Hinterland transport by rail – a success for maritime containers but still a challenge for semi-trailers

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Abstract
This article examines why semi-trailers are not moved to and from seaports by rail at the same rate as maritime containers. The segments are compared in terms of the transport markets they serve, the competition they meet and the operational and technological principles they apply. The article includes a brief examination of how current trends affect the role of rail for hinterland transport of semi-trailers as well as empirical findings from the case of Port of Gothenburg and its Scandinavian hinterland. Admittedly, rail is more competitive for hinterland transport of containers than of semi-trailers, but there are still significant opportunities for reaping the benefits of rail transport also for semi-trailer transport in the hinterlands of European ports.

Keywords: Hinterland transport, intermodal transport, container shipping, RoRo shipping, semi-trailer.

Introduction

The challenge of liner shipping has moved from the sea, first to the ports and then to the hinterland. The increased scale of ships and ports has not been matched by larger trucks and, like in most other transport networks, costs and lead time are increasingly generated in the capillaries rather than in the arteries. The business model of maximising the revenue by filling the ships and then "fixing" the hinterland operations then simply does not work anymore.

One way of increasing the scale of hinterland transport means is to use trains and barges rather than trucks. Compared to road, both rail and inland waterways come with advantages such as lower environmental strain, lower nuisance in port city traffic, lower transport distance costs, faster throughput in ports and, in most cases, less sensitiveness to delays by traffic congestion. The advantages are distributed among most actor categories and each of them can find reasons for advocating the use of alternatives to road for hinterland transport (Woxenius*, et al.*, 2004). For instance, the latter two advantages appeal to truckers since they are rarely compensated for standing in lines at ports' gates and in congested traffic. Notable disadvantages are costs and lead times over short distances and rail congestion close to the ports.

Most main container ports in Continental Europe experience a modal shift from road, but rather to inland waterways than to rail. The UK and Scandinavia are, however, confined to coastal shipping and rail as alternatives to road. In Sweden, the increase of rail shuttles to and from Port of Gothenburg is a frequently cited showcase of rail competition and of recapturing market shares from road transport. The rail volumes have tripled in seven years and the current 23 rail shuttles with ten different rail operators now have a market share of some 40% (Port of Gothenburg, 2008). Nevertheless, the success of hinterland transport by rail is generally confined to maritime containers; semi-trailers are seen on the tracks to a far smaller extent.

The purpose of the article is to explore why semi-trailers are not moved to and from seaports by rail at the same rate as maritime containers. It investigates the effect of current trends and includes an analysis empirically based on the Port of Gothenburg and its hinterland connections in Scandinavia.

Hinterland transport by rail

Hinterland transport of vehicles and unit loads "cross-docked" in ports is a comparatively old phenomenon, but business activity and policy making has clearly been intensified over the last, say, 25 years. In 1982, the UN first used the term *Dry Port* underlining the integration of services with different traffic modes under one contract (Beresford and Dubey, 1990). Research on hinterland transport is also comprehensive. Examples with their main geographical context are: Notteboom and Rodrigue (2005 - USA), Rodrigue (2008 - USA), IBI Group (2006 - Canada), Beavis (2007 - Australia), Wang and Cullinane (2006 - Asia), Woodburn (2006 and 2007 - UK), Pettit and Beresford (2007 - UK), Debrie (2004 – south-west Europe), Gouvernal and Daydou (2005 – north-west Europe), van Klink and van den Berg (1998 - Rotterdam with hinterland), Bundesamt für Güterverkehr (2005 – Germany), and Roso (2006 - Sweden). All these publications are more or less confined to the container segment whereas semi-trailers are merely overlooked, although Bundesamt für Güterverkehr (2005) goes a little further than containers in the scope. In fact, Pallis*, et al.* (2007) found that about half of port research, however not limited to hinterland transport, published in scientific journals 1997-2006, and 70% of the articles published in the latter half of the decade, had an explicit reference to container ports and terminals. Other commodities, including RoRo cargo, was dealt with in only 5% of the articles, the rest address more general port management and policy issues without differing between cargo segments. There is obviously research also about RoRo shipping, but mainly regarding RoRo shipping itself and in competition with road transport, see, e.g., Brooks and Trifts (2007) and Xu and Wu (2007).

Nevertheless, the trade between EU neighbours still dominates despite the immense growth of the EU-Asian trade, so neglecting the RoRo segment is not justified by negligible volumes, at least not for the UK and Scandinavia. According to Osborn (2008, based on data from the UK Department for Transport Maritime Statistics), UK ports handled 4,1 million accompanied semi-trailers and 3,6 million unaccompanied ones in 2006, corresponding to about 15 million TEU[1]. This should be compared to the 8 million TEUs handled in UK ports in 2004 (House of Commons, 2007). In Swedish ports, 850 000 containers (1,4 million TEUs) where handled in 2007 compared to 2,8 million semi-trailers, trucks, trailers and other RoRo units. In weight, the 43,3 million tons of the RoRo segment was almost four times the 11,7 million tons of the containerised cargo (Ports of Sweden, 2008). The Swedish statistics is not divided into accompanied and unaccompanied RoRo traffic.

