VOL.IV No 3 DECEMBER 2007

JMR

JOURNAL OF MARITIME RESEARCH

Spanish Society of Maritime Research

VOL.IV N.3
DECEMBER 2007

JMR JOURNAL OF MARITIME RESEARCH

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UNIVERSITY OF CANTABRIA

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Layout: JMR

Printed bay: Gráficas Fisa, S.L.

ISSN: 1697-4840

D. Legal: SA-368-2004

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Journal of Maritime Research, Vol. IV. No. 3, pp. 3-16, 2007

ISSN: 1697-4840

INCREASING SAFETY OF NAVIGATION ALONG THE DANUBE RIVER

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Received 3 March 2007; received in revised form 8 March 2007; accepted 8 August 2007

Abstract

The rapid development of information technology has mirrored itself also in inland navigation. The technology developments cover all area of interest in inland navigation system, from electronic charts and modern standard of communications to the management of traffic and ports area management.

The Danube River is the largest and longest natural waterway of Europe, with a very important and strategic role in the EU policies for expanding a sustainable intermodal transport chain across Europe. Romania started a large scale project for modernization of the Danube navigation waterway in order to provide the needed infrastructure for the featured increase of traffic good between the North Sea and the Black Sea. The working load is focused on a 200 Km section of the Danube River, between Calarasi and Braila towns.

A team of researchers from our University had participated at the field inspections and evaluation for establishing the location of the traffic monitoring transponders and priorities of the working stages. The aim of this paper is to present the main technical problems that must be solved in the most difficult for navigation sectors of the Danube in order to increase safety of navigation and eliminate de natural bottlenecks.

Keywords: Danube River, Inland waters, traffic management, River Information System.

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INTRODUCTION

There is an increasing need for information exchange between parties in the inland navigation world. In particular, the exchange of traffic related information, dealing with safety, and transport related information mainly focused on efficiency, may benefit to actors involved in both types of activities.

During the last decades, a significant number of services and systems, dealing with vessel traffic and transport management, have been developed and some are in operation.

The inland waterborne transport sector is now faced with the challenge of integrating these building blocks into a common architecture that offers some degree of consistency and synergy across applications.

Comprehensive and international guidelines for River Information Services (RIS Guidelines) were needed, in order to harmonize the already existing river information systems and services.

These RIS Guidelines describe the principles and general requirements for planning, implementing and operational use of River Information Services and related systems. These RIS Guidelines are equally applicable to the traffic of cargo vessels, passenger vessels and pleasure craft.

In Romania, the RIS system will be implemented in short time, the project being financed by the Romanian Ministry of Transport, the IT infrastructure is provided by the Romanian Asesoft and UTI Groups and the VTMIS software will be make available by the HIT Traffic company from Holland.

The concept for Inland ECDIS has been developed in the German ARGO project in co-operation with INDRIS. The concept for RIS architecture has been developed by the WATERMAN thematic network, a research action under the 5th framework programme of the EU in the fields of VTMIS (maritime navigation) and RIS. Using these achievements, the RIS architecture has been elaborated comprehensively and in detail the R&D-project COMPRIS of the European Union in 2003.

THE ROMANIAN DANUBE RIVER INFORMATION SYSTEM (RIS)

Key functions of the Danube RIS

VTS centres for local traffic management by means of a tactical traffic image on shore will be established for the safety of navigation in difficult local situations and the protection of the surrounding human population and infrastructure from potential dangers of shipping. It emphasises on traffic organisation. The difficult local sectors may be:

(a) Narrow fairway and/or shoals
(b) Narrow bends
(c) Narrow and/or many bridges

(d) Fast water currents and/or cross currents
(e) Fairway with traffic regulations, e.g. one-way-traffic
(f) Conjunction of waterways
(g) High traffic density

The tactical traffic image (TTI) is produced by collecting shore based radar and vessel tracking and tracing information, and displaying the vessel information on an Inland ECDIS. The standards for Inland ECDIS and inland vessel tracking and tracing should be used. For a long river stretch and heavy traffic, the TTI may be enhanced by target tracking.

Navigational support is the generic term for some services to assist inland navigation.

In the traffic arena, navigational support is provided by pilots to prevent the development of dangerous vessel traffic situations on board or in special circumstances on shore. Nautical support is provided by tug boats or boatmen to assist in safe navigation and mooring. In the transport arena, *vessel support services* are services given to the skipper by e.g., bunker boats, waste oil removal boats, vessel equipment firms, and repair organisations.

RIS should optimise the traffic flow by:

(a) Support of the lock/bridge master in short term decisions for planning of the lock and bridge cycle by presentation of an electronic lock diary, by a database, and by registration of waiting times
(b) Support of the lock/bridge master in medium term decisions by data exchange with the neighbouring locks
(c) Support of the skipper by transmission of waiting times
(d) Optimising of lock circles by calculation of ETAs/RTAs for a chain of locks, transmission of RTAs to skippers

A vessel tracking and tracing system with a database and appropriate means of communication (e. g. VHF, GSM - voice and data) is recommended to be established in order to enhance lock and bridge planning.

In case of an accident, the RIS centre delivers the data without delay to the emergency services.

Depending on the risk assessment, a calamity abatement service may register only certain types of vessels and compositions or all vessels.

It should be the responsibility of the skipper to report the required data.

A ship reporting system with a database and appropriate means of communication should be established.

Position and sailing direction of the vessel should be reported:

(a) When entering or leaving the area of a RIS centre
(b) At specified reporting points within the area of the RIS centre
(c) When the data has been changed during the voyage

(d) Before and after stops of longer than a specific period

Logistic applications of RIS comprise:
(a) Voyage planning
(b) Transport management
(c) Inter-modal port and terminal management
(d) Cargo and fleet management

Voyage planning is the task of the skipper and the vessel owner. Voyage planning comprises the planning of the loading and the draught of the vessel, as well as the planning of the ETA and of possible loadings or unloading during the voyage. RIS should support voyage planning by

(a) Fairway information service
(b) Strategic traffic information
(c) Lock and bridge management

Transport management means the management of the transport chain beyond the scope of navigation driven by freight brokers and transport service quality managers. It is aimed at:

(a) Controlling the overall performance of the contracted fleet managers/skippers and terminal operators
(b) Controlling the progress in the contracted transports
(c) Monitoring unexpected threats for the reliability of these transports
(d) Finalising the transport (delivery and invoice)

The competent authorities should design their information systems in a way that the data flow between public and private partners is possible.

Communication and information exchange between private and public partners in RIS for logistic applications should be carried out according to the procedures and standards that are being agreed for RIS.

The competent authorities should provide ample room for logistics applications within the bounds of their possibilities, such as:

(a) The exchange of information between users and customers relating to vessels and terminals
(b) Fleet planning support
(c) ETA/RTA negotiations between vessels and terminals
(d) Vessel tracking and tracing
(e) Electronic market places

The competent authorities should indicate the data structure in use to application builders.

Implementation of Danube RIS system

In accordance with the Romanian and EU policies, implementation of the RIS System on the lower Danube started in 2004. Environmental impact assessment, model and field studies were performed between 2004 and 2006. Professors from Constantza Maritime University-College of River Navigation participated on the multidisciplinary teams that evaluate on the field the practical solutions for monitoring the Danube River traffic and to increase safety of navigation.

In accordance with the feasibility study findings, all the river and maritime ports along the Danube will have a number of 22 VTS local cells that will generate RIS inputs that will be collected in four VTMIS Regional Centers at: Tulcea and Galatzi dor the maritime Danube and at Giurgiu and Drobeta Turnu Severin for the middle part of the Danube River.

The first section of the system (Drobeta Turnu Severin area) was launched in 2005 and all the system will became fully operational in 2008, with a total cost of 4.600.000 €.

Based on an own development programme, VTMIS Transponder was designed by the Romanian UTI Group, manufactured and commissioned in less than 10 months by UTI research and development team, in compliance with the client's specific requirements.

VTMIS Transponder & Base Station are products dedicated to vessel monitoring on territorial waters, developed in compliance with the relevant international standards. VTMIS Transponder & Base Station have a very flexible implementation platform, which was especially designed so as to meet any naval operational needs. All system is based on AIS communication protocols.

Technical features of the equipment implemented on the Danube River, including Danube-Black Sea Channel

VTMIS Transponder works as a stand-alone equipment, with internal power supply using batteries with 48h autonomy and internal management of consumption regimes. Radio communication with Base Station are done on AIS frequencies , using FATDMA communication protocol with information updating each 3 seconds.

VTMIS Base Station provides full coverage for operation areas of VTMIS transponder equipment and communication with VTMIS transponder equipment on AIS frequencies. Using the same transponders, VHF communications with other Base Stations is enabled as well as format conversion and asynchronous channel and LAN transmission to the management software application and differential corrections for VTMIS transponder equipment.

MODERNIZATION OF THE LOWER DANUBE WATERWAY

Evaluation of the necessary measures for improving navigation on Danube in Romania, started with the most difficult sector on the Romanian Danube, respec-

tively between Calarasi and Braila (km 375 to km 170). This study was ordered by the Romanian Transport Ministry, ISPA Implementation Unit and was conducted by several interdisciplinary research teams, including professors from Constantza Maritime University, Faculty of Navigation and College for River Navigation.

The Danube sector which is the study subject is placed in south east of Romania and represents the last 200 km of Danube river navigation area. The sector analyzed is approximately situated between city of Calarasi in the upper part and city of Braila in the lower part. The sectors starts at km 375, located at 5 km upper of Borcea channel entrance, in front of Chiciu village on Romanian side and Silistra city on Bulgarian side. The studied sector ends at km 170, located on main Danube arm, right in the lower part of Cremenea Arm (main Danube arm) and Macin Arm confluence. As administrative the sector studied, km 375 to km 170, is placed inside or at the limits of Calarasi, Ialomita, Braila and Constanta regions.

The necessity of improving navigation on Danube River between Calarasi and Braila

Danube sector between Calarasi and Braila (km 375-km 170) is an important sector of the 7th Pan-European Corridor. At the same time this waterway ensures connection between Danube River with Danube-Black Sea Canal and Maritime Danube sector.

Recommendations of Danube Commission for Calarasi-Braila sector mention to have a navigational channel with minimal depth of 2.5 meters and a width of 150-180 meters.

On summer–autumn season, the water flows are considerable reduced in this sector, so the navigation conditions become very difficult.

As follow, on the main Danube arm, exactly downstream of km 346 on old Danube (Bala channel junction), the 2.5 meters reference depth is not assured for a period around 160 days each year, channel depth being reduced in some critical point up to 1.5-2 meters. Figure 1 shows the Danube River section between Calarasi and Hirsova, where the most critical points are concentrated (numbered from 1 to 10).

For this reason, during these periods, the navigation have to be deviated on the Bala-Borcea secondary route, where there are a higher water flow and depths are higher than Old Danube channel, but, navigation is more difficult because the waterway is narrow and with many curves.

Using this secondary route, the distance between Calarasi and Cernavoda becomes longer with 105 km for ship's intended to go or to come to or from Danube – Black Sea Canal. In the same time, as follow of reduced dimensions and sinuous way of navigation channel on Bala and Borcea channels, in some areas navigation can be done only on one way. More, larger convoys have to be broken and barges must to be passed one by one.

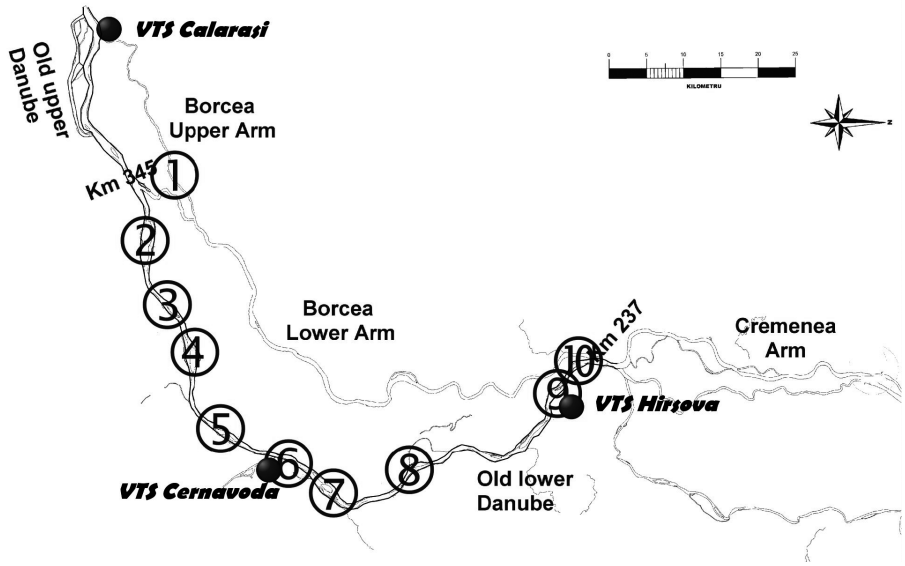

Figure 1. The most difficult sector of the Romanian Danube, between Calarasi and Hirsova, with ten critical points for navigation.

Therefore, the ship's carrying goods between maritime Danube ports of Braila, Galati, Tulcea or Ukrainian ports on Danube and Danube – Black Sea Canal or Constanta port, cannot be loaded at full capacity during 5 months annually.

This very unfavorable situation for navigation is caused in principal by morphological and hydrological phenomenons produced at Bala channel bifurcation (km 346) with following negative effects:

— Time evolution of water distribution between Bala channel and Danube River unfavorable for main channel of Danube – on way to Cernavoda, this taking only 20% to 40% of total flow during dry season.
— Constant degradation of Danube bottom (Cernavoda – Harsova – Braila sector), consequence of reduction of water current energy and low capacity to carry sediments, resulting in sand bank forming, secondary channels and continuously reduction of navigation channel section.
— Degradation of Bala channel together with shore constant damage follow the strong current.

These phenomena's are increased by the Parjoaia submersion rock, situated on right side of the river at km 347, inducing modification of flow direction to Bala channel.

Flows redistribution problem in Bala channel inlet area has been treated in many studies after for different scopes. Through international programme PHARE was realized a series of preliminary studies inside "Study for improvement of naviga-

tion on Danube in Bulgaria and Romania" programme, which final report was elaborated in 1999. This study analyzes the critical points for navigation on lower Danube, including Calarasi – Vadul Oii sector.

The new research study used the results and conclusions of study made in 1999 by Harris and others, and the problems were detailed and actualized, including development of a new mathematical model of flows. Is appreciate that this model will not modified conceptual the study solutions but will be able to provide dates for solutions ending. The final solution will show if the Parjoaia rock blow-up integrally or partially, represents the optimal solution for maintaining as long as possible the required depth of water.

Solutions for improving navigation on Calarasi – Braila Danube River sector

The on field measurments and mathematical model findings showed that in order to secure a fluent and low risk river navigation on the Calarasi – Cernavota – Hirsova – Braila route, a dregged fairway with a width of 180 meters and a minimum depth of 2.5 meters Mean Water Reference Level (MWRL) must be maintained. Assuming also an additional water depth of 0.5 meters to cover the first year sedimentary deposits – net dredging depth will be 3.3 meters MWRL for calibrate dredging.

