewhat continuous scales. The choices range from strategic ones, defining the basic features of the resources and in which main markets to trade them, to short-term operational decisions fine-tuning the service or adapting to temporary changes in market conditions. Most choices are intrinsically linked, but one general divider lies between commercial decisions and technological ones.

Commercial openness

Commercial openness (CO) is defined here as the scope of customers accepted for a specific transport service. This can be an active decision by the transport service provider, a natural result of the fundamental design of the transport system or dictated by regulation of the transport market. It regards the choices of customers, related to the scientific field of industrial marketing and purchasing with theories of buyer-seller links. The approach applied here focuses on the transport service segment or concept, thus differing from most theories of industrial marketing and purchasing that take a focal company perspective. A transport service is often produced by actor hierarchies complicating the analysis with subsequent buyer-seller links. Furthermore, a transport company often provides or takes part in providing different types of services.

Transport demand is derived from human and industrial activities, although transport supply also induces demand. Forwarders and other intermediaries consolidating a multitude of shippers and individual transport demands play a certain role when they productify clusters of transporting, transferring and storing activities into logistics or transport services. In relation to the transport operators, they are referred to here as *proxy customers,* as suggested by Ohnell and Woxenius (2003).

The regulation of the transport sector has been successively relaxed for about forty years. The current trend in Europe is to neutralise competition between transport modes, although rail and SSS are particularly promoted.

The CO of a service can be measured using the following three dimensions as Woxenius (2010) suggests:

Accessibility: measures the possibility for a customer to access the system for a single transport without a long-term contractual agreement. It ranges from contracted service to one specific customer, to equal accessibility for any customer based on first come, first serve principles. Guaranteed service to some customers while limiting others to using only excess capacity falls in between these extremes.

Time discrimination: this measures the restrictions on the customer's choice of time of transport or ability to wait until the last minute to make such a decision, relating to what Ramstedt and Woxenius, (2006), denotes as timing and order time, respectively. This ranges from unlimited capacity and complete freedom for the customer to choose a departure time, to rigorous booking procedures for a certain number of predefined time-slots with limited transport capacity. Supplying sufficient capacity at specific times to absorb variations in demand without requiring booking falls in between.

Price discrimination: measures the price the occasional user has to pay in relation to frequent users contracting large volumes or repeated services.

The simplest measure, however, is the *range and number of customers* potentially served by a transport service. It is thus related to the target group of a service.

Technological openness

Technological openness (TO) is defined here as the *scope of cargoes or cargo containment technologies accepted by a transport system*. Also, this can be an active choice or can be dictated by the pattern of transport demand or regulation. A system with the lowest TO is specially adapted to suit a certain cargo or type of unit load and severely restricts the CO, but subsystems can be optimised to fit well-defined tasks.

TO is difficult to measure with a simple indicator, but can be analysed along the dimensions of *physical character of the cargo, typical parcel sizes, handling and storage requirements* and *containment technology* used. Hence, the interface towards vehicles and vessels, handling equipment and storage facilities is in focus.

Many transport systems are designed for multi-modal coverage, requiring a choice of adaptation to facilitate the modal transfer. This strongly influences the design of physical system components such as vehicles, vessels and transfer devices. When deciding upon a standard, adopting the principle of the lowest common denominator implies inefficiencies in subsystems to achieve good overall performance.

The openness to carrying passengers and freight in the same vehicles and vessels is of particular interest, since the article aims at analysing conventional ferry, RoPax and ro-ro freight services. The traffic modes are becoming more specialised in either passenger or freight conveyance, but they still ride together to a large extent and the equipment is sometimes shared between the segments.

A matrix with commercial and technological openness

The combination of CO and TO has a good deal to say about the character of transport services. The matrix developed by Sjöstedt *et al.* (1994) is adapted here, illustrated in Figure 1 with SSS segments representing somewhat extreme positions for each quadrant of the matrix. The four main categories of ships used by Paixão and Marlow (2002) are useful. These are: (1) traditional single-deck bulk carriers, (2) container feeder vessels, (3) ferries and (4) bulk carriers and tankers, but the fifth category, sea-river shipping, is excluded here. The ship categories are referred to here as segments, emphasising that although the names relate to the employed ships, the analysis regards the services provided by the ships.

Bulk carriers and tankers are used in transport services strictly adapted to particular commodities with few potential shippers, and they are well suited to illustrate the lower left quadrant with low TO and low CO. The ships trade in a market with few shippers due to the large parcel sizes suitable for these ships. In that sense, the CO is lower than that of traditional single-deck bulk carriers, and the TO is very low due to the strong adaptation to single commodities. Nevertheless, product parcel tankers, commonly used in SSS, carry different cargoes in different tanks, but often for the same shipper. The TO is higher than the CO in that case. A ship for liquid natural gas (LNG) is extremely limited in terms of TO and CO. Technically, it can take less demanding categories of liquid bulk, but at a deterring price due to the extremely costly ship. Bulk carriers are technically rather flexible for different types of cargo, but the parcel size renders a low CO rating.

Ferries engaged in SSS represent the other extreme, with the combination of very high TO and high CO, particularly the conventional ferries, or “multipurpose” as Baird (1997) denotes them, and RoPax sub segments due to the very open interface between cargo and passengers. Virtually anything allowed on the road is accepted, perhaps excluding lorries with hazardous cargo on ships with passengers, and passengers without a vehicle can walk on board. The openness has contributed to making ro-ro traffic a significant market in European shipping, accounting for 450 million tonnes of business for European ports (UNECE, 2010, p.19). The bridge-substitute term for short ferries indicates that they compete not only with transport services but also with fixed infrastructure. Ferry crossings are often embedded in trucking services and sales of tickets and a combination of the booking and a first come, first served policy imply very low barriers for private users and trucking companies. The services fulfil the three plights of traffic, transport and rate, as defined by Sjöstedt (1994), reasonably well; the rate plight is not strict since forwarders, large trucking firms and travel agencies often have significant discounts on the tariffs (Borgemark, 2010) and commuters have seasonal tickets.