Rail transport of semi-trailers is technically impossible in the UK (Haywood, 2007), but a fairly extensive business in Sweden. Almost all wagons operated by the largest Swedish intermodal operator, CargoNet AB, can carry semi-trailers. The main business is domestic intermodal transport, but in April 2008 CargoNet moved some 7000 semi-trailers to and from Swedish ports with connections to RoRo shipping. Of these, 3000 were related to Port of Gothenburg with RoRo connections to the UK and Benelux and the remaining 4000 to southern ports connecting Sweden and Germany (Backman, 2008). This corresponds to an annual volume of some 168 000 TEUs or roughly half of the volume of the container shuttles related to PoG. Finnish hauliers' use of Sweden as a land-bridge with rail between the ports of Stockholm and Gothenburg to reach the UK is a still small but fast growing market (ibid.).

Different contexts for hinterland transport of maritime containers and semi-trailers

Transport of goods loaded in maritime containers and semi-trailers address different markets, apply different business strategies and technologies, but they very much share the cost, lead-time and sustainability challenge of operating the hinterland part of the transport chains. Operators striving for getting semi-trailers onto rail can learn from their colleagues in the container segment that so far have been more successful, but just copying their business model would not suffice. A thorough understanding of what the segments have in common and how they differ is hence needed. This section thus, however briefly, examines the different contexts for hinterland transport of the load unit types. It should be noted that dividing into factors is a delicate task and a reductionist approach would probably fail, so the division is here made merely for illustrative reasons than for analytic sharpness.

Semi-trailers are used for intra-European flows, which follow much stricter schedules than container transport mainly aiming for trans-ocean trade. The different competition situations between modes and between shipping lines implies that the business priority for the RoRo operators lean towards customer convenience while the container segment aim at economies of scale. The geographic concentration is thus higher in the container segment but the competition with all-road transport is less fierce, implying that the hinterland is deeper for containers, i.e. they generally travel further inland from each port. The different transport rhythms mean that shippers require a precision in the range of hours for semi-trailers and days for containers. Semi-trailers also dwell in port for a shorter time and storage in ports is not often used for absorbing slack in the transport planning. The higher value of the semi-trailer also means that they are not left waiting for new tasks at the same rate as containers.

Not only researchers have a particular interest in the container segment. The higher work content and investments for container operations make ports focus this segment whereas particularly accompanied semi-trailers driven over RoRo ramps by the truck drivers comes with very little business to the port but yet with barriers for getting the semi-trailers onto rail. Hence, container operations are often overrated by the ports overlooking the potential of increasing their turnover from RoRo traffic.

[1] Here, a semi-trailer is conservatively assumed to correspond to two Twenty Foot Equivalent Units (TEUs). Semi-trailers allow more than double the cube of a TEU, but sometimes they are not fully loaded in terms of cube and the permissible weight on roads is the same for a semi-trailer and two TEUs on a semi-trailer chassis.

According to Schramm (2006), the success of intermodal chains is highly dependent on who is organising the chain and how well the operations are integrated. Container transport chains are typically organised by the shipping lines, their agents or specialised sea forwarders. They are used to think in chains split between modes, whereas the road hauliers or road-based forwarders typically plan for the same vehicle throughout the transport chain although using sea as "bridge substitutes". The planning and operation barriers for using rail are accordingly higher for semi-trailers. The rendering is summarised and partly added to in the table below.

	Container	**Semi-trailer**
Transport market	Transocean/deep sea/short sea	Intra-European/short sea
Port geography	Few large hub ports + feeder ports	Many ports – partly "bridge substitute"
Hinterland depth	Deep	Shallow
Precision	Day	Hour
Competition	Rail and road for feeder leg	Rail and road + fixed connections
Transport coordinator	Shipping line, line agent or sea forwarder	Shipper, road haulier or general forwarder
Business priority	Economies of scale	Customer convenience
Cargo dwell time in port	Days	Accompanied – minutes or none Unaccompanied - hours
Empty unit dwell time	Days/weeks	Hours/days
Work content for ports	Substantial	Limited
Rail technology	Very simple – flat wagon/twist locks	Advanced – pocket wagon/king-pin box
Road technology	Awkward at end points	Simple and accessible
Road-rail transhipment	Fairly simple - automation	Dimensioning factor in weight and handling

Table 1. Comparison between the container and semi-trailer shipping segments.