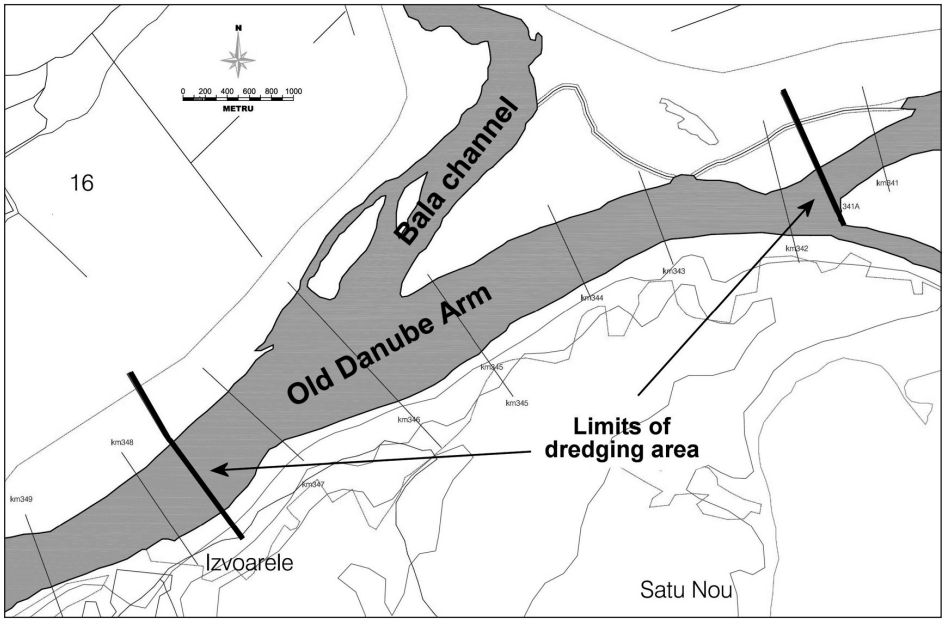

Figure 2. Area Turcescu-Bala, between km 341 and km 349.

In this paper we will discuss only four critical points, marked on the map from figure 1 as #1, #4 and #7.

Location #1 is known as Bala-Turcescu area and the Caragheorghe sandbar. A bottom pavement must be built on Bala channel at MWRL -1.85 meters and building bottom protection against erosion of the pavement on a distance of 300 meters downstream. Additionally on the Bala channel a conduct dyke must be build up to projected level of MWRL +5 meters and upstream to the limit bottom protection of the pavement. Shore defenses for the head of Turcescu Island protection and hydro technical constructions for water flow regularization are also needed at the Bala inlet (see figure 2 and figure 3).

Locations of other working areas for dragging operations are related to other critical points for navigation around Epurasul, Seica, Ceacaru, Tiu, Fermecatu, Fasolele islands. Supplementary constructions will be definited as position and solution after detailed study on water flow mathematical model and sediments carriage on analyzed sector.

Annual dredging operations for maintenance on upper part of Borcea channel to assure navigation to Calarasi port and for local traffic will be a constant operation along this part of the Danube.

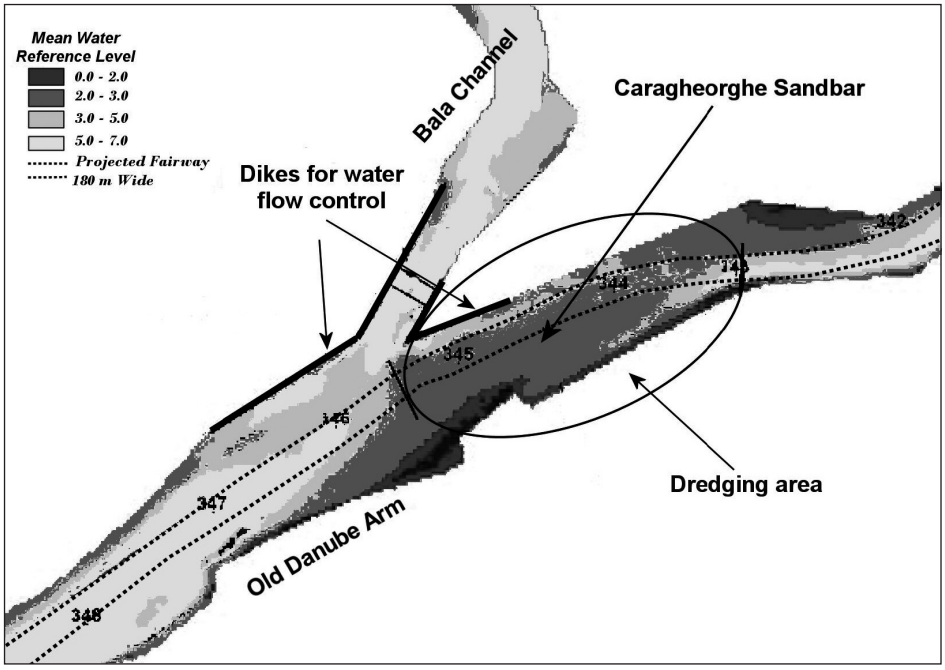

Figure 3. Area Turcescu-Bala, actual depth of water expressed as MWRL

Regarding proposed solutions for improvement of navigation conditions on studied sector Calarasi – Braila dredging operations for navigational channel calibration will have to be done in other nine locations, identified as critical points (figure 1). These locations are:

— location # 2 – Lebada, km 341-336;
— location # 3 – Mirleanu, km 329-325;
— location # 4 – Fermecatu Island (upper and lower part), km 323-318;
— location # 5 – Cochirleni, km 310-307;
— location # 6 – Cernavoda, km 297-296;
— location # 7 – Fasolele Island, km 292;
— location # 8 – Alvanesti, km 276;
— location # 9 – Harsova, km 250;
— location # 10 – Giurgeni, km 245-242;

Figures 4 and 5 depicts the geographical and hydrographical situation around Fermecatu Island (location #4).

The dredging volumes are important for channel calibration, these volumes are appreciate at 585,167 – 1,181,039 sqm, the difference represented the volume of dredging operations to deepen the channel from 2.50 meters to 3.50 meters.

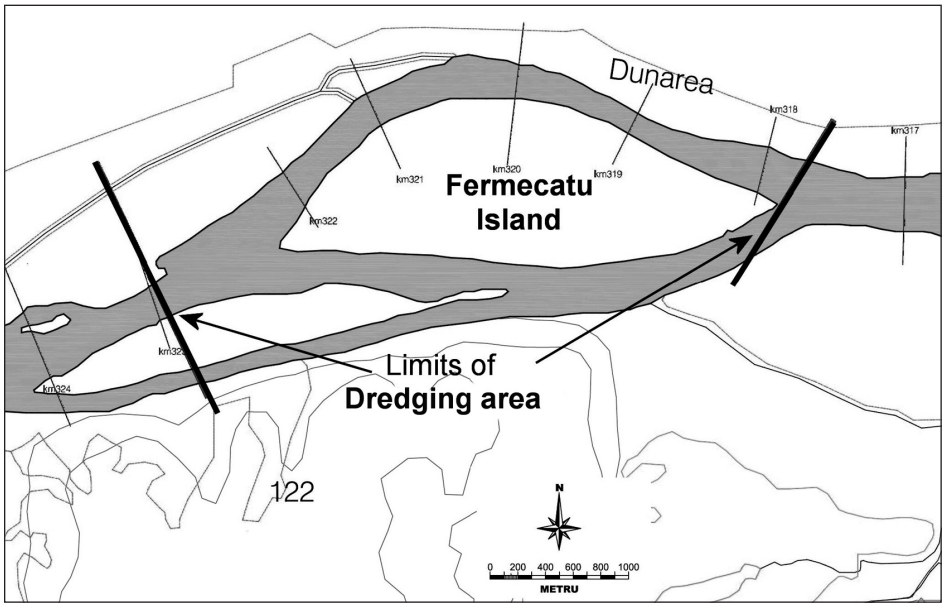

Figure 4. Area Fermecatu Island, between km 317 and km 324.

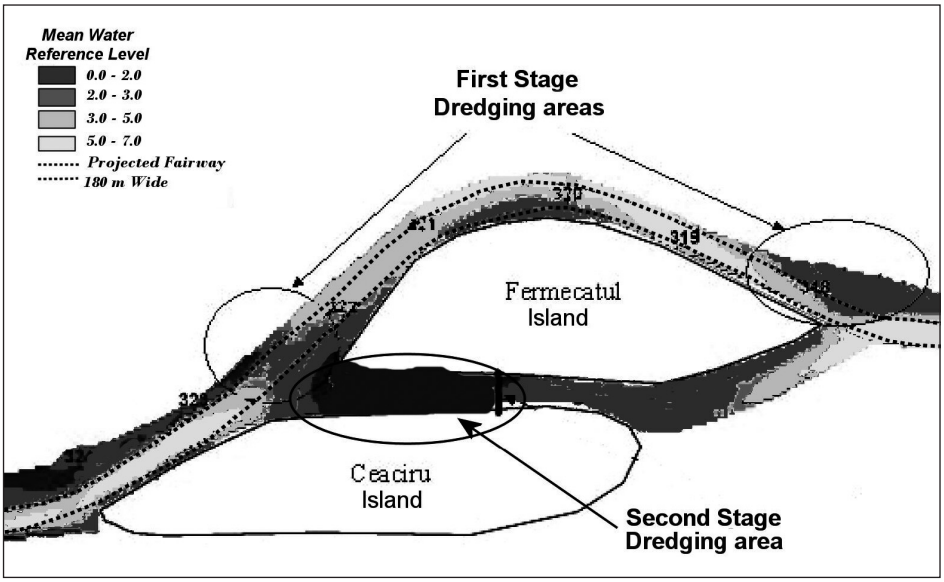

Figure 5. Area Fermecatu Island, actual depth of water expressed as MWRL.

The volume of maintenance dredging is appreciate to be 350,000 cm per year. Dreg material is formed by fine sand generally and medium sand as subsidiary. This material is characterized by a low pollution potential, his storage on shore or in water doesn't create pollution problems.

According with the last study appreciations (including Harris and others), through these hydrographic works will provide all the required water volume on Danube during the period of low flows, necessities represented by navigation, irrigation, water supply and cold system with water for Cernavoda nuclear power plant.

Regarding consolidation/defenses shore projects, the research included solid defenses projects, with special elements for protection, only in sectors with special critical risks. Are considered in this category that shore areas where the errosion process is very active and present a real danger for important economic and environmental objectives. In total, shore defenses are stipulated for around 4000 meters length. Dike's totally length is around 1700 meters and of the bottom sills around 1900 meters.

CONCLUSIONS

River navigation on the Danube is regaining the primary role played before the starting of the war in former Yugoslavia. Increasing of cargo flow along all parts of the Danube is a direct consequence of the transport policies promoted by EU and designation of the Danube River as the 7th Pan-European Transport Corridor.

Romanian governmental authorities are trying to recover the delays in modernization of the Danube river navigation infrastructure and multimodal transport facilities, in order to eliminate the natural bottlenecks along the river and to increase the cargo operation capacities of the river ports.

In our paper we underlined the last investments and research done for increasing safety of navigation along the lower Danube. These activities were focused on two main directions:

— Traffic management and monitoring, using latest technological facilities for implementation of the VTMIS system;
— Dredging and hydrographic construction work for rehabilitation of the navigation fairway at a uniform standard of 150-180 meters wide and at least 2.5 meters depth of water, all over the year.

Regarding the VTMIS system, it will become fully operational in 2008. Based on AIS technologies, it will cover almost all the length of the Danube River, focusing on the ports area and the most difficult navigation sectors.

On field evaluation and research analysis, including mathematical flow models, were used to establish the best actions to de done for creation and maintenance of the navigation waterway at the prescribe parameters. These type of civil engineering works are concentrated in the Calarasi – Hirsova sector, on the old Danube arm. Importance of this sector is increased by the inbound/outbound traffic of the Danube-Black Sea channel, the short route that could connect the maritime ports from the Romanian Black Sea with the North Sea ports.

Electronic navigation charts for the Romanian Danube were also produced. The only practical problem that still must be solved is related to the continuous update of these charts, in accordance with the day by day water level. This problem will be solved using also the VTMIS capabilities, that include monitoring and data collection from automatic water level sensors.

In parallel with the hydrographic construction work on the ten critical point located between kilometers 107 and 375, installation of new and modern navigation aids will start for marking the safe navigation waterway.

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Journal of Maritime Research, Vol. IV. No. 3, pp. 17–36, 2007

ISSN: 1697-4840

SHIPPING AIR? TRACKING AND FORECASTING THE GLOBAL SHIPMENTS OF NEW AND USED CARS

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Received 16 March 2007; received in revised form 30 March 2007; accepted 15 August 2007

Abstract

Flows of new cars span the globe, using dedicated car carriers carrying up to 6,500 cars. A more recent development involves the shipping of used cars. This paper presents the results from our research around the world, featuring Japan as a major used car supplier, while more recently, South Korea has emerged as a significant player. As production is increasingly localised, flows of new vehicles are declining; used vehicle flows are seen by some shipping lines as a market opportunity to improve vessel utilisation and enhance margins. Future trends will be driven by newly motorising markets. Although these could absorb considerable volumes from the established industrial countries, some governments are placing restrictions on such imports. The shippers' side has seen consolidation in recent years, as well as vertical integration. Shippers serving used car flows have split into those that have become more specialised, and those engaged in more informal flows using cars as backloads on reefers, fishing vessels, container ships and general cargo ships. The vessels themselves have seen a trend away from pure car carriers (PCC) towards more flexible pure car and truck carriers (PCTC). This in turn is also having a wider impact on shipping logistics.

Key words: Shipping, logistics, car shipping, used cars.

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INTRODUCTION

This paper is based primarily on the findings of a field-survey of new and used car movements carried out during 1998 and 1999 and subsequently updated on a regular basis using the contacts and sources tapped into at that time. The field-research was global, but focused particularly on Europe, the Far East, Australasia and North America; it is the first time such an exhaustive survey on used car shipping has ever been carried out. Use was made of published data, interviews, first-hand field observations and informal information as appropriate. As a combination of published and unpublished material was used, it is not always possible to quote sources of certain information; this is especially true of used-car movements which are in many cases very profitable, somewhat informal and therefore rather jealously guarded; also reliable data are not always available on these. A central thrust of the research is to examine ways in which used-vehicle shipments may be used to complement the mostly larger volumes of new vehicles as a means of gaining economies of ship-space utilisation. A summary of findings from the original study was published in 2002 (Beresford et al. 2000), while an updated abridged version was presented in 2006 (Beresford et al. 2006).

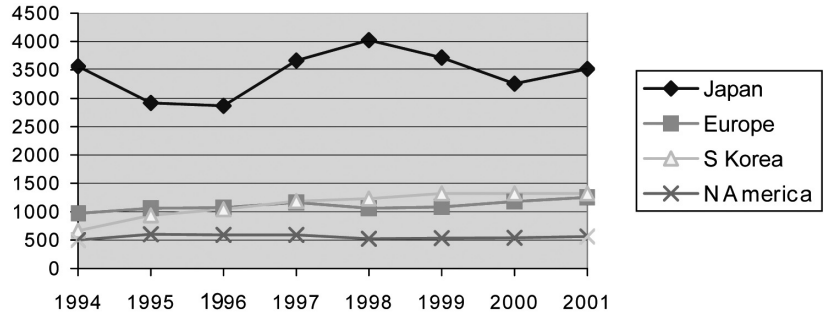
Car manufacturers still rely very heavily on shipping. Dedicated car carriers carry between 2,000 and 6,500 tightly-packed cars across the seas, depending on the type of vessel used. The smaller vessels are largely employed for shorter haul and coastal routes, while the larger 4000-6500 car vessels are used on intercontinental deep sea routes. Not surprisingly, several car makers have become intimately involved in vehicle shipping and distribution themselves, e.g. Toyota through their Logistics Services division (Drewry, 2006). Some still have close links with fleets of car carrying vessels, with several plants located on the quayside for direct loading. Others subcontract to specialised shipping firms such as MOL or WalleniusWilhelmsen (see for example, Coia, 2007). Cars are one of the few cargos that can move themselves. This allows the use of dedicated roll-on, roll-off (RO-RO) car carriers.