Traditional single-deck bulk carriers are used in a segment where the flexible ships facilitate a high TO. The CO, however, is regarded as low due to the limited number of shippers requiring transport of the relatively large parcels over routes where ships are suitable. Rail is a strong competitor for smaller parcels.

Container feeder vessels represent a special case that is flexible from a shipper’s perspective, yet very specialised from a shipowner’s perspective. The CO is comparatively high due to the small parcel size and the fact that big trade flows have adapted to containerisation over the years. Comparatively large products, such as sailing boats, are increasingly designed to be transportable by containers in one or several pieces. The TO, which is in fact low, is nevertheless experienced as high by the shippers thanks to the interface. For different parts of the served market, short sea container shipping competes with direct calls by trans-ocean vessels (Paulauskas, *et al.*, 2002 and Tolli and Laving, 2007) and with rail and road transport, but also, as noted by Paixão and Marlow (2002), with dedicated shipping services and is increasingly replacing the traditional general cargo vessels. The outcome of this brief analysis is presented in Figure 1.

The classification relates to the direct users of the service, but the mentioned character of hierarchies producing transport services and the effect of proxy customers implies that the ultimate shippers face a quite different TO as well as CO. A parcel might well be forwarded by ro-ro shipping for a part of the conveyance, but the user maintains its apprehension of the TO and CO of the parcel service. The user neither benefits from the higher TO nor suffers from the lower CO, since a forwarder plays an intermediate role as a proxy customer. The ro-ro service is hence *embedded* in the parcel service.

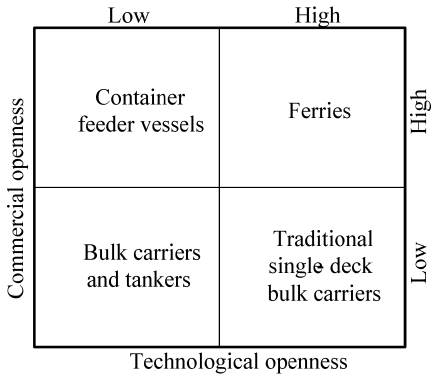

Fig. 1. Short sea shipping segments represented by typical vessel type used, placed in the four fields of the TO-CO matrix.

The depiction in the four-field matrix is, of course, for illustrative and pedagogic purposes; transport services can be placed more specifically along the axes of TO and CO. This, however, requires a narrower focus or even a strictly contextual one regarding a specific route or geographic market.

Trade-offs

The concepts of CO and TO are complemented by introducing a number of more specific *trade-offs* facing transport system designers, as discussed in a shipping context by Bergantino and Bolis (2008) and by Stopford (2009, pp. 580-581). The decisions are subject to trade-offs ranging from a single big decision about which types of equipment to employ via defining the network operation principles, to continuous minor operational decisions. The rendering here focuses on technical and operational aspects, thus adding more to the explanation of TO than to that of CO. In addition to the trade-off between *specialisation vs. flexibility* that this article focuses on, examples of technical and operational trade-offs that transport system designers must consider are presented in Table 1. This list was developed in an international pedagogic project (Woxenius, 2002) and has been adjusted and validated during lecturing and tutoring assignments with numerous classes of masters students.

Table 1. Trade-offs in transport systems design.

accessibility	*vs.*	large transport resources
large transport resources	*vs.*	frequency
frequency	*vs.*	filling grade
filling grade	*vs.*	efficient transfer operations
direct transport	*vs.*	terminal network
speed	*vs.*	fuel consumption
fuel consumption	*vs.*	tied-up capital

These trade-offs are selected since they affect the users of transport services, and they are further elaborated on in a shipping context in the analysis, complemented with some trade-offs that are more specific to SSS. Although it is at the discretion of the transport operator to decide on the trade-offs in the design phase, most of them have implications for transport accessibility, time and price, and thus affect the customers of the transport service.

The trade-offs could be divided along their magnitude or timeframe in strategic, tactical and operational decisions, but that would be a drastic simplification, since each trade-off reflects decisions on different levels. Decisions on speed, for instance, include giving throttle, working out timetables and time windows, and setting the design speed of vehicles and vessels, as well as deciding the general transport quality offered to shippers and thus which transport market to approach. The time-frame of the decisions on speed also differs strongly between the traffic modes, as investigated by Ramstedt and Woxenius, (2006) and speed in shipping includes both cruising speed and cargo handling speed (Laine and Vepsäläinen, 1994).

3. Flexibility vs. specialisation in the South Baltic Sea

Short sea shipping has a diverse nature, as there are difference in the logistics roles that are played, the employed ships and how they are operated. Hence, short sea shipping is not easily defined (for a discussion, see, e.g., Paixão and Marlow, 2002) and further analysis requires a restricted scope. Literature on SSS is consequently rather geographically specific in scope (see, e.g., Baird, 1997 (Scottish east coast); Bergantino and Bolis, 2008 (South Italy); Brooks and Trifts, 2008 (Atlantic Canada); Castells and Martínez, 2006 (South-west Europe); Chlomoudis, *et al.*, 2007 Greece); Jauernig and Roe, 2001 (Lithuania); Mangan, *et al.*, 2002 (Ireland/UK); Martínez and Olivella, 2005 (Pyrenees); Ng, 2009 (North Europe); Parantainen and Meriläinen, 2007 (Baltic Sea); Roe, 1999 (East Europe); Rowlinson, 2010 (UK); Torbianelli, 2000 (Mediterranean) and Woxenius and Bergqvist, 2011 (Sweden)) although there are examples of more generic approaches (see, e.g., Sauri, 2006). There is also some literature covering a full economic region in articles (see, e.g., Baird, 2007 (Europe); Paixão Casaca and Marlow, 2005 (Europe) and Perakis and Denisis, 2008 (USA)), edited conference proceedings (e.g., Wijnolst and Peeters, 1995) and as chapters in books (e.g., chapter 11 in Wijnolst and Wergeland, 2008).