The increasing size of container ships is often cited, but this is actually a factor not distinguishing between the segments. The capacity difference between Sovereign Maersk of S-type (6600 TEU) that went into service in 1997 and Emma Maersk of the PS-type (11 000 TEU) that entered the Maersk fleet in 2006 (Maersk Line, 2008) is 66%. Incidentally, this is very close to the increase of capacity measured in lane meters of the RoRo ferries serving Dover, which according to Osborn (2008) has grown by 69% between 1998 and 2008.

Drivers for increased hinterland rail transport of semi-trailers

Current trends are definitely positive for rail freight transport. Factors internal to the industry include the increasing costs of road haulage (although the cost of fuel might be considered partly external), congestion at port gates and in port city traffic, increased volume and concentration of semi-trailer flows to a scale suitable for rail due to strengthened intra-EU trade. Rail and unit load technology is also evolving and the image of road transport is undermined for environmental but also quality reasons, leading to that the road transport sector faces recruitment problems. Shortage of drivers and increased costs also foster an increased share of unaccompanied semi-trailer transport by sea and, hence, a better position for rail to take part in the business.

The image of road haulage is also found among the factors external to the industry itself implying that the shippers increasingly demand rail rather than road transport. It also leads to political pressure for changes and if not responded by the industry at a satisfactory rate, potentially aggressive regulation waits around the corner. Another factor that starts to affect is emission caps that, at least in Sweden, impedes process industries and logistics nodes to expand unless the modal split is changed. One example is Arlanda airport in Stockholm that cannot increase the number of flights since the CO_2 emission rights include the extensive airport connections by road transport.

An illustration: Port of Gothenburg

In 2007, Port of Gothenburg (PoG) handled 686 000 RoRo units in terminals at both banks of the river Göta that flows through the city. The dedicated RoRo freighters of shipping lines like DFDS Tor Line and Cobelfret call the terminals on the north bank, where also a substantial container terminal with a throughput of 841 000 TEU in 2007 is localised (Port of Gothenburg, 2008). Stena Line uses own terminals on the south bank for both dedicated RoRo freighters and ferries also carrying passengers. About 50 000 of the semi-trailers transported by Stena Line are transported via the conventional intermodal terminal in the city centre, about 5 kms from the docks, for rail transport throughout Scandinavia by CargoNet (Backman, 2008). The empirical analysis is, however, here delimited to on-dock rail at the north bank terminals, that accounts for just one third of the RoRo flows, but contains a larger share of unaccompanied semi-trailers and is more realistic for on-dock rail.

The total volume arriving by road via PoG and the RoRo terminals at the north bank is about 100 000 units for export and about 105 000 for import. The semi-trailers originate or have their final destination in one of 22 main regions, defined by PoG as the catchment area around a major intermodal terminal. The share of empties has not been obtained in the statistics in Table 2, but the work content for the ports and the sea and rail operators is basically the same for loaded and empty units.

	Export			Import		
Distance	Share of total semi-trailer volume	Number of regions	Average volume per region	Share of total semi-trailer volume	Number of regions	Average volume per region
0-150	54%	3	18 329	60%	3	20 758
151-250	25%	8	3 156	22%	8	2 890
251-400	12%	7	1 726	15%	7	2 210
>401	9%	4	2 302	3%	4	866
Total	100%	22	4 615	100%	22	4 742

Table 2. Semi-trailer volumes via the north bank terminals of PoG in 2006 (data from PoG).

The current container rail shuttle services annually move about 350 000 TEU with a turnover of about €60 million. As mentioned above, the system handles 40% of all containers to and from PoG. The cost saving for industry is about a 10% decrease of its transport costs, implying that the current rail shuttle system saves about €6 million in business economic costs annually. The system also relieves the streets of Gothenburg and decreases the emissions of CO_2 with about 42 000 tons every year.

Challenges for semi-trailers on rail

Some of the factors affecting hinterland rail transport of semi-trailers are picked up here in the empirical context of PoG. As shown above, there are 22 Scandinavian regions involved in the transport of semi-trailers but the flows are far from evenly distributed between them. For rail it is unfortunate that about 60% relates to the three closest regions. Although some of the container shuttles connecting PoG prosper at transport distances less than 150 kms, the closest distance range is here deemed to be virtually out of reach for semi-trailers on rail due to the semi-trailers' strict turn-around schedules. Nevertheless, one semi-trailer shuttle of just 50 kms was investigated in 2004 since the petrochemical industry in Stenungsund had to adhere to an emission cap when extending their production facilities (Bärthel, 2004), but the shuttle has not been realised. Lacking special conditions fostering the competiveness of rail on really short distances, the 100 000 semi-trailers transported further than 150 km should still be within competitive reach for rail.