Margins are often larger on used vehicles than on new units, but volumes are smaller. Used vehicle flows can provide ideal make-up cargo, or in some cases, return loads. In both situations, the used vehicles could then become critical to a line's overall ship utilisation and, by implication, profitability. During the 1990s and early 2000s, global trade in new and used vehicles grew faster than either new unit production or consumption. This happened despite the huge shifts in production capacity under 'localisation' strategies, aimed at producing vehicles in 'transplant' facilities nearer to their markets, by principally – though not exclusively – the Japanese and Korean vehicle manufacturers. This move towards 'transplanting' had been in evidence in other industrial sectors for several decades (Dickens, 2002; Lee, et al., 2006). European transplants in North America were also increasingly evident during this period. This development was due to two key features (Wells & Nieuwenhuis 2005):

— Despite the shifts in global production capacity, there remained considerable structural imbalance in terms of supply and demand, most obviously with Japanese and Korean supply capacity vastly exceeding domestic demand;
— Vehicle manufacturers adopting policies whereby certain production locations became the global source for a product, rather than making all products in all regions, thus necessitating exchanges of certain vehicles between production sites and markets.

Evidently, the main structural cause of new car shipments remains the high level of production in the Asia-Pacific region - just over 23 million units for 2004 (ANE 2005, 6) compared with sales of about 16.8 million units. In practice, by far the most dominant source in terms of shipping new cars remains Japan because both China and India, as far less mature economies, are modest importers and almost non-existent exporters. South Korea is recovering its global exporting position through its sole surviving independent car maker, Hyundai-Kia-Asia and now General Motors (GM) -owned Daewoo, while modest exports by Samsung-Renault have only just begun (Stein, 2006a,b). Equally, by far the dominant destination region is North America, principally the US. This is a very important market for new cars produced in Japan, South Korea and Europe despite investments by firms from those regions in productive capacity in North America and despite the huge home supply. Exports from the main exporting markets are shown in figure 1.

Figure 1: New Car Exports by Source Region 1994-2001 (000s of units).



Source: Beresford et al. 2002

Clearly, in view of the investments involved, shifts in automotive production tend to be of a long-term character (Nieuwenhuis & Wells 1997; Herfort, 2002 a,b). Moreover, the ways in which individual companies choose to use the capacity available to them will vary from case to case. Note that the introduction of one really successful model can have a significant impact on overall shipping figures, as it 'stimulates' a given market and in some cases supports it almost single-handedly.

Table 1: Worldwide New Car Transport Volume

Year	1998	1999	2000	2001	2002	2003	2004	2005*	2006*	2007*
1000 Units	7,107	7,792	8,602	8,454	8,890	9,627	10,734	11,105	11,575	12,050
% change	n/a	+9.6	+10.4	-1.7	+5.2	+8,3	+10.5	+3,5	+4.2	+4.1

*** estimate **forecast**

Source: adapted from NYK Factbook 2005.

USED CARS

Exports of used cars and commercial vehicles have grown steadily over the past two decades or so (Beresford et al. 2006). Although overall volumes are still lower than new car flows, they are not that far behind and still rising. Industry sources suggest that the number of used vehicles moved by ship is now around three million units per annum, although statistics are not centralised if they are recorded at all (Lloyd's List 2005). Used car flows do not fit comfortably with the larger new vehicle movements in that flows are in most cases quite different in terms of both volume and geography. There are no official figures for the total number of used cars shipped around the world, but judging from our field research and from the limited published figures available, it is clear that volumes are increasing quite rapidly despite the constraints of import restrictions in a number of countries. The main flows of used cars go:

— From Japan/Korea to Asia-Pacific (Vietnam, New Zealand, Russia, Sri Lanka, Bangladesh, etc),
— From Japan/Korea to South and Central America (mainly west coast – Peru, Chile for transit, Costa Rica),
— From Japan/Korea to the Middle East/Mediterranean (Gulf, Cyprus, Pakistan),
— From Japan/Korea to Africa,
— From Japan to Ireland/UK, from US/Canada to Central America/Caribbean, and
— From US/Canada to the Middle East (Gulf, Saudi).

Other routes are mainly overland with some minor shipping flows, e.g. from the USA to Mexico, or from Dubai to Iraq, Iran and Pakistan, Western to Eastern Europe and from the Gulf to East Africa and other areas. In addition to Japan, South Korea emerged as a key source country in the late 1990s, exporting some 87,000 used cars in 1998, mainly to SE Asia, Latin America and oriental Russia (Beresford et al. 2000). More recent developments in this market are explored below. As a level of market saturation has been reached and consumers increasingly favour new over used vehicles, the South Korean market has begun to generate levels of surplus used cars of good quality in volumes similar to those seen leaving Japan perhaps

ten years earlier. In recent years, many cars have also been exported from the European Union to East and Central Europe, where there is considerable demand for good used cars and where EU entry has forced the lifting of bans on used imports – e.g. in Poland (Drzewiecki et al. 2006).

Prestige marques such as BMW and Mercedes-Benz are also shipped in large numbers into Middle East hubs such as UAE ports (Beresford et al. 2000). This disguises final destinations for these cars in markets such as Iraq, Iran, and particularly Pakistan, which are substantial markets for Japanese, Korean and European vehicles. Flows from Europe to Africa are even longer established, using both land and sea routes. The signs are that both the push and pull factors in these trades will grow with positive consequences for shipping volumes, although the volatile nature of these trades makes a flexible and adaptable approach to shipping essential. French vehicles – especially Peugeot – have long been exported to West Africa via import gateways such as Abidjan and Dakar, as well as being transported overland, often by private individuals from the EU (Beresford et al. 2002).

JAPAN

Japan's post-war economic miracle is nowhere more evident than in the country's volume of vehicle exports (Dicken, 1999). In around fifteen years, from the early 1960s to the late 1970s, Japan rose from its position of minor player to world leader by number of units exported; of necessity, all went by sea (Table 2). This is marked by a peak in total vehicle exports and truck exports in 1985 of 6,730,472 units and 2,238,104 units respectively. Car exports peaked in 1986 at 4,572,791, while buses/coaches peaked in 1992 at 75,046 units. After this, localised production near recipient markets caused a gradual reduction in the proportion of vehicles shipped from Japan itself. Recent years have seen a slight recovery as demand increases from newly motorising markets, particularly in the Far East.

Japanese used vehicles are exported in very large numbers, reflecting their durability and acceptability in almost all parts of the world, irrespective of the apparent disadvantage in most regions of their right-hand drive configuration. In 2004, Japan officially exported 837,782 used vehicles (source: Jumvea), in 2005 the official figure was 940,000 (JAN 2006) and in 2006, the million unit barrier was reached (JAN 2006b). Of these, the largest recipient markets were Oceania – primarily New Zealand -

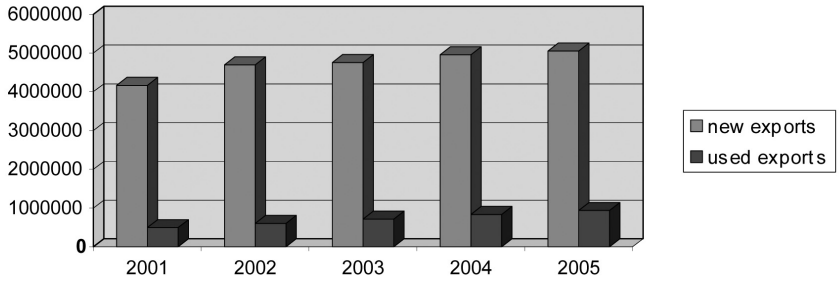
Table 2: Japan's New Vehicle Exports 1950-2005.

Year	Cars	Trucks	Buses	Total
1950	7	5,409	93	5,509
1960	7,013	31,028	768	38,809
1970	725,586	351,611	9,579	1,086,776
1980	3,947,160	1,953,685	66,116	5,966,961
1990	4,482,130	1,309,121	39,961	5,831,212
2000	3,795,854	617,870	41,163	4,454,887
2005	4,363,168	611,956	77,937	5,053,061

Sources: JAMA Motor Vehicle Statistics, JAN 2005 and 2006.

other Asian markets, Middle East and Europe respectively (see Tables 2 and 3). It is likely that unofficial figures are in fact even higher. Traditionally, Japanese car buyers have tended to replace their cars in line with the very severe periodic test, the '*shaken*' vehicle inspection. This is due when the car is three years old, then at five years old and then every two years, so next at seven years old. It is these five and seven year peaks that have fed the used export market in the past.

Fig. 2: Japan: New and Used Vehicle Exports



(Source: adapted from JAN 2006)

Used trucks – shipped in far smaller quantities than cars – head mostly for the Gulf for onward distribution via ports such as Dubai and Jebel Ali. Other major Japanese used commercial vehicle markets include the Philippines, South Africa, Singapore, Sri Lanka, Pakistan (via UAE), North Korea, and again, Russia and New Zealand (see table 3). Singapore is perhaps unusual in that it acts as a distribution hub for trucks (over 10,400 in 2004), but it is comparatively unimportant for car movements (around 2,700 the same year) and buses (only 24 in 2004). Field evidence confirms that specialist vehicles such as cranes and trucks are sufficiently durable to last several decades, become war-damaged in some cases, and still remain exportable (Pettit et al. 2005).

Japanese used exports appear to constitute around 30% of global used vehicle exports, if the industry estimate of around three million used units shipped annually is correct (Lloyd's List, 2005). With another 300,000 units leaving South Korea every year, these two Asian countries combined account for perhaps 40% of world total used vehicle shipments. On the whole, used cars tend to be shipped from ports that also ship new cars. Virtually all the major automobile ports (about twenty in number) are located in a belt located across southern Japan. Road transport is often slow and very expensive in these countries so each port tends to serve a captive hinterland; this further solidifies the already close relationship which exists between specific assembly plants and specific ports. At import gateways, especially in Europe, several thousand new vehicles sit adjacent to several hundred used units at any one time. This has stimulated revised terminal configurations in some cases. New port

investments around Saint Petersburg, for example, have been made partly on the basis of used vehicle flows (World Cargo News 2006).

Table 3: Principal markets for Japanese used vehicles 2004

Recipient market	buses	cars	trucks	total
UAE	2433	103,912	32,758	144,103
New Zealand	1299	124,384	9,368	135,049
Russia	17	111,132	11,025	122,174
UK	21	56,868	221	57,110
South Africa	1676	28,074	8,154	37,904
Philippines	531	21,247	11,160	32,938
Chile	616	23,842	2,962	27,420

source: JUMVEA

Technical aspects of the vehicles themselves may also influence used markets. Japanese home market vehicles are right-hand drive (RHD). This theoretically limits exports in the first instance to the 50 RHD markets around the world, as against the 143 left-hand drive (LHD) markets. However as we see in the case of Peru, for example, LHD conversions can be cost-effective in some cases, while other LHD markets will accept RHD cars. The fact is that Japanese cars, trucks and other vehicles are accepted and respected worldwide for their quality and durability, and are attractive for conversion, or for driving as seen.

SOUTH KOREA

Perhaps inspired by its larger neighbour, the Republic of Korea has become a major exporter of used vehicles in its own right, especially in the past few years (Table 4). In fact, the majority of used vehicles are now exported from the country, rather than remarketed or recycled internally (Kim, 2007). According to the latest information, on average by 2006 this had grown to around 1 million units a year, leaving only around 500,000 end-of-life vehicles for the conventional dismantling and recycling system (Kim 2007). This requires further investigation, as the large difference between this figure and the previous – official – data in Table 4 implies this marks a dramatic increase. In reality we may be dealing with a discrepancy between official and unofficial figures. Kim (2007) studies this issue from the point of view of vehicle dismantling, shredding and recycling, rather than vehicle trades and as a result may well have unique access to real flows on the ground, beyond the control of customs officials. Experience in Japan in the 1990s suggests, official and unofficial figures can diverge considerably (Beresford et al. 2002). We intend to carry out further investigation into this recent rise in Korean used exports. In any event, and in view of the fact that South Korea is effectively an island, these units provide good business for shipping companies.

One of the main reasons for the marked increase seen in recent years is the growth in demand from the Russian market, which was worth US$45 million in 2004, this compares with a German market worth only $13 million in the same year.

The UAE is also growing strongly, although this is mainly as a hub for onward shipping to other Middle East markets, as well as Pakistan and parts of East Africa. The main recipient regions for Korean used vehicles are the Middle East, with 236,000 units in 2004, Asia with 51,000 units, Europe (mainly Russia) with around 10,000, Latin America with 15,000, while other markets took some 8,000 (Korea Customs Service, 2005).

Table 4: South Korean Used Vehicle Exports 2002-04

Year:	2002	01/02 %	2003	02/03 %	2004	03/04 %
Value in MUS$	358	+5%	468	+31%	793	+69%
1000 units	133	+10%	184	+38%	320	+74%

Source: Korea Customs Service, 2005; note values are quoted for point of export.

The high levels of shipments into Jordan and Costa Rica are largely due to the fact that these markets act as local distribution hubs for used cars. Jordan provides transit into other Middle East markets, such as Iraq and Syria. Costa Rica feeds wider Latin American markets in Central and northern South America, as well as the smaller Caribbean markets. In Germany, used Korean 4-wheel drive sport utility vehicles (SUVs) are highly prized, while in recent years both Jordan and Syria are benefiting from a boost in transhipments to Iraq (Beresford et al. 2006).

Table 5: Korean Used Vehicle Exports by Country (ranked by 2004 US$ value)

Country	2002	2003	2004	% change 03-04
Jordan	63,679	167,216	301,082	+80
Vietnam	125,985	121,111	156,127	+29
Russia	9,629	18,000	45,151	+151
Sudan	15,224	26,845	41,101	+53
UAE	1,194	15,097	33,431	+121
Philippines	27,920	13,972	21,845	+56
Costa Rica	27,967	18,138	18,724	+3
Syria	160	4,507	15,115	+235
USA	13,220	13,096	13,340	+2
Germany	183	473	12,931	+2632
Others	72,425	69,921	134,556	+92
TOTALS	US$ 357,586	US$ 468,378	US$ 793,407	+69

Source: Korea Customs Service, 2005.

Used Korean vehicles are now to be found in almost as many countries as are used Japanese vehicles, as respect for them grows and as repair and maintenance capabilities become embedded.

NEW ZEALAND

The world's largest single recipient market for used cars is New Zealand. Imports of used cars from Japan grew steadily here from a mere 2,000 in 1981 to an impressive 124,000 by 2004 (Beresford et al. 2006). This compares with a new car market of only 75,000, with new sales increasingly confined to official and fleet purchasers. Many shippers use reefer vessels used for exporting crops such as kiwifruit and then bring back used cars as a backload. The prominent role of New Zealand has led to a number of local shippers taking on a key role in the trade and shipping of used cars. This business generally suits the more entrepreneurial shipping companies with the necessary flair and flexibility. Kiwi Car Carriers (KCC) was set up formally in the mid 1990s, but had been operating vessels for some years from New Zealand to Japan (Beresford et al. 2002; www.kiwicar.com). They are part of the Windward Passage group, based in Japan. Ships are chartered, mainly from agents in Greece and for many years also from Hyundai Merchant Marine (HMM). Shipments contain used vehicles exclusively, with some crashed cars also brought in for parts. However, KCC have carried out some new car contracts from Korea and Japan to Australia. On these they mixed loads, carrying Daewoo and some Hyundai on behalf of other shippers. New Zealand dealers were among the first to buy used vehicles directly via online auction sites which allow them to see cars and commercial vehicles being auctioned in Japan on-screen. They can then bid for these online. The vehicles are shipped via local agents and specialist carriers, such as KCC.

VEHICLE SHIPPING

Market demand for car shipping is still high and exceeds the supply of vessels (Coia, 2007). Although shipping companies are building new vessels, demand is becoming uncertain because of the growing role of transplants – factories established by Asian manufacturers near their western markets, and Europeans in North America. Other factors include economic fluctuations, while opportunities for cross-trading are increasing in the used car market. The effects of these factors are that future sailing patterns need review and that relationships between companies may need to be developed so as to make the best use of the available vessels. It is thus essential to build flexible portfolios of geographic scope, capacity and capabilities – the latter both sea-borne and on-shore (Nieuwenhuis 2001). It is expected that EUKOR who are currently building new vessels - partly to further enhance their presence in the market - will become big cross traders as they will have over 80 vessels available. Some of this new building will be used to replace vessels which are currently older than 15/20 years and will soon be scrapped, although at present their capacity is still needed to meet demand (Nightingale 2005).