The context chosen here is SSS in the SBS, where transport links have been rapidly enhanced over the last years, as identified by Paulauskas and Bentzen (2008). The ro-ro services between Sweden and Continental Europe are particularly focused on here, but services connecting Sweden and Denmark are excluded. The port range chosen implies the coastal rims from Helsingborg to Nynäshamn on the northern side and from Lübeck-Travemünde in Germany to Klaipeda in Lithuania on the southern side. The focus means that this section thus falls into the first literature category of a limited geographical scope. The Sweden-Continental Europe ro-ro market is also served by the Gothenburg-Kiel and Nynäshamn-Gdansk routes. The latter is included in the study, while the former competes more with the routes through Denmark, and hence lies outside the scope of the study.

The SBS shipping and hinterland transport market has been extensively investigated as part of the Öresund and Fehmarn Belt infrastructure projects. Several EU Interreg projects (for instance, Baltic Gateway and Baltic Gateway PLUS, 2008; East West TC and East West TC II, 2010 and SEBTrans and SEBTrans-Link, 2005), national projects and academic studies (see, e.g., Chaos and Borkowski, 2003; Frid, 1995; Stemmler, 2005 and Woxenius, *et al.*, 2006) have also focused on the area.

The section analyses the market offer as of March 2010, but also looks ahead towards a new competitive situation. Particular attention is paid to the North Sea and Baltic Sulphur Emission Control Area (SECA) after 2015 when Annex VI of the MARPOL Convention on Short Sea Shipping stipulates using low-sulphur distillates or off-setting cleaning technologies, and the Fehmarn Belt connection planned to be ready by 2018.

The current ro-ro market offer in the South Baltic Sea

Liner shipping in the SBS started in 1692 with a domestic post, passenger and freight service between Ystad in Scania and Stralsund in Pomerania (Magnusson, 2004), a Swedish tenancy at the time. Services have evolved over the centuries, and Southern Sweden and Continental Europe is currently served by more than ten shipping routes, despite the competition from the Öresund Bridge (opened in 2000), that together with the Great Belt Bridge (opened in 1997/1998) offers a non-shipping alternative, although however, with significant detours (Dahllöf, 2010). Passenger ships dominated during the tax-free era, although not to the extent of the ferry services from Gothenburg, Helsingborg and Stockholm that were even more oriented towards cruising and on-board shopping, entertainment and consumption. The adaptation to the freight customers' demand manifests itself by an increase of lane metres at the expense of passenger capacity and cabins. This has been achieved by replacing some of the ships and by rebuilding others. Data about the ferry lines serving this market and the vessels they use are consolidated into Table 2.

The market is sectioned into sub-markets with somewhat different characteristics. It is still striking how similar the ships are in size and speed. There is only a 40% difference between the longest and the shortest of the 28 ships. Among the ships in the SBS, Unity line's Skania stands out in terms of speed, and she was built as Superfast I, serving Ancona-Patras in the Adriatic Sea (Unity Line, 2010). The rest of the ferries are firmly clustered around the 20 knots speed capacity, although the cruising speeds are slower, particularly during night sailings. Differences in sailing speed at day and night are marked in Table 2 as an interval in the duration column, and Polferries publishes cruise speeds rather than design speed in its marketing material (Polferries, 2010). The average age of almost 20 years is rather high although many vessels have been rebuilt. There is a pattern of older ships being used further to the east and Polferries is the operator with the highest average age.

The TO is very high, particularly for the ferries mixing passengers on foot, in own cars, in buses and in rail wagons with accompanied trucks, unaccompanied semi-trailers, containers and swap bodies on mafis, and other ro-ro units as well as rail freight wagons. Of the 28 ships, only one is actually used for freight only and that is employed on the long route between Kiel-St. Petersburg-Karlshamn-Kiel. Many of the ferries have generous deck openings and ramps, although short port turn-around times limit the openness to freight that requires labour-intensive loading.

Configurations obviously differ between conventional ferries, RoPax and ferries also carry rail wagons, but each type of ferry does not differ dramatically between the sub-markets, indicating a homogenous TO between the routes. This is not explained by standardised shipyard configurations, such as those common in the tanker, dry bulk and container segments, since ferry configurations are often adapted to individual routes. According to Baird (2007), however, the Flensburger shipyard built 28 standard 'production line' ro-ro vessels between 1998 and 2005, but the ships used in the SBS are produced by many different shipyards.

Another plausible reason for the similarity in overall size and speed is that the ferry lines want to keep open the options of moving vessels around in their networks or reselling their vessels to operators of other routes. Chartered vessels are also likely to be more of a standard design, but very few of the ferries in the SBS are chartered. Yet another reason for the homogenous ship sizes might be restrictions in manoeuvrability regarding draught, quay and ramp measures in the called ports (Maksimavicius, 2004). The ships' draughts today are rather well aligned with the allowed draught of about 7 m in most ports in the area. The shallow waters of the SBS also restricts the use of installed power (Kjellberg, 2011).

The sizes might be similar, but the ferry lines approach the trade-offs between ro-ro decks and passenger compartments differently. The decision on freight *vs.* passengers requires further particularisation due to the trade-offs between truck, car and rail lane metres, but with some use overlap, and between restaurants, shops and other public areas and cabins. These decisions are very difficult to make, particularly when considering seasonal changes and different exposures to business cycles.