A major drawback for on-dock rail is that the RoRo handling is not concentrated in one terminal as the container handling, but spread around the port area. This impedes the mix of containers and semi-trailer in the rail shuttle services, either the handling area in the port has to be designed for multipurpose handling or the set of wagons has to be separated into semi-trailers and containers. Both solutions require some investment, planning and movement between the terminals on road or rail. A less attractive, but more realistic, alternative is to have different rail shuttles for the different load units.

One major factor limiting the market potential of semi-trailers on rail shuttles to and from PoG is the lack of railway tracks. The Stena terminal was designed for easy access for passengers by public transport or own cars as well as for truck drivers, so there was little effort made to facilitate on-dock rail opportunities. There are no plans for future rail connections at the current site, but relocalisation of the Stena terminals is discussed. The tracks along the northern bank are also used by Volvo Cars and the port access track lack capacity for a significant increase.

Although most Swedish intermodal terminals can handle semi-trailers there is a technical and logistics barrier in the sense that far from all semi-trailers are fitted for vertical handling by gantry crane or reach-stacker, although even large-volume semi-trailers, so called mega-trailers, can now be moved by rail. Another technical barrier is the Swedish rolling stock, which except for the CargoNet fleet often is confined to carrying containers. Due to the current success of intermodal transport, the lead time for receiving new ones from manufacturers is very long.

Potential for a Scandinavian rail shuttle system for semi-trailers

The perspective of the rail shuttle system for semi-trailers is here widened by comparing road and rail in terms of cost efficiency and CO_2 emissions. The aim is to estimate the potential volumes and the relative financial and environmental performance of a full scale rail shuttle system for semi-trailers. Cost parameters are based on interviews with actors in the current rail shuttle system and from models and publications related to intermodal transport (e.g. Flodén, 2007 and Bergqvist, 2008). The evaluation of environmental performance is based on the method of "NTMCalc" which is developed by the non profit organisation The Network for Transport and Environment, focusing on establishing a standard for calculating environmental performance for different traffic modes (NTM, 2008). The method is in turn based on previous research regarding pollution and environmental impact of transport (e.g. Blinge, 1998 and Flodström, 1998) and continuously updated with new parameters from industry and academia in order to provide a contemporary evaluation tool.

The next step in the evaluation is to estimate the share of semi-trailer volumes that can be transferred from road. In the current container rail shuttle system there are profitable shuttles below 100 km. The nature of semi-trailer transport as elaborated upon above does suggest somewhat longer distances for profitability. In this paper we estimate a break-even point at 150 km. Given the fact that almost 100 000 semi-trailers are transported further than 150 km, there is a substantial potential incorporated into the market segment of semi-trailers on rail. Another positive aspect is that the geographic pattern of semi-trailer and container hinterland transport roughly overlaps. This implies synergies for co-loading both on pickups and delivery routes as well as between the terminals.

The potential performance and output of a semi-trailer based system is hard to estimate due to aspects of synergies and necessary infrastructure development at the endpoints of the rail transport. Given the assumption that necessary infrastructure development would be compensated with synergies from mixing containers and semi-trailers in the shuttles, the potential cost savings would be about 10% as in the current rail shuttle system. Addressing the market of distances further than 150 km implies that the system could transport about 80 000 semi-trailers annually. This would add an annual turnover of about €30 million to the current rail shuttle turnover, imply business cost savings of about €3 million and a reduction of CO_2 emissions with about 25 000-30 000 tons.

A third and equally important aspect of a semi-trailer rail shuttle system is the transport time. Much of the road infrastructure in central Gothenburg is strained and the congestion problems are increasingly severe. This is crucial for semi-trailers since the peak in demand for semi-trailers being delivered into the port coincides with the rush hours of cars. Rail transport would relieve the road infrastructure and foster a smoother flow of semi-trailers to and from the port. In summary, there is a great potential in a rail shuttle system for semi-trailers in terms of costs, transport time and environmental performance.

Conclusions

There are obviously large differences between container shipping and RoRo-shipping and, admittedly, rail is more competitive for hinterland transport of containers than of semi-trailers. Still there are significant opportunities for reaping the benefits of rail transport also for the large flows of semi-trailers to and from European ports and trends point in the direction of more semi-trailer trains. The empirical basis of this article is transport between PoG and its Scandinavian hinterland but the issue is highly relevant also for the UK with a similar mix of containers in deep sea and short sea shipping (mainly by feeders) and semi-trailers in short sea shipping. Yet, it is acknowledged that the UK has a significant disadvantage of its small rail loading profile impeding piggy-back with semi-trailers (Haywood, 2007), with restriction at some lines even for high-cube (9 ft 6 in.) maritime containers on standard rail wagons (Woodburn, 2006). Nevertheless, the high market penetration of semi-trailers in domestic UK road haulage, the increasing determination to fight climate change and the severe congestion situation on UK roads and tracks might foster investments in rail gauge increases or even all new rail lines.

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