As is the case in other sectors such as container shipping (see, for example, Araujo et al. 2003), car carrying capability is concentrated into a relatively small – and shrinking as a result of consolidation – number of large or very large operators

(see Table 6). This reflects both the needs for economies of scale – translating into global service provision – and the greater bargaining power available to bigger carriers who need to interface with ever larger consolidated automotive groups. Nearly 90% of deck-metres and 87% of vessels are owned by the top seven operators (Araujo et al., 2005).

Table 6: Major Operator Ranking 2004

Ranking	Operator	Vessels	%	Capacity (cars)	%
1	NYK Line	80	17.8	383,740	18.4
2	EUKOR	72	16.0	335,102	16.0
3	"K" Line	63	14.0	294,446	14.1
4	Mitsui OSK Lines	63	14.0	287,718	13.8
5	WalleniusWilhelmsen	48	10.7	263,450	12.6
6	HUAL	33	7.3	169,816	8.1
7	Grimaldi	31	6.9	120,504	5.8
	Others	60	13.3	235,549	11.3
	TOTALS	450	100	2,090,355	100

Source: Lloyd's List, 2005.

The practice of "feedering" via hub ports may increase as operators try to match supply and demand and try to allocate vessels of different sizes to different markets (Coia, 2007). A number of major ports are competing for hub status since car trades provide considerable opportunities for value added activities in hub ports stemming from economies of aggregation. With regard to maximising load factors, although a number of lines definitely do not mix new and used vehicles on the same vessel (or if they do, it happens very rarely), other lines are happy to mix shipments (Herfort, 2002b). Some car manufacturers insist on single make loads and resent seeing their new cars 'devalued' by mixing new with used cars. Used cars, however, tend to be more profitable for the shipping firms, who anyway want to maximise their capacity utilisation. In their effort to maximise capacity utilisation while at the same time taking the opportunity to exploit the dynamics of the market, the carriers have adopted somewhat different strategies (Lloyd's List 2005). Some of these can be summarised as follows:

MOL:

— Enlarge the fleet to 90 modern vessels by 2009.
— Pursue an 'aggressive growth' strategy with pure car and truck carrier (PCTC) expansion as the main focus.
— Develop its 'Four Continents' service (this covers South Africa, Europe, US East Coast, Mexico and South America East Coast).

NYK:

— Match vessel capacity to demand as closely as possible
— Focus on the larger 6,000-6,500 unit vessels
— Develop hub and spoke distribution

WalleniusWilhelmsen:
— Offer regular services on key routes
— Match capacity to demand
— Keep flexibility of schedules and vessel deployment to handle peaks and troughs

UECC:
— Expand services and increase geographical coverage
— Make key investments in land facilities
— Develop IT systems to improve vehicle monitoring within the supply chain
— Focus on tracking, tracing and performance data

K Line:
— Build on rapid growth of 2003-5 by deploying four or five new vessels per year to refresh the fleet
— Upgrade North and South Atlantic services
— Develop North Atlantic Shuttle (NAS), link with short sea KESS network for Baltic/Scandinavia
— Expand pre-delivery inspection (PDI) and logistics services in Asia/Australia

EUKOR:
— Strengthen the fleet
— Upgrade services, e.g. by shortening lead and response times
— Manage steady growth by deploying three to four new vessels per year

It is interesting to note that no line is explicitly targeting the growing volumes of used vehicles as a means to balance flows or raise average load factors. It has been demonstrated that, in general, used vehicle movements do not fit comfortably with the pattern of outbound new vehicle flows or with return ballast legs (Beresford et al. 2002). However, as volumes of shipped used vehicles – especially cars – rise, it is likely that critical volumes are reached on an increasing number of routes with the result that this grey trade (organised outside manufacturers' official distribution networks) will be taken into account more and more in the lines' route development strategies. Until then, this at times lucrative trade is left to smaller, more specialised, more flexible, and perhaps more entrepreneurial operators.

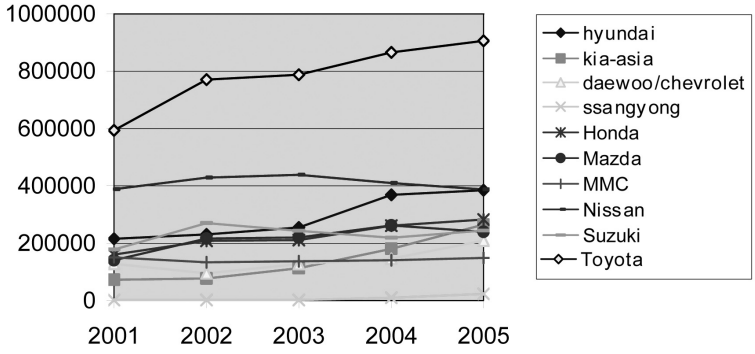
FUTURE PROSPECTS

New Vehicles Manufacturers

Significant changes to the volumes of new cars shipped seem imminent. Although much of Japanese close-to-market production is now in place through their transplant facilities in Europe and North America, they are still expanding, with new capacity in Eastern Europe and China (Nikkei Weekly 2006). For South

Korean car makers, this transplanting trend is only just beginning (Kia, 2006). Having seen their European sales rise markedly in recent years, much of this rise in Eastern Europe, Korean manufacturers are now building European plants to localise production (Phillips, 2006). Figure 3 shows European sales increases by Korean manufacturers in recent years compared with their Japanese rivals. It is evident from this that between 2001 and 2005, the Koreans more than doubled their sales in Europe. These figures include the EU members and the countries of East and Central Europe, as well as Turkey, but they exclude Russia. However, an increasingly market-driven Russia is becoming a significant sump for Korean products, welcoming new and used imports as well as locally assembled Korean cars. Daewoo's Nexia and Hyundai's Accent were among the top five sellers in Russia in 2005 (Stein and Smolchenko, 2006; Smolchenko 2007).

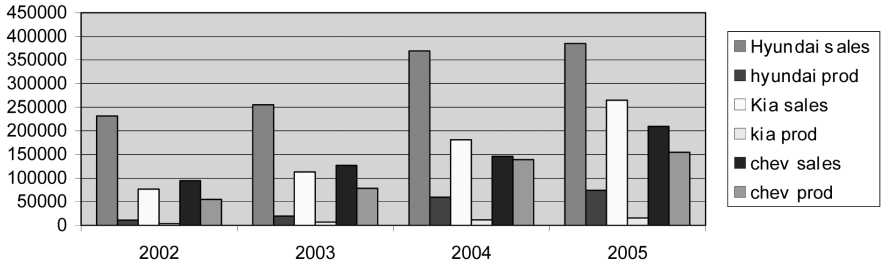
Fig. 3: Korean and Japanese Car Makers' Sales in Europe 2001-2005 (units)



Source: JATO Dynamics, reported in Automotive News Europe, 2005.

Russian assembly of Hyundai vehicles exceeded 40,000 in 2005 while 16,000 Kias were assembled (Stein and Smolchenko, 2006). These numbers are set to rise steeply over the coming years, and it already helped Hyundai fortify its position as best selling foreign brand in Russia. As part of their expansion strategy, Korean car makers have also been localising production elsewhere in Europe. This trend was started by Daewoo in Eastern Europe well before these countries started to join the EU. Although not all of Daewoo's production and assembly capacity in the region was retained by GM when it bought the remains of Daewoo in 2002, the now re-branded Korean Chevrolet division retains significant production capacity in Europe, including joint ventures in Russia (Storey, 2003). In addition, both Hyundai and Kia have new capacity in Central Europe, adding to assembly capacity Hyundai had already established in Turkey. As a result, a growing proportion of the Korean vehicles sold in Europe are also assembled in Europe. This trend is outlined in figure 4.

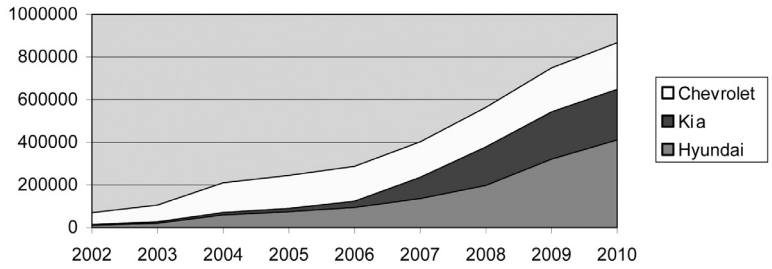
Fig. 4: European Sales and Production Korean Manufacturers (units)



Source: adapted from J D Power, 2005.

Once the new Hyundai and Kia facilities in central Europe are fully operational, the proportion of vehicles produced locally will increase further. J D Power forecasts indicate that combined Hyundai and Kia production will reach over 600,000 units annually by 2010, as outlined in figure 5 (Power, 2005). These figures also include production in Russia where GM is opening a Chevrolet assembly facility. There is existing production in the region by Chevrolet-Daewoo via ZAZ in Ukraine. Kia is building a plant in Slovakia, while Hyundai is planning a facility in the Czech Republic. A side effect of this localisation of production of low cost new cars may be a depressing effect on imports of used vehicles. This could have implications for shipments of used cars into the region, although current trends suggest both new and used can still be absorbed by these central and East European markets in some numbers, with non car-making countries, such as Bulgaria, happy to keep their borders open to used imports (Frink, 2006).

Fig. 5: European Production Forecast Korean Manufacturers to 2010 (units)



Source: adapted from J D Power, 2005.

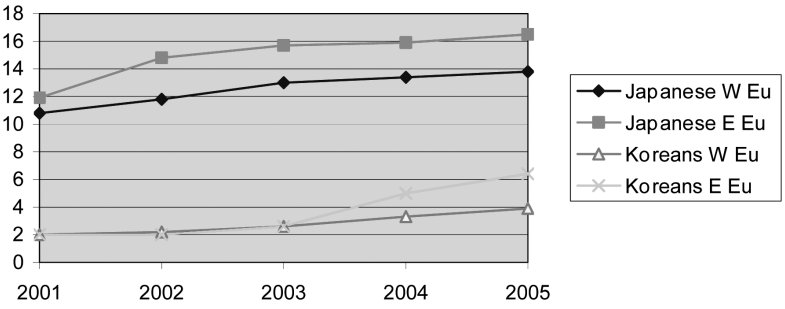
Hyundai and its Kia affiliate now consider Europe an essential part of their global strategy. Hyundai has announced that it is aiming to become Europe's second best selling Asian brand after Toyota, thus displacing Nissan, with sales of 800,000 vehicles a year by 2010 (Stein 2006a). Hyundai's sister brand Kia, meanwhile, has announced it aims to sell half a million vehicles in Europe by 2010 (Stein 2006b,

Phillips 2006). Although these targets may be somewhat overambitious, it is a clear indication of the firms' intentions. Hyundai's success in recent years is due in no small part to chairman Chung Mung-Koo's determined quality drive (AFP, 2007). European buyers have responded to this.

Ssangyong sales have also increased since the firm once again became separated from Daewoo. Now owned by Shanghai Automotive Industry Corporation (SAIC) of China, its new range of SUVs has been well received in markets such as Germany both as new and used vehicles. Renault-Nissan is also set to contribute to the Korean expansion in Europe by importing SUVs from their Samsung division (ANE, 2007). Export volumes of Samsung cars are very small at present, but planned production increases may push the firm beyond what the home market can absorb and exports may then increase further, although regional markets such as China, Philippines, Indonesia or Vietnam are likely to be targeted well before Europe. In any event, shipping will play a key role in the supply-chain.

In a saturated market such as Western Europe, such sales increases must be at the expense of others. At present this does not appear to be most of the Japanese makes, which have also shown growth. Instead, it appears that European mainstream brands have suffered most, whereby a certain amount of 'cannibalism' within GM between Daewoo-Chevrolet and Opel/Vauxhall cannot be ruled out. However, the key battleground is probably Eastern and Central Europe. Here, Daewoo established a Korean presence years before EU membership of key markets in the region, notably Poland and Romania, and this Korean presence has been maintained in East and Central Europe's markets so far. Japanese players have also managed to retain an advantage in the area, as outlined in Figure 6.

Fig. 6: Japanese and Korean Market Shares in Eastern and Western Europe 2001-2005 (%)



Source: adapted from J D Power, 2005.

It is clear that price and a newly expanded dealer network –particularly for Kia– are key elements in the Korean expansion in Europe. Low labour costs in Central Europe will also become a key element. Labour costs in Slovakia are now significantly lower than in Korea itself. Although labour costs represent only about 8-12%

of the ex-works price of a car, operating margins in volume car making are such today, that apparently small differences can easily determine whether a particular model is viable or not (Nieuwenhuis and Wells, 1997; Haglund, 2001). Add to this the cost of shipping, and the economics of building in central Europe look even more attractive. The closure of west European plants and the continuing trek eastwards by European and 'westwards' for US manufacturers are part of the response to the new competitive advantage Koreans and Japanese will be enjoying in central and Eastern Europe in the next few years as their new facilities come on stream.

Vehicle Shipping

The likely effect of this branch-planting on shipped volumes from Korea is clear. Any Korean car sold in Europe that is built in Europe is not shipped from Korea. With Korean production capacity likely to reach a level close to half typical European market demand by 2010, new car shipping volumes from Korea to Europe will be much reduced, unless the ambitious sales projections of Korean manufacturers are realised. It is possible, however, for some cross shipments of models between Korea and Europe to occur. This would involve small volumes of models built only in one location, or for which there is a temporary shortage in another location, even though it may also be built there – the local plant may be operating at capacity, for example. Alternatively unique models may be built in each location with cross-shipments used to supply each market with the full range, sourced from different manufacturing locations. This is already happening to some extent in the case of the Japanese (see below), as well as Americans and Europeans. This would not be sufficient to sustain current new car shipping volumes from Korea. Similarly, although more mature, Japanese shipments are likely to change in nature. Japanese production in the EU and adjacent countries is still increasing as new investments are coming on stream. This has the effect of both reducing shipments from Japan, and increasing shipments of some models from Europe to other markets. Honda already imports some models from the US, rather than Japan, while Suzuki has in the past imported some cars from India, another flow that is likely to grow. On the other hand, inland shipping of cars along the Danube and Rhine is likely to show further growth; there are already early signs of this trend, due in part to increased pressure on land and rail-based car transport capacity (Ricciuti 2006, 2007).

With used vehicle markets and residual values increasingly being manipulated by the car manufacturers and their agents, the desire to push older cars from the developed markets will become stronger. This desire will grow once the implications of the European End of Life Vehicle (ELV) directive begin to bite. For the manufacturers in Europe, the ELV responsibility will be growing steadily over the next decade, while similar legislation is being implemented in Japan and Korea (Kim, 2007). Despite some scope for sales of used parts, the recycling of cars is only mar-

ginally economic, and working under the threat of a return to the depressed scrap steel prices of the turn of the century, if steel demand from China falls. In this context, exports of older cars, as well as used parts for older cars to less demanding markets may well come to be seen as an easy option, as it is already in Japan and South Korea. Long distance movements, e.g. to Africa, the Middle East and Latin America will invariably require maritime transport and a number of shipping lines are well-positioned to capitalise on these flows with ballast running for at least part of their return leg. More locally, there are significant flows of used cars from Western Europe into the new EU member states in the East, notably Poland where used imports in the first nine months of 2006 alone reached 574,405 units, despite imaginative taxation regimes designed to control this trade (Drzewiecki and Gronkiewicz 2006; Drzewiecki et al. 2006). Although driving vehicles eastwards to satisfy this demand is often the logical solution, short sea shipping also plays a major role, specially in and around the North Sea and the Mediterranean (Beresford et al., 2002). The Baltic is also playing a growing role as a conduit for used car shipments (World Cargo News, 2006).