The ship configurations obviously differ a great deal between different routes. It is thus common to rebuild ships before moving them to another route, which is evident from Table 2**Fel! Hittar inte referenskälla.**, that shows the older ships have been rebuilt. The pattern appears to show that rebuilding precedes a move to new routes, rather than representing refurbishment at fixed ship ages. Stena Line, for example, spent 25 M€ to rebuild two ferries employed at the Gothenburg-Kiel route, adapting them for the Karlskrona-Gdynia service (Stena Line, 2010c). This is a domino effect caused by the delivery of two so-called super ferries to Stena Line's Hook van Holland-Harwich route

Table 2. South Baltic Sea ferry lines between Sweden and Continental Europe, sorted from west to east in Sweden. March 2010. The last service started in September 2010.

Country-port		Duration	Frequency	Type	Vessel/s	Built/ rebuilt	Length/ width/ draught	Gross tonnage	Road lane metres	Rail lane metres	Cars	Pax	Design speed	Operator (country)
S-Malmö	D-Travemünde	9	2-3/d	RP	Finneagle	‘99	188/29/7	29 800	2200			440	22,1	Finnlines Nordö Link (FI/I)
					Finnpartner	‘95	183/29/7	32 500	3050			272	21,3	
					Finntrader	‘95	183/29/7	32 500	3050			274	21,3	
S-Trelleborg (Helsingborg)	D-Travemünde	7-8 (9-10)	2-4/d (1/w)	CF	Nils Holgersson	‘01	190/30/6	36 500	2640			744	22	TT Line (D)
					Peter Pan	‘01	190/30/6	36 500	2640			744	22	
				RP	Nils Dacke	´95	180/27/6	26 800	2400			300	19,5	
					Robin Hood	´95	180/27/6	26 800	2400			300	19,5	
S-Trelleborg	D-Rostock	5,8-7,5	2-3/d	CF+R	Mecklenburg–Vorp.	‘96	200/29/6	36 200	3200	945	90	745	22,5	Scandlines (D+S)
					Skåne	‘98	200/29/6	29 000	3295	1110	440	600	21	
S-Trelleborg	D-Rostock	5,5-7,5	3/d	RP	Huckleberry Finn	‘88/’93/‘02	167/26/6	24 700	2200			400	20	TT Line (D)
					Tom Sawyer	´89/´93/‘01	167/26/6	24 700	2200			400	20	
S-Trelleborg	D-Sassnitz	4,0	4-5/d	CF	Sassnitz	‘89	171/24/6	20 300	900	711	180	1000	21	Scandlines (D+S)
					Trelleborg	‘82	170/24/6	10 800	680	755		900	17	
S-Trelleborg	PL-Swinoujscie	7-9	1-3/d	RP F	Galileusz	‘93/’06	150/23/6	13 000	1740			125	19	Unity Line (PL)
					Wolin	‘86/’02	189/23/6	22 900	1720	650		370	18	
					Gryf	‘91	158/24/6	18 600	1800			180	17	
S-Ystad	PL-Swinoujscie	7,0	1/d	CF	Wawel	´80/’89/’04	164/27/7	25 100	1500		500	1000	16,7	Polferries (PL)
S-Ystad	PL-Swinoujscie	7	2/d	CF+R CF F+R	Polonia	‘95	170/28/6	29 900	1100	604	830	918	20,2	Unity Line (PL)
					Skania	‘95	174/24/6	23 700	1850			1400	27	
					Jan Śniadecki	‘88	155/22/5	14 400	490	590		57	19	
					Kopernik	‘77/’94/’08	160/22/6	14 200	975	650		360	18	
S-Karlshamn	LT-Klaipeda	14	6/w	RP	Lisco Optima	‘99	186/26/6	25 200	2300		180	337	22,5	DFDS Lisco (DK)
					Lisco Patria	‘92	154/24/6	18 300	1800			213	18	
S-Karlshamn	D-Kiel (one-way)	16	1/w	F	Tor Baltica	‘77/’86	164/23/8	14 400	1880			12	18	DFDS Lisco (DK)
S-Karlskrona	PL-Gdynia	12	2/d	CF	Stena Baltica	‘86/’94/’05	162/28/6	31 200	1590		450	1200	19,5	Stena Line (S)
				RP	Stena Finnarrow	‘96/’98	168/28/6	26 000	2400		800	200	21	
S-Nynäshamn	PL-Gdansk	18	5-6/w	RP	Baltivia	´81/´89/´07	147/24/6	17 800	1400			178	19	Polferries (PL)
				CF	Scandinavia	‘80/’99	145/25/6	23 900	650		500	1800	18	
Totals/averages		**9,6**			**28 ships**	**1990/19,3y**	**5087** (L)	**685 700**	**54 050**	**6015**	**3970**	**15 469**	**20,0**	
Min values		**4**	**1/w**		**1 ship** (per route)	**2001/9y**	**145/22/5**	**10 800**	**490**	**590**	**90**	**12**	**17**	
Max values		**18**	**4-5/d**		**5 ships** (per route)	**1977/33y**	**200/30/8**	**36 500**	**3 295**	**1 110**	**830**	**1 800**	**27**	
Ratio Max/Min values						**3,67 (y)**	**1,4/1,4/1,6**	**3,4**	**6,7**	**1,9**	**9,2**	**150,0**	**1,6**	
S-Helsingborg	D-Travemünde	11,5	6/w	F	Antares	‘88	158/25/7,5	20 200	2100			12	20,5	SOL (S)
					Vasaland	‘84	155/25/8,5	20 000	2060			12	18,5	

Legend: ***Sailing duration:*** in hours, the longer times generally refer to over-night sailings. ***Frequency:*** d=day, w=week, m=month. ***Type*:** CF=Conventional ferry, CF+R=Conventional ferry + rail, RP=RoPax, F=Freight ferry, F+R Freight ferry + rail. ***Cars:*** might be trade-off with lane metres. ***Speed:*** In knots. Polferries’ comparatively slow speeds regard cruising speed. Compiled from Fakta om fartyg (Facts about vessels), 2010, ferrylines.com, 2010, and the operators’ websites/fleet lists (DFDS Lisco, Finnlines Nordö Link, Polferries, 2010, Scandlines AB, Scandlines GmBH, TT-Line, Unity Line, and Stena Line, all 2010).