CONCLUSIONS

It is clear that the stable, established flows of new cars from Asia to Europe and North America are declining as production is localised in these recipient markets. We have seen this trend for the Japanese and it is clear that the same is now happening for the Korean manufacturers. Instead, much more complex flows of new cars will emerge with smaller shipments from producing emerging markets to recipient emerging markets, combining with shorter routes from established manufacturing locations – notably Japan and South Korea – to such emerging markets, particularly in Asia. From the shipping lines' point of view, cautious optimism is probably the most accurate stance to take; on mainstream routes (Japan/Korea to Europe and the US and intra-Europe) projected volumes will remain high and the key challenge will be matching vessel deck-metres to demand. Off these main routes, dexterity will be called for, in order to cope with complex hub and spoke networks and less predictable long-run demand. In any event, concentration of shipping capacity into fewer larger companies is likely to continue for the foreseeable future, but emerging markets coule offer opportunities for lines to hedge (spread their risk) or build new revenue streams.

Other specific flows will involve specialist cars such as Mercedes or BMW shipped from established manufacturing locations to emerging markets, as well as mature markets (e.g. the UK market has already been supplied with BMWs and VWs sourced from South Africa). A fresh flow of new vehicles may well emerge from China to serve world markets with cheaper cars assembled at low-cost plants. Chinese manufacturers have ambitions to export to Europe and North America, but

as yet their quality and safety do not match expectations in these mature markets (Bolduc, 2006; Webb, 2006; Bursa, 2007). This is likely to be overcome by about 2010-2015 when flows of cheaper Chinese cars will start moving around the world. It will be some time before these are replaced by local manufacturing nearer the recipient markets. In the interim there could well be a decline in global new vehicle shipping volumes as Japanese and Korean production, still dominant as the source of new units distributed worldwide by sea, is localised and before significant Chinese exports begin.

Used vehicle shipments are likely to increase with the growth of emerging car markets and the increasing number of push-factors (classically legislation on environment, safety and quality) in developed markets such as Japan, South Korea and the EU. However, questions are beginning to be asked about the ethics of this trade in the longer term which could be seen as a form of 'environmental dumping' (Nieuwenhuis and Wells 1999). On the one hand, some markets may get better cars than they would otherwise have had and the cars' total life-span is extended. On the other hand, this could be portrayed as yet another attempt by the 'North' to offload an environmental problem onto the 'South', allowing manufacturers to carry on under an unsustainable 'business as usual' scenario. Facing up to reality is then left to the next generation of car bosses. All in all, the global used car trade provides a promising business opportunity, particularly for flexible and entrepreneurial companies on land and at sea, but also one that may increasingly require careful political and public relations handling, as well as clever route, fleet and logistics management.

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Journal of Maritime Research, Vol. IV. No. 3, pp. 37–53, 2007

ISSN: 1697-4840

A FREIGHT TRANSPORT DEMAND MODEL TO EVALUATE POLICY ACTIONS FOR SHORT SEA SHIPPING IN SICILY

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Received 30 March 2007; received in revised form 11 April 2007; accepted 20 August 2007

ABSTRACT

This research aims at developing a modelling tool to predict the impact of different policies on the modal split of the freight transport demand in Sicily (in particular, road versus short sea shipping). To gain this objective, a random utility model, precisely a *nested logit* one, has been formulated and estimated trough a *stated preference* (*SP*) survey which has involved about 40 road-based freight transport Sicilian firms. The resulting demand model has been applied to forecast the modal split scenarios deriving from several projects regarding the Sicilian freight mobility system (some projects are public plans and other ones are proposed by the authors).

Keywords: freight transport demand in Sicily, short sea shipping, logistic terminals, random utility models, *stated preference* surveys.

INTRODUCTION

The sea-road intermodality development in Sicily is hindered by the critical condition of the regional port system, that can be ascribed to the following weak points:

— The most important ports are placed in congested urban areas, thus suffering from limitations on their development;

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— The most important port nodes show low degrees of accessibility (conflict between the truck traffic and the private car one);
— Low levels of automation for port functions.

Furthermore, statistical data from the port authority of Palermo, which has a leading role in the sea-road intermodality market, highlight that, in the last years, the use of semi trailers in Ro-Ro freight transport has shown a 30% incidence, which implies a wide range of potential improvement in terms of efficiency. This critical aspect can be related to the following findings of a survey on the Italian road freight transport sector, conducted by a division of the Trucker National Register, in 2000 and 2004: the Sicilian road transport market is characterized by a great presence of small-sized enterprises (≤ three vehicles), which represent about the 68% of the whole sector; moreover, in about the 86% of the cases, the operators aren't included in unions; it follows that their propensity to technological innovations is very low.

The above-explained considerations have induced the authors to build a modelling tool for supporting the Sicilian policy of short sea shipping by simulating the Ro-Ro market shares stemming from several projects, some of which are public plans, while other ones are proposed by the authors.

SURVEY OF LITERATURE

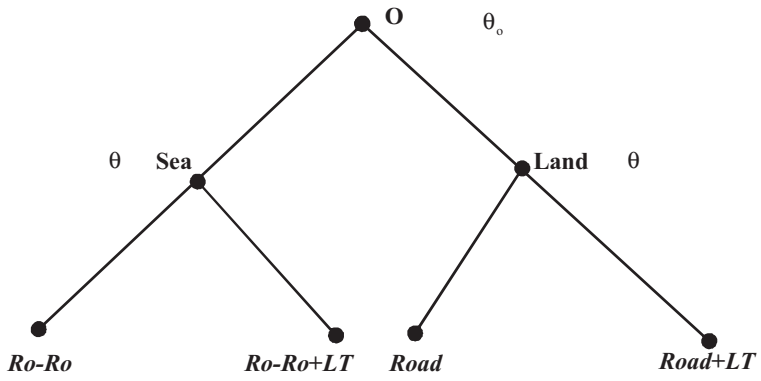
The study under consideration rests on the literature about freight transport demand modelling, with respect to the mode choice simulation. In particular, the aforesaid research focuses on *consignments models*, which can reproduce the transport mode choice process, carried out by a producer or a shipper for a single consignment, by applying the *random utility theory* (Ben Akiva and Lerman, 1985; Ortùzar and Willumsen, 1994). Furthermore, a contribution has derived from the current of research on the estimation of the above-mentioned demand models trough *stated preference* data (Bolis and Maggi, 1999; Bolis and Maggi, 2002; Cascetta et al., 1996; Danielis and Rotaris 1999; Danielis and Rotaris 2002; Fowkes and Shinghal; Fridstrom and Madslien, 2002; Maier and Bergman, 2001; Mangan et al., 2002).

MODEL FRAMEWORK

As stated before, the authors' aim consists in developing and calibrating a *nested logit* model, through a *stated preference* survey, to simulate the mode choice of sicilian freight transport operators (in particular, road versus short sea shipping), allowing for the possibility of demanding the utilities supplied by logistic terminals, that are on the agenda of regional policy makers (Dipartimento Trasporti e Comunicazioni della Regione Sicilia, 2003)[1]. In detail, the resulting decision-making process has been represented according to a sequential approach: there is a first stage of choice

between the "Sea" option and the "Land" one; at the second step, under the two above-mentioned cases, the decision maker consider the possibility of using a logistic terminal (see Fig. 1).

Fig. 1: Modal split model structure



θ_o: parameter determining the variance of the first decision-making step error term ("Sea" versus "Land");
θ: parameter determining the variance of the second choice level error term.

To model Sicilian truckers' choice behaviours, the following explanatory variables have been introduced: door to door transport service price (Cost); travel time (Time); service frequency (Freq); risk of delay (Delay); risk of damage for goods (Damage) and a dummy variable for the logistic terminal case (LT). So, the perceived utility functions associated with the four alternative modes of transport can be expressed as follows:

$$U_{Ro-Ro} = V_{Ro-Ro} + \varepsilon_{Ro-Ro} = V_{Ro-Ro} + \eta_{Sea} + \tau_{Ro-Ro/Sea} \quad (1)$$

$$U_{Ro-Ro+LT} = V_{Ro-Ro+LT} + \varepsilon_{Ro-Ro+LT} = V_{Ro-Ro+LT} + \eta_{Sea} + \tau_{Ro-Ro+LT/Sea} \quad (2)$$

$$U_{Road} = V_{Road} + \varepsilon_{Road} = V_{Road} + \eta_{Land} + \tau_{Road/Land} \quad (3)$$

$$U_{Road+LT} = V_{Road+LT} + \varepsilon_{Road+LT} = V_{Road+LT} + \eta_{Land} + \tau_{Road+LT/Land} \quad (4)$$

$$V_{Ro-Ro} = \beta_T \cdot Time + \beta_C \cdot Cost + \beta_F \cdot Freq + \beta_D \cdot Delay + \beta_{DA} \cdot Damage \quad (5)$$

$$V_{Ro-Ro+LT} = \beta_{LT} \cdot LT + \beta_T \cdot Time + \beta_C \cdot Cost + \beta_F \cdot Freq + \beta_D \cdot Delay + \beta_{DA} \cdot Damage \quad (6)$$

$$V_{Road} = \beta_T \cdot Time + \beta_C \cdot Cost + \beta_F \cdot Freq + \beta_D \cdot Delay + \beta_{DA} \cdot Damage \quad (7)$$

$$V_{Road+LT} = \beta_{LT} \cdot LT + \beta_T \cdot Time + \beta_C \cdot Cost + \beta_F \cdot Freq + \beta_D \cdot Delay + \beta_{DA} \cdot Damage \quad (8)$$

Where, considering j = "Ro-Ro", "Ro-Ro+LT", "Road", "Road+LT" and K = "Sea", "Land":

— U_j: perceived utility if a shipment is carried out by mode j.
— V_j: systematic part of .
— ε_j: random part.
— η_K: random error associated with composite alternative K.
— $\tau_{j/K}$: random error associated with alternative j.
— $\beta_T, \beta_C, \beta_F, \beta_D, \beta_{DA}, \beta_{LT}$: coefficients.
— Cost: transport service price (10^3 euros).
— Time: travel time (hours).
— Freq: service frequency binary variable (1: high; 0:low).
— Delay: risk of delay binary variable (1: high; 0:low).
— Damage: risk of damage for goods binary variable (1: high; 0:low).
— LT: dummy variable for the logistic terminal case (1 if a logistic terminal is used; 0 otherwise).

Under the *nested logit* framework, in the different cases, the probability of choosing a mode of transport can be written as follows:

$$p\left[Ro-Ro\right] = p\left[Ro-Ro/Sea\right] \cdot p\left[Sea\right] \quad (9)$$

$$p\left[Ro-Ro+LT\right] = p\left[Ro-Ro+LT/Sea\right] \cdot p\left[Sea\right] \quad (10)$$

$$p\left[Road\right] = p\left[Road/Land\right] \cdot p\left[Land\right] \quad (11)$$

$$p\left[Road+LT\right] = p\left[Road+LT/Land\right] \cdot p\left[Land\right] \quad (12)$$

The complete formulation of the mode choice probability is showed below only in relation to the Ro-Ro alternative, since it presents the same structure for the various options:

$$P_{Ro-Ro} = \frac{\exp(V_{Ro-Ro}/\theta)}{\exp(V_{Ro-Ro}/\theta)+\exp(V_{Ro-Ro+LT}/\theta)} \cdot \frac{\exp\left\{\delta \ln\left[\exp(V_{Ro-Ro}/\theta)+\exp(V_{Ro-Ro+LT}/\theta)\right]\right\}}{\exp\left\{\delta \ln\left[\exp(V_{Ro-Ro}/\theta)+\exp(V_{Ro-Ro+LT}/\theta)\right]\right\}+\exp\left\{\delta \ln\left[\exp(V_{Road}/\theta)+\exp(V_{Road\ LT}/\theta)\right]\right\}}$$

$$\delta = \theta/\theta_o \tag{13}$$

In order to calibrate the above-explained demand model, an *SP* survey has been carried out. The *SP* technique is a market research survey tool to analyse individual preferences towards completely new products or services and those factors affecting the demand of existing goods, in relation to which no set of *revealed preference data* (*RP*) is available. In more detail, such a method consists in the presentation to individuals of imaginary situations (although realistic) characterized by the availability of several choice options (described by quantitative and qualitative attributes), among which respondents can be asked to choose the most preferred alternative. So, an *SP* experiment permits the researcher to quantify the impact on preferences of each attribute (*main effects*) and of the most significant interactions between attributes, that can be defined as the effects of two or more factors which, when acting together, produce an influence different from the sum of the their individual effects.

The attributes selected for an *SP* survey vary according to a pre-specified set of levels (e.g. different values of a price). The set of choice scenarios deriving from all the possible combinations of the attribute levels is named *full factorial design*; when its size becomes high, respondents will experience fatigue in doing the choice exercises. The scientific literature (Cascetta, 2001; Ortùzar and Willumsen, 1994; Louviere et al., 2000; Permain and Swanson, 1991) suggests several approaches (*experimental design* techniques), to reduce the number of scenarios to be presented to the decision makers, that can be employed in conjunction with each other.

One of the most used methods is the *block design* one requiring the division of the choice set (*full factorial design*) into sub-sets (blocks) that are submitted to different groups of respondents drawn from the sample. The technique under consideration is to be performed in the following way: a *block variable* (corresponding to an interaction between two or more attributes) is selected and the scenarios are divided into as many clusters as the levels of the *block variable* (low/high). The researcher can also use different *block variables*; in this case, the blocks are formed according to the interaction of the *block variables*[2]. Such a procedure leads to blocks with choice scenarios showing, for each attribute, the low level as many times as the high one and, for every interaction between any two attributes, the concordance case (low/high level for both items) as many times as the discordance one (low level for an attribute and high level for the other one).

To achieve the same outcome, one could apply another widely adopted approach, that is the *fractional factorial design* one. It rests on the assumption that some or all interactions between attributes are negligible, since the scientific literature (Cascetta, 2001; Ortùzar and Willumsen, 1994; Louviere et al., 2000; Permain

and Swanson, 1991) states that, in practise, *main effects* explain the largest amount of variance in response data, 80% or more. Under this method, the number of choice exercises can be reduced by making the levels of some attributes correspond to the ones of interactions between the remaining factors (the most important ones), whose levels are drawn from a *full factorial design* built by excluding the attributes to be confounded with interaction terms[3].

APPLICATION

The levels of the mode choice attributes

The levels of the explanatory variables, selected to investigate the choice behaviour of road-based carriers, have been determined by a data set concerning a sample of origin-destination links involving Sicily. In particular, a comparison between the road mode and the Ro-Ro one has been effected in terms of travel time and transport monetary cost, with respect to freight traffic from/towards Sicily (generators/attractors: Trapani, Caltanissetta, Ragusa) towards/from Northern Italy (attractor/generator: Milano), Central Italy (attractor/generator: Perugia), Southern Italy (attractor/generator: Potenza).

Such an approach has implied a high degree of realism for the choice scenarios submitted to the sample of Sicilian truckers. In more detail, the estimations executed to construct the afore-said data set are based on the following assumptions and information:

- the average transport monetary cost, in the case of the road mode, is 1.354 euros per truck-km (source: Trucker National Register, 2005); it has been turned into euros per ton by a load factor of 17.5 tons per vehicle.
- To calculate the travel time, in the case of the road mode, the authors have adopted mathematical formulations taking account of the national regulations on the driving time[4] (Torrieri et al., 2002).
- A nationwide survey by the authors has pointed out that a break-bulk terminal can produce a 40% rise in load factors. Furthermore, the average price for transhipment has been estimated at 2 euros per ton and the waste of time at the terminal is 4 hours under normal conditions.
- A recent study by the authors on the Sicilian ports has revealed that the average time for loading trucks is 4 hours, in the case of a cargo consisting of trucks, semitrailers and private cars.
- As for Ro-Ro routes, the main destination ports are Genova (Northern Italy), Civitavecchia (Central Italy), Napoli (Southern Italy), while the origin is the port of Palermo. In addition, data provided by shipping companies have been considered to evaluate the sea transport service cost[5] and the travel time.