(Stena Line, 2010b). Stena Line and several of the other ferry lines use route-specific ship names, and moving ships within the network implies not only rebuilding but also renaming. This indicates that there is a certain inertia to moving vessels within the operators' networks, and it is not common to try to adapt to seasonal changes.

Frequencies of individual shipping lines range from once a week to five departures per day. However, some of the routes are served by two shipping lines and some routes are geographically close. Customers without strong preferences due to taste, volume discounts or exactly which port to call can then benefit from a high *experienced frequency* (for further elaboration on the issue, see Ramstedt and Woxenius, 2006) although departures of different shipping lines are generally clustered close in time.

The operators obviously face severe restrictions in changing both speed and frequency that are often created by the distances and turn-around times. They can be fine-tuned but major changes come with stepwise cost increases.

For the Sweden-Germany routes, the most western routes to Travemünde attract trucking companies since the drivers can have a full night's rest and the ferries shorten the road distance in Germany. TT Line deploys the ferries on the Trelleborg-Travemünde service to a Helsingborg-Travemünde service with one round trip during the weekend. Finnlines/Nordö Link shares an oligopoly with TT Line and the newest ships are used at this segment.

The next market segment, sorted from west to east, represents the shortest sailings, particularly Trelleborg-Sassnitz, which has a four hour crossing and also is used with the highest frequency. The Trelleborg-Rostock route hosts the largest ferries and was historically part of the Danish, German and Swedish railway administrations; the two Scandlines companies also offer significant rail ferry capacity with a stricter tie between the ship and ro-ro terminal (Maksimavicius, 2004).

The Sweden-Poland routes are served by eleven ships mixing freight and passengers, and four of them have rail capacity. The routes serving Russia and the Baltic States – Karlshamn-Klaipeda and Karlshamn-Kiel, which is part of the Kiel-St. Petersburg-Karlshamn-Kiel route – are the ones with the most evident freight focus. The former service relates to the rapidly increasing trade flows east-west in the SBS (East West TC and East West TC II, 2010 and Palšaitis and Bazaras, 2004) including transit to, e.g., Belarus, Russia and Ukraine (Burkovskis and Palšaitis, 2002 and Bazaras and Palšaitis, 2003). The latter service is also the only one serving more than two ports, although it leads too far out to denote it a network.

The CO of the SBS ro-ro services is high, but price discrimination applies as the dominating forwarders, large hauliers, the state-owned railways and larger bus operators are favoured by large rebates (Borgemark, 2010). This also stimulates an oligopolistic situation on the shipping market's buyer side, since the disadvantaged smaller rail and bus operators and forwarders, as well as hauliers with a direct shipper relationship, use the routes via Denmark to a greater extent. They might also be outcompeted or choose to join forces with the larger actors to benefit from their volume discounts. Favouring the large customers, able to act as proxy customers for a wide range of shippers, individual road hauliers and rail operators as well as individual passengers, and the following deterrence of smaller users and thus implies a risk of successively lower CO.

One factor stimulating a high CO, however, is the fact that the forwarders tend not to use a single ferry line at each segment with an oligopolistic market offer. The use of several market offers will probably continue since the forwarders are not interested in fostering a monopolistic market situation. As an example, the current ferry between Denmark and Germany is regarded as expensive due to a monopolistic situation (Dahllöf, 2010). In all, the market offer is comparatively homogenous and it is difficult to distinguish a niche player in the current market.

Most of the shipping lines deal with controllability (Woxenius, 2010) by detaching their services from the door-to-door services, by accepting a low resource utilisation (Styhre, 2009) and by applying simplified booking procedures. The shipping services can thus be seen as embedded in transport services provided by the shipping lines' direct customers. At the Trelleborg Port Conference in November 2008, the senior managers of Polferries, TT Lines and DFDS were asked for their aspiration for involvement in their customers' door-to-door services. Polferries and TT Lines made it clear that their aspirations are truly low, basically waving at the customers from their ferries. DFDS's attitude, on the other hand, is far more aggressive stating that the worst possible position is to be a curtailed subcontractor of a commodity service. This must, however, be put in a company profile context. Polferries and TT Lines specialise in comparatively short bridge-substitutes, while DFDS operates more on longer distances with more direct contacts with industrial shippers. Two industry experts' view on the CO and TO of the present offer in the SBS is presented in Figure 2 along with a few plausible services analysed in the following section.

Changes in the modal competition to 2020

The market situation in the SBS has adapted to Sweden's 1995 entrance into the European Union and Poland and the Baltic States' entrance in 2004, to the abolishment of tax free in 1999, to the fixed-link competition from the Öresund and Great Belt bridges in 1997-2000 and to the more recent effects of the last recession. After the adaptation, the competition adhered to the general rule of the European freight transport market, which Savy (2009) identified as fiercest within each mode and not between the modes. This applies at least to the narrower geographical context for comparatively short distances on either side of the two ports in the SBS, as investigated by Stemmler (2005). Now, however, two significant challenges affecting the competitive strength of shipping against other modes lie ahead.

The first relates to operational costs. After 2015, Annex VI of the MARPOL Convention on SSS stipulates the use of low-sulphur distillates (0.1% sulphur content) or off-setting cleaning technologies in the North Sea and Baltic SECA. Several studies investigate the supply of and price for fuels (Purvin & Gertz, 2009) and their effects on shipping (Kehoe, *et al.*, 2010), but it is fair to say that it will be a significant challenge for the western ro-ro services in the SBS to compete with all-road and all-rail transport through Denmark with increased fuel costs. Maritime industry representatives have mentioned tripled fuel costs and up to doubled operational costs for short sea ro-ro shipping. The situation will be eased somewhat by increasing costs for road transport when the Eurovignette is fully implemented.