— To take into account the scarce accessibility of Italian ports, the speed of trucks on the way linking the generic origin (destination) with a port has been set at 50 km/h.
— The cost of crossing the Straits of Messina (about 50 euros) is equal to the one of the berth for the driver, as a consequence, they have not been considered to compare the road mode with the Ro-Ro one.

Table 1 presents the levels of the attributes selected for the SP survey.

	ΔT * (hours)	**ΔC ** (euros)**	**Service Frequency**	**Risk of Delay**	**Risk of Damage**
Levels	5	-200	Low	Low	Low
	7	-500	High	High	High
	9	-800			
	11	-1000			

* Gap in terms of travel time between a transport mode and the "road" option.
** Gap in terms of monetary cost between a transport mode and the "road" option.

SP experiment design

To design an *SP* experiment, the scientific literature (Cascetta, 2001; Ortùzar and Willumsen, 1994; Louviere et al., 2000; Permain and Swanson, 1991) requires two levels for each attribute; therefore, both variable ΔT and variable ΔC has been broken up into two elements ($\Delta T_1, \Delta T_2, \Delta C_1, \Delta C_2$), each one of which is characterized by two levels determined so as to obtain every level of the original factors by any pair of the component variables' levels (to be summed up). The choice scenarios that can be constructed by combining the shown levels with each other are 128 (the number of levels raised to the power of the number of attributes): a choice set that can't be proposed to a decision maker; so, they have been reduced to two blocks of 8 choice exercises, to be presented to two different groups of respondents, through the joint use of the two beforedescribed *experimental design* techniques. In particular, at a first step, a *fractional factorial design* of 16 choice scenarios has been gained by making the levels of the service frequency, the risk of damage for goods and the risk of delay correspond to the ones of interactions between the other attributes[6], according to the following relations:

$$Freq = (\Delta T_1,\ \Delta T_2) \tag{14}$$

$$Delay = (\Delta T_1,\ \Delta C_1) \tag{15}$$

$$Damage = (\Delta T_2,\ \Delta C_2) \tag{16}$$

At a second stage, the *fractional factorial design* of 16 decision contexts has been subdivided into two blocks of 8 choice exercises, by using as *block variable* the interaction between ΔT_1, ΔT_2, ΔC_1, ΔC_2. The final output is reported in Tables 2, 3.

Table 2: First block of choice experiments submitted to Sicilian truckers

	ΔT (hours)	ΔC (euros)	Service Frequency*	Risk of Delay*	Risk of Damage*
Block I	11	-1000	1	1	1
	11	-200	1	0	0
	9	-400	0	1	1
	9	-800	0	0	0
	7	-400	0	0	0
	7	-800	0	1	1
	5	-1000	1	0	0
	5	-200	1	1	1

* 0: low level; 1: high level.

Table 3: Second block of choice experiments submitted to Sicilian truckers

	ΔT (hours)	ΔC (euros)	Service Frequency*	Risk of Delay*	Risk of Damage*
Block II	11	-400	1	1	0
	11	-800	1	0	1
	9	-1000	0	1	0
	9	-200	0	0	1
	7	-1000	0	0	1
	7	-200	0	1	0
	5	-400	1	0	1
	5	-800	1	1	0

* 0: low level; 1: high level.

A step further has consisted in matching each of the above-showed decision contexts with the closest one belonging to the data set employed for identifying the attribute levels, so as to present comparisons between specific modes of transport to Sicilian truckers, thus building the choice scenarios around the existing respondents' experience.

Features of the sample

The sample selected for the *SP* survey consists of 33 road-based freight transport Sicilian firms, whose representatives have been involved in face-to-face interviews. About the 51% of this group refers to small-sized firms with a number of available vehicles inferior to 10, whereas the 49% is represented by enterprises with more than 10 vehicles (only the 9% relates to operators owning at least 100 means of transport).

Model estimation

As stated before, the Sicilian haulers' preferences have been modelled by a *nested logit* formulation. In detail, the resulting decision-making process has been represented according to a sequential approach: there is a first stage of choice between the "Sea" option and the "Land" one; at the second step, under the two above-mentioned cases, the decision maker consider the possibility of using a logistic terminal. To estimate the model parameters, the authors have adopted the Alogit 4.2 software processing 264 choice observations. Table 4 shows only the coefficients of the utility

Table 4 : The nested logit model for Sicilian carriers' mode choices (Rho-Squared = 0.571).

Attributes	Coefficients	Standard Error	T Student
Time (hours)	-0.094	0.030	-3.1
Cost (10^3 euros)	-1.577	0.519	-3.0
Damage (1/0)	-0.715	0.268	-2.7
LT (1/0)	1.122	0.425	2.6
Variance, θ	0.912	0.367	2.5

function attributes that have proved statistically significant.

The resulting value of time is about 60 euros per hour; this output is validated by a recent European scale survey (CSST, 2005) on the road freight transport hourly cost (toll, fuel consumption, wear and tear on tyres, maintenance, depreciation, taxes), which for Italy reports the value of 67.8 euros per hour.

Model-based analysis of various policy action scenarios on short sea shipping

The calibrated *nested logit* model has been applied to the west side of Sicily to evaluate the effectiveness of various planning scenarios in favour of *short sea shipping*.

Tables 5a, 5b, 5c: Sicilian truckers' mode choices if Sicily were provided with logistic terminals.

O-D Link: Caltanissetta - Milano (Northern Italy)					
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}^*
Ro-Ro	31.36	1.08	0	0	20.93%
Ro-Ro+LT	35.36	1.01	0	1	48.96%
Road	24.28	2.00	1	0	5.02%
Road+LT	28.28	1.46	1	1	25.09%
O-D Link: Caltanissetta - Perugia (Central Italy)					
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}^*
Ro-Ro	25.96	1.09	0	0	15.88%
Ro-Ro+LT	29.96	0.97	0	1	40.38%
Road	18.91	1.45	1	0	8.76%
Road+LT	22.91	1.04	1	1	34.98%
O-D Link: Caltanissetta - Potenza (Southern Italy)					
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}^*
Ro-Ro	23.96	0.87	0	0	8.60%
Ro-Ro+LT	27.96	0.79	0	1	20.50%
Road	7.94	0.87	1	0	17.59%
Road+LT	11.94	0.64	1	1	53.32%

* model-based choice probability.

In detail, with respect to different connections between Sicily and the rest of Italy, whose origin is the Sicilian province of Caltanissetta (selected owing to its barycentric position), travel times and monetary costs of the several transport modes have been estimated. Firstly, the model has been employed to predict the choice behaviour of Sicilian haulers in case Sicily were provided with logistic terminals:

As the reader can observe in Tables 5a, 5b, 5c, with regard to the Sicily-Northern Italy traffic, the model has pointed out that the 70% of the operators would opt for the Ro-Ro transport and, amongst these ones, the carriers demanding the services of a logistic terminal would correspond to the 49% of the whole sector; furthermore, in the remaining 30% of the cases, for the most part (25%), freight would be transported by road and handled by a logistic terminal; consequently only the 5% of the total would choose the traditional road-based mode. In the

Tables 6a, 6b, 6c: Truckers' mode choices in case the port of Palermo accessibility were improved.

O-D Link: Caltanissetta - Milano (Northern Italy)						
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}*	Difference**
Ro-Ro	30.86	1.08	0	0	21.20%	0.27%
Ro-Ro+LT	34.86	1.01	0	1	49.59%	0.63%
Road	24.28	2.00	1	0	4.87%	-0.15%
Road+LT	28.28	1.46	1	1	24.34%	-0.75%
O-D Link: Caltanissetta - Perugia (Central Italy)						
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}*	Difference**
Ro-Ro	25.46	1.09	0	0	16.18%	0.30%
Ro-Ro+LT	29.46	0.97	0	1	41.14%	0.76%
Road	18.91	1.45	1	0	8.55%	-0.21%
Road+LT	22.91	1.04	1	1	34.13%	-0.85%
	O-D Link: Caltanissetta - Potenza (Southern Italy)					
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}*	Difference**
Ro-Ro	23.46	0.87	0	0	8.86%	0.27%
Ro-Ro+LT	27.46	0.79	0	1	21.13%	0.63%
Road	7.94	0.87	1	0	17.37%	-0.22%
Road+LT	11.94	0.64	1	1	52.64%	-0.67%

* Model-based choice probability.
** Computed in per cent points, with regard to the reference scenarios of Tables 5a, 5b, 5c.

case of links between Sicily and the other areas (Central and Southern Italy), for the use of a logistic terminal, the estimations show a global incidence of 70-75%; on the contrary, the role of the Ro-Ro option severely decreases.

The Ro-Ro traffic generated and attracted by Western Sicily is mostly organized by the port of Palermo, in the form of a mixed traffic (freight and passengers). However, this port can be considered a critical node of the regional transport network because of its low accessibility. Therefore, through the calibrated mode choice model, a comparative analysis has been executed, on the ground of effectiveness, about two projects for improving the port accessibility:

The implementation of the General Urban Public Transport Plan of Palermo to mitigate the urban traffic congestion, in relation to which the authors have estimated a 0.5 hour time saving for truckers covering the urban routes connecting with the port[7] (see Tables 6a, 6b, 6c).

The development of the Ro-Ro services supplied by the near port of Termini Imerese for moving truck traffic away from Palermo, by increasing the service frequency and the availability of Ro-Ro docks and port spaces. Such an action would imply for truckers a 1.16 hour time saving, also thanks to a throughway that connects the hinterland of Termini Imerese with its port bypassing the urban traffic (see Tables 7a, 7b, 7c).

As emerges from the preceding tables, the specialization of the port of Termini Imerese in Ro-Ro services, according to the port system logic, entails a slight growth of the Ro-Ro freight transport market share, in comparison with the port of Palermo accessibility improvement case. Such a finding requires investments for Termini Imerese to support Palermo in organizing commodity flows, rather than to become a transport node specialized in Ro-Ro freight traffic utilities.

Tables 7a, 7b, 7c: Truckers' choices if the Ro-Ro services at the port of Termini were upgraded

O-D Link: Caltanissetta - Milano (Northern Italy)						
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}*	Difference**
Ro-Ro	30.18	1.08	0	0	21.56%	0.63%
Ro-Ro+LT	34.18	1.01	0	1	50.43%	1.47%
Road	24.28	2.00	1	0	4.67%	-0.35%
Road+LT	28.28	1.46	1	1	23.34%	-1.75%
O-D Link: Caltanissetta - Perugia (Central Italy)						
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}*	Difference**
Ro-Ro	24.78	1.09	0	0	16.59%	0.70%
Ro-Ro+LT	28.78	0.97	0	1	42.16%	1.78%
Road	18.91	1.45	1	0	8.26%	-0.50%
Road+LT	22.91	1.04	1	1	32.99%	-1.99%
O-D Link: Caltanissetta – Potenza (Southern Italy)						
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}*	Difference**
Ro-Ro	22.78	0.87	0	0	9.23%	0.63%
Ro-Ro+LT	26.78	0.79	0	1	22.01%	1.51%
Road	7.94	0.87	1	0	17.06%	-0.53%
Road+LT	11.94	0.64	1	1	51.71%	-1.61%

* Model-based choice probability.
** Computed in per cent points, with regard to the reference scenarios of Tables 5a, 5b, 5c.

Tables 8a, 8b, 8c: Truckers' choices if the Ro-Ro utilities at the port of Termini Imerese were upgraded and telematic services were introduced.

O-D Link: Caltanissetta – Milano (Northern Italy)						
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}*	Difference**
Ro-Ro	30.18	1.08	0	0	21.03%	0.10%
Ro-Ro+LT	33.68	1.01	0	1	51.56%	2.61%
Road	24.28	2.00	1	0	4.57%	-0.45%
Road+LT	28.28	1.46	1	1	22.84%	-2.25%
O-D Link: Caltanissetta - Perugia (Central Italy)						
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}*	Difference**
Ro-Ro	24.78	1.09	0	0	16.23%	0.35%
Ro-Ro+LT	28.28	0.97	0	1	43.27%	2.89%
Road	18.91	1.45	1	0	8.11%	-0.65%
Road+LT	22.91	1.04	1	1	32.39%	-2.59%
O-D Link: Caltanissetta - Potenza (Southern Italy)						
	Time(hours)	Cost (10^3 euros)	Damage	LT	P_{choice}*	Difference**
Ro-Ro	22.78	0.87	0	0	9.11%	0.52%
Ro-Ro+LT	26.28	0.79	0	1	22.78%	2.29%
Road	7.94	0.87	1	0	16.89%	-0.70%
Road+LT	11.94	0.64	1	1	51.21%	-2.11%

* Model-based choice probability.
** Computed in per cent points, with regard to the reference scenarios of Tables 5a, 5b, 5c.

Moreover, in the Termini Imerese port development case, the authors have quantified also the impact, on the waste of time at the port, of introducing innovations like electronic ticket and telematic management of document flows. Thanks to meetings with the representatives of some important consortia of Sicilian truckers that have implemented innovative forms of interacting with port operators (agreements to minimize the time spent for buying tickets and to pay reduced fares), a 0.5 hour saving in the time spent at the port has been assessed, which implies a further rise in the short sea shipping competitiveness, as reported in Tables 8a, 8b, 8c.

CONCLUSIONS AND FUTURE STEPS

An interesting output of the model calibration process consists in the positive coefficient for attribute LT, an explanatory variable quantifying the impact of using a logistic terminal on the road mode and the Ro-Ro one; such an outcome can be interpreted as the positive role perceived by Sicilian carriers for the availability of a logistic terminal, that could be ascribed to some ben-

efits emphasized by the authors during the interviews: the possibility of being informed about the current position of the cargo and the opportunity of consuming, within the same area, several services such as those ones provided by bars, restaurants, hotels, repair shops, petrol stations, banks, etc.

Future steps of the research consist in the following activities:

— Investigating the effects on mode choices of attributes relating to Sicilian haulers like the firm size, the chiefly conveyed commodity, the use of semi-trailers.

— To minimize errors in predictions, combining with *SP* data the *RP* observations on the modal split between the road mode and the Ro-Ro one, that have been collected during the *SP* survey trough the "typical journey "section of the questionnaire.

ENDNOTES

1. Mainly load factor and route optimization services.
2. If two block variables were considered, the possible levels of the interaction between themselves would be four: low-low; high-high; low-high; high-low.
3. For the final design, the number of decision contexts is calculated by raising the number of levels to the number of the "not confounded" attributes power.
4. After 4.5 hours of driving, truckers are obliged to stop for 45 minutes. After 10 hours of travelling, truckers are forced to stop for a period depending on the nature of freight. Moreover, the time spent for crossing the Straits of Messina has been quantified at about 1 hour.
5. The considered fares excludes the value added tax and the cost of the additional services.
6. During the interviewing phase, the authors have found that the travel time and the transport monetary cost are the most important variables explaining truckers' mode preferences.
7. This plan requires the development of the urban railway transport system and three new tram lines serving the outskirts of Palermo. Thanks to such interventions, one could forecasts a rise in the average speed of the ways to the port from the 7 km/hour level to the 18 km/hour one.

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MODELO DE DEMANDA DE TRANSPORTE MARÍTIMO PARA EVALUAR ACCIONES POLÍTICAS EN EL SSS DE SICILIA

RESUMEN

El presente artículo describe un proyecto de investigación en el que los autores desarrollan una herramienta de modelización que sirva de apoyo a las acciones llevadas a cabo en Sicilia por los políticos, para favorecer el *transporte de cabotaje*. En particular, con la finalidad de simular la división modal de la demanda del transporte de mercancías se ha calibrado un modelo *nested logit* a través de una encuesta de *preferencias declaradas* (*stated preference*, *SP*) realizada a 33 empresas sicilianas relativas al sector del transporte de mercancías por carretera. El modelo resultante se ha aplicado en la parte occidental de Sicilia para evaluar la eficacia de algunos escenarios que promuevan el *transporte de cabotaje*.