The other change also relates to the external competitive situation and the added competitiveness of rail and road that will be contributed by the Fehmarn Belt connection that is planned to open in 2018. All-road and all-rail will then be offered a dry-shod alternative with a significant shortcut compared to the current detour over Jutland in Denmark. The current bridge-substitute between Rödby and Puttgarden is, as mentioned above, costly as a result of Scandlines maintaining a monopoly, so the bridge user fee is not likely to deter road and rail operators when compared to today's situation. There will, however, also remain a significant detour when using Fehmarn Belt connection: 200 kms compared to the ferries Travemünde-Malmö/Trelleborg (Dahllöf, 2010).

Lingaitiene's (2008) main parameters of speed and costs, and partly traffic safety, of the competing transport modes are thus significantly affected. The desktop stage of the research is finalised with an analysis of plausible effects of these "shocks" to the market situation in terms of CO, TO and the trade-offs listed in section 2.

Plausible effects on ro-ro shipping in the SBS

Although the changed circumstances will mostly affect the competitiveness with other modes, the corresponding actions by the shipping lines are also likely to affect the competition internal to ro-ro shipping in the SBS. One decision for the operator to make is whether to buy the cleaner distillates, change fuel to LNG or to install scrubbers or other cleaning technology. DFDS has, for instance, tested an exhaust gas scrubber on their Tor Ficaria on the Gothenburg-Immingham route (Danish Shipowners' Association, 2009) and Viking Line intends to fuel a cruise ferry with LNG on the Turku-Stockholm route from 2013 (LNG World News, 2010). The shipping-specific trade-off of *low-sulphur fuel vs. cleaning technology* will obviously affect the balance between operational and capital costs and thus affect the economic cruising speed for the vessels. It should be noted, though, that aquatic environmental concerns imply that the use of scrubbers in the Baltic Sea is disputed.

One main issue is whether the employed ships will continue to take passengers and freight together. It is asserted here that if scrubbers are or LNG is used, a significant portion of the SBS ro-ro shipping will remain almost as-is, with comparatively large versatile ships combining many types of transport demands and operating at comparatively high speeds. An illustration is Viking Line's new-building, however to be operated north of the SBS, mixing passenger and freight in a large 57 000 GT vessel with a top speed of 23 knots (*ibid.*). The high levels of TO and CO in combination with low requirements for controllability could thus remain in this segment.

The new conditions might foster even larger ships to utilise economies of scale, hence addressing the trade-off *accessibility vs. large transport resources*. Increased size, however, requires increased quantitative demand since the speed and frequency for each ship is, as argued above, to a large extent determined by the distances and turn-around times. Respecting the trade-off *large transport resources vs. frequency*, it is doubtful if shipping lines dare to invest in larger ships in the western part. The eastern part is, however, less subject to competition from other modes and Stena Line is, as mentioned above, about to engage larger ships on the Karlskrona-Gdynia route (Stena Line, 2010c).

SSS has a particular relationship with the trade-off *frequency vs. filling grade* as elaborated by Styhre, (2009). Few transport services, except for urban public transport and parts of long-distance passenger rail, have such a tolerant view on low resource utilisation. Nevertheless, with higher operational costs follows more attention to filling the ships. This indicates that Stena Line and DFDS Lisco have the competitive advantage of operating large networks facilitating a rather flexible planning of which types of ships to deploy. This is, however, in the long run, since there is inertia to moving vessels according to seasonal or short-term changes in demand. With different uncertainties in different routes, however, network size matters.

The trade-off *filling grade vs. efficient transfer operations* is not likely to be affected much; short turn-around times will still be prioritised before denser loading like containerisation. The shipping segment is ro-ro and the decision to transport rolling units is robust in this shipping market. Also, for *direct transport vs. terminal network*, options are limited in a market almost defined by direct transport.

More concerns will obviously be given to *speed vs. fuel consumption* as well as to *fuel consumption vs. tied-up capital*. Without scrubbers or LNG, there will simply be a new economic equilibrium although shipper preferences obviously have to be considered. The western-most routes are today, as mentioned above, favoured by the trucking companies due to shorter driving distance in Germany but also because they give the drivers a full night's rest. This opens up for a new compromise where slow RoPax ships can offer a full night's rest, but leave cars and accompanied trucks a longer distance in Germany to drive.

Another plausible and much more interesting outcome is that the new competition pressure makes the compromises of flexible concepts unattractive. This would foster niche concepts to capture parts of the market. One branch might be that high speed catamarans restricted to passengers and cars reappear in the SBS on longer routes than to the island Bornholm[1]. None of the SBS ports is a major city so most passengers require transport options to and from the ports. Besides the conventional option with cars and a few buses accepted, there might be a market for passenger-only ferries, implying a very low CO and TO. Timetables for buses and trains thus have to be co-ordinated in both ports, adding a great deal to the need for controllability.

For freight, current operators, or more likely new entrants, might decide to add services with a cost minimisation strategy. Such niche services could be based on simple but large ro-ro ships or even barges pulled across the SBS by tug boats. The latter would resemble how Crowley serves Puerto Rico with oceangoing triple deck ro-ro barges (Crowley, 2010). In addition to low fuel costs, this concept can cut the relatively high costs of crews and capital for versatile ships also serving passengers, and the strict adaptation to individual routes would be significantly relaxed. Since the cargo hold in terms of ro-ro decks will be detached from the tug boats, the latter can be very well utilised regarding time. The ro-ro segment already has short turn-around times, but relaxing the demands for time-utilisation of the cargo hold will facilitate changed operations in the ports. Restricting to unaccompanied semi-trailers and other ro-ro cargo would obviously imply much lower TO and CO than today's ferries, but allowing longer loading times implies that awkward ro-ro cargoes can be accepted, thus somewhat increasing the TO. Contrary to the trend in fast passenger ferries, the need for controllability would decrease.

As part of the case study interview, the two experts from the shipping and port industries were asked to position SOL's new service (see next section), competing ro-ro services and the prospective new services outlined above in a CO-TO matrix, see Figure 2.