METODOLOGÍA

Los autores han desarrollado y estimado un modelo *nested logit*, a través de una encuesta de preferencias declaradas, para simular el comportamiento de los transportistas sicilianos en su elección ("carretera" vs. "Ro-Ro"), tomando en consideración la posibilidad de utilización de los servicios de las terminales logísticas (incremento del factor de carga y los servicios telemáticos) que actualmente no están disponibles en Sicilia.

Bajo la forma de un experimento de *SP* se ha presentado, a la muestra de personas que debe responder el cuestionario, un conjunto de escenarios de elección que presentan diferentes alternativas, caracterizadas por algunos atributos que varían de acuerdo a un número fijo de niveles, en el que se les pide que expresen sus preferencias (no necesariamente teniendo que elegir entre diferentes alternativas).

Para analizar la elección del modo de transporte por parte de los transportistas sicilianos, se han seleccionado los siguientes atributos: precio en euros de los servicios de transporte puerta a puerta, para un embarque promedio de 17.5 toneladas (tamaño del envío para las conexiones origen-destino de largo recorrido que tienen lugar en Sicilia); tiempo de viaje programado (horas); frecuencia de los servicios (semanales); confianza en términos del riesgo de sufrir retrasos (alta, baja); seguridad como el riesgo que corren los productos de ser dañados (alta, baja). En los casos considerados ("carretera", "Ro-Ro", "carretera + terminal logística", "Ro-Ro + terminal logística"), los niveles de los atributos empleados se han determinado a través de una base de datos referente a una muestra de conexiones origen-destino que tienen lugar en Sicilia (véase la Tabla 1).

Los escenarios de elección resultantes de combinar los niveles mostrados son 128: este es un conjunto de elección muy amplio para mostrar a los políticos, de manera que se han reducido a dos grupos con 8 alternativas de elección, para ser presentados a dos grupos diferentes de personas que los respondan, a través de la utilización conjunta de dos técnicas de diseño experimental, diseño factorial fraccionario y diseño de bloques (véase la Tabla 2).

La muestra de entrevistados consiste en 33 empresas sicilianas de transporte de mercancías por carretera. Como se estableció con anterioridad, las preferencias de los transportistas sicilianos se han modelizado a través de la formulación *nested logit*. En detalle, el proceso resultante de decisión se ha representado de acuerdo a una aproximación secuencial: hay una primera etapa de elección entre las opciones de "mar" y "tierra"; y en la segunda fase, bajo los dos casos ya mencionados el político considera la posibilidad de utilizar una terminal logística. Para estimar los parámetros del modelo, los autores han adoptado el Alogit 4.2 para procesar las 264 observaciones de elección resultantes de las entrevistas. La Tabla 3 muestra los coeficientes de los atributos de la función de utilidad que son estadísticamente significativos al utilizar el programa Alogit 4.2 para la estimación del modelo.

El valor resultante del tiempo es de aproximadamente 60 euros por hora, resultado que concuerda con una encuesta reciente a nivel europeo (CSST, 2005) sobre el coste por hora del transporte de mercancías por carretera (peaje, consumo de combustible, desgaste y desgarro de los neumáticos, mantenimiento, depreciación, impuestos).

CONCLUSIONES

El modelo calibrado *nested logit* se aplicó en Sicilia occidental para evaluar la eficacia de algunos escenarios que promuevan el transporte de cabotaje.

En detalle, se han estimado los tiempos de viaje y los costes monetarios de los diferentes modos de transporte con respecto a los proyectos a favor del transporte de cabotaje y a las diferentes conexiones entre Sicilia y el resto de Italia, cuyo origen se encuentra en la provincia de Caltanissetta (seleccionada debido a su posición baricéntrica). En primer lugar, utilizando una encuesta a nivel nacional llevada a cabo por los autores en las terminales logísticas, se ha utilizado el modelo para predecir el comportamiento de elección de los transportistas sicilianos si la región de Sicilia estuviera dotada de terminales logísticas. De esta manera, considerando el tráfico entre Sicilia y el norte de Italia, el modelo señala que el 70% de los operadores optaría por el transporte Ro-Ro y que dentro de éstos, un 49% de las compañías demandarían los servicios de una terminal logística; además, en el 30% de los casos restantes, para la mayoría (25%), la mercancía debería ser transportada por carretera y manipulada en una terminal logística; en consecuencia sólo un 5% del total elegiría el modo tradicional de transporte por carretera. En el caso de las conexiones entre

Sicilia y otras regiones de Italia (centro y sur), para el uso de una terminal logística, las estimaciones muestran una incidencia global del 70-75%; por el contrario, el papel de la opción de Ro-Ro se ve severamente reducido.

El tráfico de mercancías de transporte intermodal marítimo-terrestre generado y atraído en la parte occidental de Sicilia es en gran medida manipulado en el Puerto de Palermo. Sin embargo, este puede ser considerado como un punto crítico de la red de transporte regional debido a su baja accesibilidad. Por tanto, a través del modelo calibrado de elección modal, los autores han realizado un análisis comparativo de la eficacia de dos proyectos para mejorar la accesibilidad al puerto: la implementación del Plan General de Transporte Urbano en Palermo para mitigar la congestión de tráfico urbano, en relación a este punto, los autores han estimado un ahorro de 0,5 horas para los transportistas que cubren las rutas urbanas que conectan con el puerto; desarrollar las instalaciones y los servicios de Ro-Ro del puerto cercano de Termini Imerese, lo que supondría un ahorro de tiempo para los transportistas de 1,16 horas en el acceso al puerto, gracias a una autopista de peaje que conecte con el puerto evitando el tráfico urbano. Además, en los dos casos, los autores han cuantificado también el impacto que supondría, en términos de tiempo perdido, el introducir servicios telemáticos avanzados para organizar los flujos de documentación. Teniendo en cuenta los escenarios analizados, se ha demostrado que la especialización del Puerto de Termini Imerese en servicios de Ro-Ro, de acuerdo a la lógica del sistema portuario, es la mejor solución para promover la competitividad del transporte de cabotaje.

Journal of Maritime Research, Vol. IV. No. 3, pp. 55-66, 2007

ISSN: 1697-4840

VESSEL CAPACITY UTILISATION IN FERRY SERVICES AND THE BRIDGE SUBSTITUTE DILEMMA

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Received 2 April 2007; received in revised form 11 ApRil 2007; accepted 28 August 2007

ABSTRACT

The purposes of this paper are to investigate vessel capacity utilisation in Scandinavian ferry services and to describe the concept of bridge substitute. The paper relies upon goods and passenger statistics for 19 ferry services that operate within and to/from Sweden, Denmark and Norway. The empirical outcome shows that the average annual utilisation of the vessels is 42.3% and proves that there are considerable imbalances and variations in goods and passenger flows. Furthermore, there is a relationship between vessel capacity utilisation and frequency: the utilisation is significant lower for routes with high frequency.

The paper focuses in particular on ferry services with high frequency that often fulfil the same function as a bridge, and on the understanding of the variables defining this "bridge substitute". The bridge substitute function requires good accessibility to transport networks, high frequency and excess capacity in order to reduce the total transport time for goods and vehicles by minimising the waiting time in port. The five bridge substitutes included in the study showed all a frequency above 100 departures per week and an average vessel capacity utilisation of 33.6%.

Keywords: Ferry service, capacity utilisation, vessel capacity, frequency, bridge substitute.

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INTRODUCTION

Within the geographic area of the Scandinavian countries there exists a multitude of sea links supporting the societal and commercial needs of transportation and logistics. Ferry and RoRo traffic are important components in this international transport network. Even though the market development for ferry services in recent years has faced some challenges, for example the construction of fixed links (e.g. the Öresund Bridge between Malmö and Copenhagen), new regulations and increased price of fuel (Dunlop, 2002), the goods transportation in Scandinavia has increased over the last few years. The intra-European trade and travel is rapidly expanding and cost-efficient, convenient and easily accessible transport connections are critical especially to the peripheral regions and nations (Baird, 1997).

The purpose of this paper is to investigate vessel capacity utilisation in Scandinavian ferry services. The paper focuses also on the understanding of the variables defining the "bridge substitute", i.e. short sea shipping links with good accessibility, high frequency and excess capacity.

METHODOLOGY

This paper relies upon goods and passenger data for 19 ferry services, within and to/from Sweden, Denmark and Norway (see appendix). Ten of the main shipping companies in the region are operating the routes. The transport time, distance and frequency for each route were compiled, and the maximum available lane metres (the method of measuring space capacity of ferry and RoRo ships) were collected for each vessel operating one of the routes. The different vehicles (private cars, caravans, buses, trailers with/without tow cars and lorries with/without trailers), reported on a monthly basis for export and import during the year 2004, were converted into used lane metres per month. The vessel capacity utilisation was considered to be the ratio of the actual vessel utilisation to the maximum vessel capacity. ANOVA and the Tukey's post hoc test were used for calculation of significant differences between the groups of routes.

This study has highlighted the benefits of focusing on the physical capacity utilisation of the vessels and not on price or profitability of services. Thus, a more general approach was created that enabled a comparison between sea links and between shipping concepts.

FRAMES OF REFERENCES

Physical capacity utilisation in transportation

Capacity utilisation is an important performance measure in transportation. Factors that have an effect on the transport company's ability to make use of available resources can be divided into five groups (adapted from Lumsden,1995):

— *Structural imbalances (LCU_S)* in the goods flow caused by an uneven transport demand in a bi-directional transport relation.

— *Operational imbalances (LCU_O)* occur when the goods and the resources are not optimally adapted to each other.

— *Technical imbalances (LCU_T)* occur when a carrier (e.g. vessel) is not adapted technically to varying types of goods.

— *Chain imbalances (LCU_C)* are caused by delays and unadjusted time schedules in the links and in the nodes, which affect the goods' total time through the chain.

— *Demand imbalances (LCU_D)* are caused by variations in demand (e.g. seasonal variations, state of the market).

A transport system can be the subject of different imbalances that cause losses in capacity utilisation (LCU) according to:

$$\text{Capacity utilisation} = 1 - (LCU_S + LCU_O + LCU_T + LCU_C + LCU_D).$$

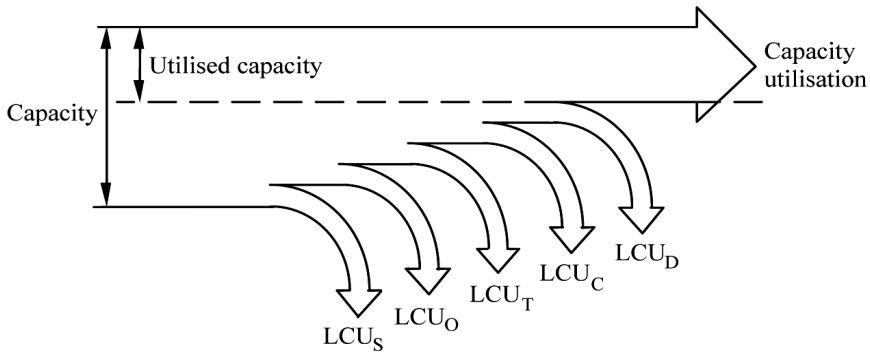

Figure 1. Different losses in capacity utilisation (adapted from Lumsden, 1995).

The imbalances are an artefact of technical factors and structural conditions of supply and demand. Imbalances due to trade pattern often involve substantially excess capacity as the shipping companies have to deploy larger vessels then necessary for the low season or for the low volume sea leg (Haralambides, 2004). This might result in significant costs. Liner shipping is particularly vulnerable to issues of matching supply and demand because of large variable demands, fixed supply in the short term and a considerable time between ordering and addition of new productive capacity (Fusillo, 2004).

Excess capacity may also be the result of strategic behaviour (Wenders, 1971; Hilke, 1984; Lieberman, 1987; Driver, 2000; Fusillo, 2003), as it can perform the

function of a buffer, for precautionary reasons (Driver, 2000). Profit-maximising companies hold precautionary extra capacity in markets where demand is cyclical or stochastic or where resources are inherently lumpy or subject to economics of scale (Lieberman, 1987). Excess capacity may also be employed as a strategic defence against rivals when a threat of entry or expansion is revealed (Spence, 1977; Hilke, 1984; Lieberman, 1987; Driver, 2000; Fusillo, 2003). The company can immediately decrease prices or increase output when entry is threatened without incurring large incremental costs. Thereby, the probability of entry is decreased by reducing the revenue prospects of potential entrants. Furthermore, larger vessels increase the shipping companies' choices (Fusillo, 2003), and also capture economies of scale which provide lower units costs. If the cost of supply shortage is higher than the cost of carrying excess capacity, the companies are more likely to err on the side of excess capacity rather than be caught short during periods of high demand (Fusillo, 2003).

The trends concerning distribution are more frequent deliveries (Lumsden, 1995), which can lead to inventory savings (Lagoudis et al., 2002). As the need for goods transportation is a derived demand from the trade and manufacturing industry (Hultén, 1997), this has resulted in increased frequency in the transport system. The importance of high frequency for shipping services is for example emphasised in studies of ferry choice in RoRo freight transportation (Mangan, 2002) and freight mode choice (Lagoudis et al., 2002; Shinghal and Fowkes, 2002). The increased frequency brings about a trade-off with economies of scale for the transport companies. The average waiting time in the nodes, and thereby the total transport time, decreases for the customers at the expense of excess capacity in the transport system.

The concept of the bridge substitute

Due to the geographical characteristics of Scandinavia, which is almost surrounded by water, short sea shipping is an important complement to the land-based infrastructure. Some ferry services are intimately connected to the road and railway networks to such an extent that they serve as replacements for bridges, and therefore can be regarded as "bridge substitutes". The function of the bridge substitute requires similar adaptability as a bridge in order to meet the demands from the user of the ferry link and to minimise the waiting time for the goods and vehicles in port. Important requirements that need to be fulfilled are:

— Good accessibility to other transport networks
— High frequency
— Excess capacity

Equivalent terms and concepts exist within shipping and transportation, e.g. bridge concept, land bridge, trailer bridge and airlift. However, these concepts show quite different characteristics and are not defined in this context.

EMPIRICAL OUTCOME

Level of vessel capacity utilisation

The empirical data of the 19 studied ferry services within and to/from Scandinavia shows that the average annual utilisation of the vessels reaches 42.3% of the total capacity, with an annual mean value per route from 23.5-62.9%. Although most shipping companies reduce the number of departures during the low season, the vessel capacity utilisation in November is as low as 35.4%, whereas the utilisation during the busiest month July, comes to 53.8% on average (table 1).

Table 1. Average vessel capacity utilisation per month for the 19 ferry routes.

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Mean	35.9	37.9	40.7	43.2	44.6	44.4	53.8	50.7	41.5	41.2	35.4	36.5
Maximum	63.1	67.7	93.7	73.5	78.3	72.8	81.0	100.8	74.6	68.6	62.2	64.2
Minimum	18.5	21.5	24.3	20.2	20.2	12.7	19.9	25.6	4.4	18.2	18.0	17.8
Standard deviation	13.9	12.9	17.1	17.3	16.6	15.6	15.5	19.1	17.6	15.0	11.4	11.9

Structural imbalances in goods and passenger flows

All the studied ferry services show structural imbalances of export and import of goods (trucks and lorries). When the passenger vehicles (personal cars, buses and caravans) are also included, the total imbalances of inbound / outbound vehicles are reduced, since the deviations in the incoming and the outgoing passenger flows are much lower than for the goods transportation. Consequently, ferry services with a higher proportion of passengers onboard do not suffer as much as goods ferry services when it comes to structural imbalances. In table 2, the level of structural imbalances and the fraction of goods onboard (related to total transported lane meters) are shown. The t-test confirms that the differences between the two groups are significant ($P<0.05$).

Table 2. Structural imbalances in the total flows of goods and passenger vehicles.

Imbalances inbound / outbound	Number of routes*	Mean imbalances	Standard deviation	Average % goods
<10%	12	2.9	2.2	32.4
>10%	5	31.7	11.5	58.3

* In two cases, the export and import figures were summarised and structural imbalances can not be calculated.