The experts' assessment, and their motivations for the placements, strengthened the view that the CO-TO matrix is useful when analysing the supply side of a transport market. TT Line (1) and Scandlines (3) were awarded the highest CO ratings and can then be characterised as the "public transport" of the SBS together with Stena Line (6) and, to a lesser extent, Unity Line's Ystad-Swinoujscie service (9). The prospective fast passenger and cars ferry service (12) and Polferries' Nynäshamn-Gdansk route (2) were rated to have the highest TO and also scored well regarding CO. Finnlines with a medium score in both openness categories stands out, while the remaining services can be characterised as niche services with low CO ratings.

[1] TT Line operated the TT Delphin with a capacity of 600 passengers, four buses and 124 cars and a design speed of 37.5 knots on the Trelleborg-Rostock route 1996-2004 (Facts about ships, 2010). The route between Ystad on the Swedish south coast and Rønne on the Danish island Bornholm in the SBS is serviced by Leonora Christina, one of the world's largest catamarans with its GT of 10 371 (IHS Fairplay, 2011).

4. Case study: New service by the Swedish Orient Line

In December 2009, Finnlines/Nordö Link and TT Line underpinned the oligopolistic market situation with a significant (up to 70%) and simultaneous rise in freight rates (Bryggare, 2010). This was heavily criticised by forwarders, particularly as the course of action was taken with neither negotiations nor notice (Dahllöf, 2010). DHL responded directly by moving the northern end-point of its intermodal train service to Italy from Travemünde to Padborg in Denmark (*ibid.*), thus withdrawing flows from the SBS ferries. In addition, forwarders and hauliers based in the Helsingborg area searched for an alternative and the price rise compelled them to start planning their own ro-ro service. Instead they chose to approach shipping lines not yet active in the SBS market.

One of these, SOL, had already found that the current actors in the SBS were badly positioned and seemed to lack strategies for the future situation, as MARPOL Annex VI, Fehmarn Belt and increasing driver salaries seemed to imply a mid-term market opportunity. SOL's concept features included comparatively slow speed, focus on unaccompanied rolling freight, integration with intermodal rail services and lean operations that were keenly alive to customers' demands. This meant that they could correspond quickly, and they launched a Helsingborg-Travemünde service in September 2010. Hence, this was designed concurrently with the first stage of desktop research during the spring.

The case study is based on both informal discussions and structured, recorded interviews with SOL's CEO Michael Kjellberg, and with Leif Borgemark, CEO of Port of Trelleborg from 1993 to 2009 and now an active advisor to SOL. The interviews were performed in February 2011, and the interviewees have reviewed the text for factual mistakes. The interviews and the analysis are outlined after CO, TO and SOL's decisions regarding trade-offs.

SOL offers six weekly departures in each direction, and a speed of 14 knots translates to an overnight sailing time of 11,5 hours. The two ships compare with the average size used in the SBS with 20 000 GT and 2100 lane metres and they stay in port during the day. For further data on the ships and the service, see Table 2 above.

The *CO* is comparatively low as the service is marketed as "a service dedicated to freight forwarders interested in saving money, miles and drivers" (SOL, 2010). This might sound attractive to most forwarders, but not all are willing to accept longer sailing times and many want drivers to accompany the freight. The service is, nevertheless, far from designed strictly for the initial 10-12 customers. In fact only one of them currently uses the service. Instead, all forwarders and hauliers are accepted, and 50 of the current 80 customers are regular users subject to rebates. The ships have cabins for 12 drivers, but the focus is clearly on unaccompanied freight.

SOL characterises the *TO* of its service to be moderate. The focus on semi-trailers and other unaccompanied rolling cargo is a restriction, compared to RoPax services,

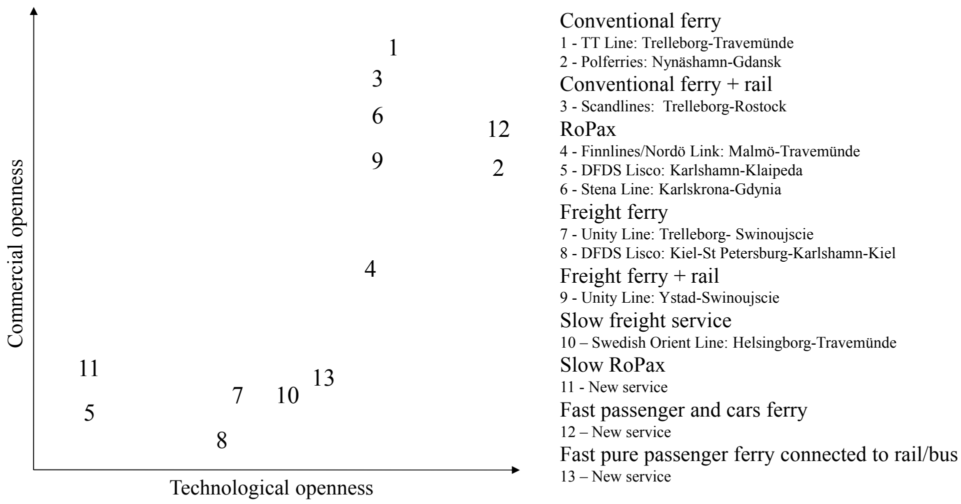

Fig. 2. Selected ro-ro services and potential niche services in the South Baltic Sea placed in the CO-TO matrix by Michael Kjellberg, CEO of Swedish Orient Line and Leif Borgemark, former CEO of Port of Trelleborg.

but the long turn-around facilitates the handling of awkward cargo and many unaccompanied units. All rolling cargo, including temperature-sensitive cargo, is accepted except for units with live animals. Compared to some RoPax services, SOL has few restrictions on hazardous cargo.

Corresponding to the trade-off between *low-sulphur fuel vs. cleaning technology*, SOL might consider equipping the ship built in 1988 with a scrubber, but the ship built in 1984 is considered too old. SOL still thinks that its focus on slow speeds will grant it competitiveness if it also uses distillates starting in 2015. Regarding *accessibility vs. large transport resources*, SOL has deployed ships adapted to demand, rather than to accessibility in ports, which is currently not a restriction for larger ships.

Large transport resources vs. frequency is a trade-off with limited options for SOL. Users require a daily frequency, but the route does not allow for an extra turn-around with reasonable speed, an issue elaborated upon by Laine and Vepsäläinen (1994). Deploying more ships at a higher frequency, corresponding to *frequency vs. filling grade,* is relevant decision for SOL. SOL's aim for a 70% occupancy rate translates to a capacity of 50-60 000 semi-trailers per year, which is in line with the current demand. A higher frequency would come with a step-wise capacity increase and requires price reductions. This was experienced by Nordö Link when it replaced two freight ferries with four large RoPax vessels. Nordö decreased the capacity by swapping to three smaller vessels but could not recover the price level. Evening departures are also more attractive to forwarders and thus more highly priced than mid-day departures. SOL's focus is to fill the current ships and eventually to replace them with somewhat larger ships rather than increasing frequency.

SOL's generous 12-hour turn-around facilitates handling of up to 120 unaccompanied units, compared to approximately 60 for the competing services with higher frequency and three-hour turn-around. Hence, SOL has a good competitive position regarding *filling grade vs. efficient transfer operations*, as it is also allows for careful loading and awkward cargo. Less dependency on accompanied lorries also implies larger volumes available for intermodal rail services, which SOL regards crucial for long-term competitiveness against all-road and all-rail.

Facing the trade-off *direct transport vs. terminal network* SOL has decided to operate a direct route, but also considered extending the route to Halmstad further north on the Swedish west coast, or calling at Malmö or Köge in Denmark en-route. Daily sailings at more than two ports would, however, lead to disadvantageous timing for forwarders, and necessitate higher speed and larger vessels. SOL does not sail on Sundays, so another option is to follow TT-line's example and operate the idle ships on another route once a week.

Nevertheless, the core idea behind SOL's service regards *speed vs. fuel consumption.* Sailing at 14 knots consumes 1,25 tons of fuel per hour, compared to 2,3 tons at the maximum speed resembling the competitors' 18-20 knots. The current price tag of about 500€/ton means 7,2 k€ per 11,5 hour voyage, saving 6,0 k€ compared to full speed. This should, in turn, be contrasted to the daily vessel costs of 9 k€ divided between 6 k€ in running costs (mainly crew costs) and 3 k€ in capital cost. SOL has thus also taken a deliberate stand-point regarding the trade-off *fuel consumption vs. tied-up capital.*

Moreover, many stated preference analyses have shown that forwarders prefer precision over short transport time. The margin between cruising and design speed facilitates a high service precision since the throttle can be used when a delay is possible. The first six months of service have been performed with 99% precision, and with only two late arrivals, caused by a malfunctioning ramp and a severe storm.

To conclude, SOL deliberately developed its service to compete with all-road and all-rail in a future situation with MARPOL Annex VI in force and with stiffened competition from the Fehmarn Belt connection. The priority was not to compete with the current ro-ro offer in the SBS, but the service could already be launched in 2010 due to an immediate market opportunity.

SOL appraised the first challenge as the most critical; they took the measure of sailing at slow speeds, virtually halving the fuel costs compared to full speed, and increasing competitiveness after 2015 when 0,1% sulphur fuel is expected to cost 60-75% more than the current 1,5% sulphur fuel (Purvin & Gertz, 2009, p. 13). The competitors seem more oriented towards lobbying for postponing the implementation of MARPOL Annex VI, installing scrubbers or converting to LNG propulsion.

The second challenge, of a more direct infrastructure for road and rail, was met by further integration with intermodal rail in Sweden and, more importantly, in Continental Europe. The aim is to involve shippers, forwarders, ports and intermodal operators in strategic alliances rather than to see SOL's service as a bridge-substitute, selling tickets at the gates. One competitive advantage is that many countries allow semi-trailers weighing 28 tons in intermodal rail, compared to 24 tons for all-road.

5. Conclusions

The study addresses theory and method development as well as empirical and contextual issues.

1. The theoretical and methodological parts of the study have shown that the concepts of commercial and technological openness provide a fair basis for analysing the flexibility of SSS systems. Existing SSS concepts exhibit wide variations in both CO and TO but the variations are far smaller, or even remarkably small, in the SBS ro-ro segment that is studied in detail. Admittedly, though, the explanatory strength for the current range of rather similar services is not impressive. Adding the outlined potential niche services, and particularly the service in the case study, however, makes the CO-TO matrix more useful.

2. The analysis shows that there is a correlation between CO and TO, but that follows from the definitions of the concepts. Structuring the analysis along trade-offs proved to be more useful at the detailed level.

3. As to empirical results, the desktop stage of the research indicated that the new rules for low-sulphur fuels and the construction of the Fehmarn Belt connection might split up the currently very homogenous ro-ro market in the SBS. However, investing in LNG propulsion, scrubbers and other emission-cleaning technology and congestion on the western land routes through Denmark and Northeast Germany is likely to hold back rapid changes.

4. The desktop study also suggested that the new competitive situation might foster the reappearance of fast ferries for passengers and the introduction of simplified services for freight focusing on energy efficiency, low personnel expenditures and less costly vessels. The latter type of service actually appeared between the two research stages, as illustrated in the case study of SOL's Helsingborg-Travemünde service.

5. The case study of SOL's service strengthens the freight-related findings from the desktop study. The lean concept combines a low CO with a moderate TO and a clear stance regarding several trade-offs. It features slow speeds, focus on unaccompanied freight and prospects for further integration with other modes into intermodal transport chains. It underpins the importance of low fuel consumption and strict alignment to a selective customer base for meeting the future challenges in the SBS.

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