Imbalances due to seasonal variations

Fluctuation of goods volumes and number of passengers due to seasonal variations is apparent for most ferry routes (in four cases no conclusions can be drawn since there are too few departures part of the year). The significant increase in pas-

sengers in July and August implies that the majority of the vessels' resources are engaged with personal cars, caravans and buses. At the same time, holidays implies a reduction of lorries and trucks onboard the vessels. Total utilised lane meters (lm) for the 19 ferry services are shown in figure 2.

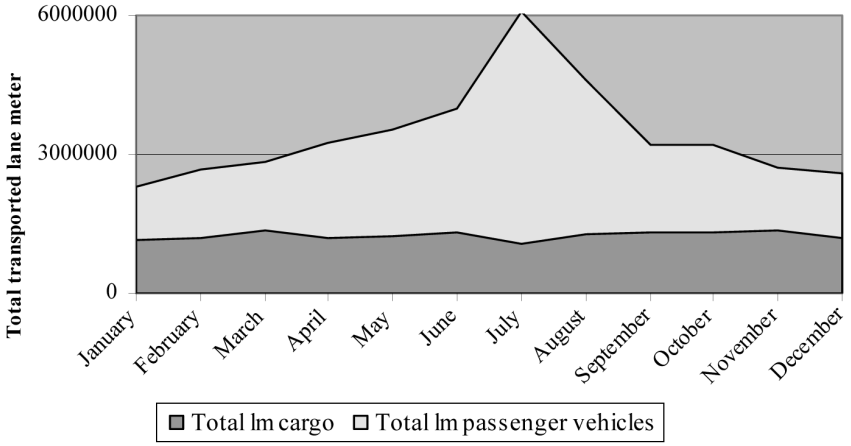

Figure 2. Total transported lane meters per month for the included ferry services show seasonal variations of goods and passenger vehicles.

Vessel capacity utilisation and frequency

The empirical outcome shows a relation between vessel capacity utilisation and departure frequency. The utilisation is significantly lower for routes with high frequency (figure 3). The ferry services with a frequency above 100 departures/week (total numbers of departures in both directions, which implies at least 7 departures/day in each direction) show an average vessel capacity utilisation of 33.6% (table 3). The result of one way ANOVA indicates a significant difference between the three groups ($F = 28.24$, $P < 0.0001$). The Tukey's method of post hoc comparison indicates that there are significant differences between the three groups at the 0.05 level.

Table 3. Total vessel capacity utilisation (as %) for the 19 routes grouped into frequency ranges.

Departures/week	<10	10-100	>100
Average annual vessel capacity utilisation	46.8	44.3	33.6
Standard deviation	15.3	11.6	8.6
Average departures/week	6	27	448
Average distance	196	105	19
Numbers of routes	6	8	5

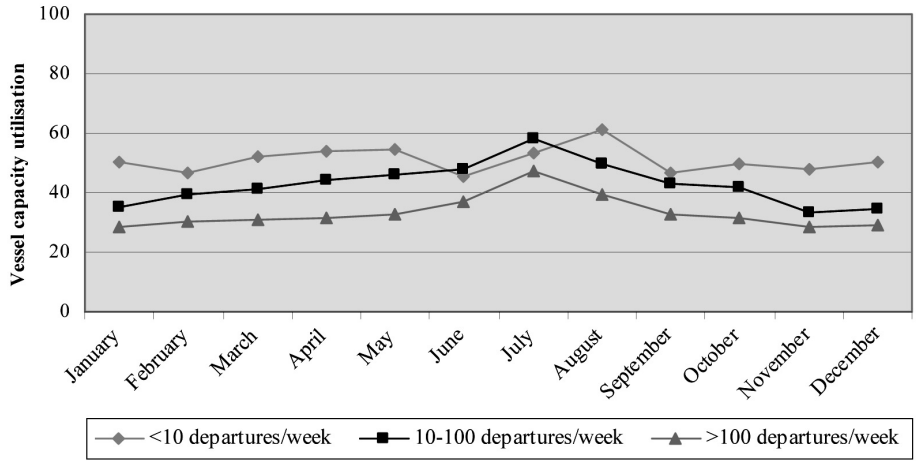

Figure 3. Relations between vessel capacity utilisation and frequency reported on a monthly basis.

The bridge substitute in practice

The bridge substitute needs to meet the requirements for 1) good accessibility to transport networks, 2) high frequency, and 3) excess capacity. The five ferry services in the group "more than 100 departures/week" fulfil these requirements and are therefore classified as bridge substitutes (table 4).

Table 4. Characteristics for the five bridge substitutes.

	Frequency (dep./week)	Distance (nm)	Transport time (h)	Average waiting time in port**
Gedser - Rostock	107	30	1 h 45 min	3 h 8 min
Göteborg - Fredrikshamn	109	50	3 h	3 h 4 min
Helsingborg - Helsingör*	505	2	20 min	40 min
Rodby - Puttgarden	684	10	45 min	29 min
Helsingborg - Helsingör*	833	2	20 min	24 min

* Two shipping companies operate the route Helsingborg - Helsingor.
** "Average waiting time in port" is the expected average time for the vehicle or passenger with random arrival in port.

First, the accessibility to the ports is good, as the five ferry services classified as bridge substitutes are integrated and complementary parts of the land-based infrastructure and they bridge natural gaps over sounds and channels. Second, frequent departures assure short waiting time for goods and passengers in port. All the routes have a frequency that exceeds 100 departures per week, which means at least 7 departures/day in both directions. This corresponds to an average waiting time in port of 24 minutes for the route with the highest frequency: Helsingborg – Helsin-

gor. Third, the study shows that the bridge substitutes have a high level of excess capacity with an annual average vessel capacity utilisation of 33.6% per departure. However, even if the monthly utilisation is low, some of the departures during the peak season are certainly full booked, even though the monthly reported transport figures do not allow an analysis of each single departure. It should also be noted that the vessels operating high-frequency round-the-clock services often spend less time in port compared to other vessels in short sea shipping. This implies that even though the vessel has large unutilised capacity per departure, the total utilisation of the vessel per year can still be high.

The transport distances for the five ferry services are fairly short. This is not a necessity for a bridge substitute, but a longer distance requires a larger fleet in order to maintain the high frequency. This is possible if the volume of goods or the number of passengers is high, which is not the case for Scandinavia. In other regions, for example in some densely populated parts of the world, the maximum distance for bridge substitutes is probably longer than in Scandinavia. This relationship between high frequency and short distance and vice versa can be seen in table 3.

DISCUSSION AND CONCLUSION

In shipping, increases or reductions in capacity are made in large and discreet units, at relatively high cost and often with a substantial time between ordering and installing. Due to losses in capacity and institutional peculiarities, the average annual vessel capacity utilisation in the studied Scandinavian ferry services only reached 42.3%.

Losses in capacity were identified in the 19 ferry services. First, *structural imbalances* in export and import figures were noted. These imbalances are difficult to handle or reduce in size because they are due to international transport patterns and caused by density of the population, separations of centres of production and consumption, type of transported goods, alternative infrastructure, etc. Second, *demand imbalances* probably cause the main losses in capacity utilisation, since the size of the vessel needs to be matched to the highest peak in the summer. As a consequence the vessels have a high level of excess capacity during the rest of the year. Shipping companies handle these variations by influencing the travel pattern by price differentiation, or by adding and removing departures. However, withdrawing capacity is costly and it may be more economical to sail even if the level of utilisation is extremely low. Even though the passenger traffic counterbalances some of the larger structural imbalances and variation in demand, these discrepancies are still of major concern for the ferry operators.

Losses can also be caused by: *Operational imbalances*, i.e. discrepancies between goods and carriers. One important issue related to providing enough vessel capacity at the right time and place is the sailing schedule. The shipping company's timetable

needs to be adjusted to suit transport demands, customers' working hours, travel pattern, port slots and travel time among others. Operational imbalances are not further discussed in this paper. Neither are *technical imbalances* that are linked to the load units and vehicles a ferry accommodates. Finally, *Chain imbalances* are not included in the study since there is a focus in this paper on the sea links with a firm perspective on the shipping company rather than a goods flow perspective (Styhre, 2005) that includes the whole chain from sender to receiver.

Low vessel utilisation due to a chronic level of excess capacity can also be explained by strategic motives. One important issue is "the concept of oversized ships". An oversized ship is in the short run too large for its transported goods volumes, which results in a high level of excess capacity. Nevertheless, this extra capacity implies that the shipping companies avoid turning down transport assignments and that they are in a better position with respect to competitors. Even though this involves higher costs, this does not mean that it will be unprofitable. However, the excess capacity should be increased only up to that point where the incremental benefits are matched by the incremental costs. Further, with linear demand growth overtime and new capacity added in large and discreet sizes, oversized ships makes future growth in volume possible, without the need for new investments in vessels. Consequently, a certain amount of unutilised capacity is tolerable in the shipping industry.

Finally, this paper shows that unutilised vessel capacity is a prerequisite of the creation of efficient shipping bridges. A "bridge substitute" can be defined by its function: to bridge gaps between land borne transport networks, offering high-frequent departures and enough capacity in order to limit the waiting time for goods and passengers in port. The bridge substitute dilemma is the trade-off between the demands for accessibility to transport networks, high frequency and excess capacity as set by the shipping companies' customers, and internal goals for high vessel capacity utilisation.

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APPENDIX

Table 5. Shipping services and routes included in the study.

Route	Shipping company	App. transport time (h)*	App. distance (nm)**	Frequency (dep./year)***
Frederikshavn - Larvik	Color Line	6.5	105	941
Frederikshavn - Oslo	Stena Line	8.5	156	647
Gedser - Rostock	Scandlines	1.75	30	5577
Göteborg - Fredrikshamn	Stena Line	3	50	5687
Hanstholm - Egersund-Haugesund - Berge	Fjordline	18	280	352
Hanstholm - Torshavn	Smyril Line	35.5	550	118
Havneby - List	Romo-Sylt Linie	0.6	3	2464
Helsingborg - Helsingör	Scandlines	0.33	2	43331
Helsingborg - Helsingör	HH - ferries	0.33	2	26285
Hirtshals - Kristiansand	Color Line	4.5	69	2105
Hirtshals - Larvik	Color Line	5.5	87	407
Hirtshals - Oslo	Color Line	9	139	614
Kobenhavn - Oslo	DFDS Seaways	16.5	272	728
Kobenhavn - Swinoujscie	Polferries	9	130	496
Rodby - Puttgarden	Scandlines	0.75	10	35544
Ronne - Sassnitz	Scandlines	3.5	52	334
Ronne - Swinoujscie	Polferries	5.25	76	24
Varberg - Grenå	Stena Line	4.25	61	781
Ystad - Ronne	BornholmsTrafikken	2	36	2918

* Source: Shipping companies' sailing lists.
** Source: www.world-register.org/dist.htm, www.distances.com and users.pandora.be/tree/wreck/north-sea/distances.html.
*** Source: Danmarks Statistiks opgørelse af transport i internationalt færgefart til og fra Danmark 2004.

Journal of Maritime Research, Vol. IV. No. 3, pp. 67-85, 2007

ISSN: 1697-4840

ELECTRONIC MARKETS BUSINESS MODELS TO INTEGRATE PORTS IN SUPPLY CHAINS

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Received 2 April 2007; received in revised form 11 April 2007; accepted 4 September 2007

Abstract

The paper explores rationales and determinants of embracing specific e-Governance models as a mean to improve port governance and enhance ports integration in contemporary supply chains. In recent times the port sector has experienced a variety of organisational and policy reforms, aiming at adjusting to major external changes. Grounding on the structures of the emerging multi-faced and multi-actors port sector, the paper establishes both the significance and the applicability of advanced port e-Governance models, based in particular on e-markets typologies. The observations and the devised theoretical framework suggest that within the evolving variation of port structures, e-Governance public-private interorganisational network models and the e-market one–stop government model provide a great opportunity towards the most wanted 'smart networking' of the plurality of port actors. Acting as cluster managers, port authorities have an array of incentives to invest in action frameworks like the enactment of 'port authority centred e-markets', in order to enhance the performance of ports as parts of regionalised supply chains networks. By examining this perspective, the paper suggests the core features that may govern the implementation of this paradigm and enabling conditions wherein an electronic port e-Governance agenda can promote the interests of stakeholders.

Keywords: Port Governance, e-Government, port actors' collaboration

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INTRODUCTION

The port sector is in a state of transition. Major changes in the production process (geographical shift of production, just-in-time manufacturing, logistics and multimodal transportation, increased exploitation of new technologies), the widespread development of containerisation, the consequent operational reforms of world shipping (exploration of both economies of scope and economies of size) and the shift of political attitudes and regulatory regimes in favour of less state intervention (i.e. privatisation, proposals for the liberalisation of port services provision in the European Union), contribute towards this direction.

There has been a remarkable variance of port governance and policy restructuring to these, mostly external driven, changes. This variance reflects different approaches on the most appropriate form of port organisation. It results in the simultaneous presence of both public and private forms of port operations, which are governed by public or quasi-public port authorities. This range of these hybrid forms of port organisation is rather well documented (Brooks and Cullinane 2007; Bichou and Gray, 2005).

Since the introduction of the EDI (Electronic Data Interchanges) systems in the mid-1980s, the port sector has progressively endorsed several new information and communication technologies (ICTs) such as web portals, intranets, extranets and support software platforms (i.e. ERPs, Workflow Managements Systems) and communication platforms (i.e. RFID technology, wireless and sensor based systems) (Kia *et al* 2000).

However, the investigation of the significance and the potential of comprehensive e-Governance concepts with specific strategic, operational, and technological implementation and use options, towards the facilitation of port actors' responses to new competitive pressures, is a totally unexplored area.

This paper focuses on examining how e-Government and the implementation of specific ICT business models, such as the port public-private interorganisational networks, the one–stop electronic port model, and its transition to a pervasive and context-aware electronic port services paradigm might facilitate this ports adjustment process, and improve the position of the several actors involved in port operations.

THE CONTEXT OF ELECTRONIC PORT GOVERNANCE MODES

The analytical framework to be presented serves in guiding the development of innovative e-Governance models in this multi-faced and multi-actors sector; it is embedded in foundation theory of port policy and e-Government, regarding the nature of the contemporary port product, in the context of ICT ramifications, intra-port competition, ports spatial and functional regionalisation, and aspects of port policy reforms towards operational and governance devolution, resulting in hybrid forms of port operation.

The e-Government wave has caught the attention of not only the software and consultant industry, but also in the policy institutions, the public administration, and an increasing number of researchers. Although there indeed was solid research on ICT in government during the 1970s, 1980s, and 1990s and fundamental new research perspectives has been introduced with current e-Government wave.

e-Government defined as the facilitation of governmental and administrative functions and activities enabled by ICTs, range from general front-end services (i.e. ministry of transportation portal) to back-office automation (i.e. public ports document management systems) and intergovernmental services integration. Emerging are also ICT applications directed towards policy input and citizen/customer involvement. In essence, as national e-Government strategies are implemented transactions might become faster and information quality improves, along with strategic public management priorities promotion such as transparency, accountability and anti-corruption.

In particular, this analysis is based on recent advances regarding the electronic markets business models in order to illustrate their importance as applicable e-Government organisational and policy perspectives to the emerging port reality.

The synthesis of these two main research strands enables the formulation of the proposed conceptual framework that allows a broader understanding for enacting emergent ICTs and network business models within port organisational forms, institutional arrangements and assessing foreseen outcomes. Hence, in our paper both the significance and the applicability of advanced port e-Government models are explored.

The suggested framework proposes an *a priori* theory for electronic port governance and delineates the rationales and determinants of port multi-actors collaborative electronic networks, the enabling mechanisms and infrastructural underpinning for achieving the objectives of joint initiatives (strategic alliances, coordinated relationships) and electronic networks formation. The basic premise is that as the port policy environment perplexes, electronic markets offer intriguing possibilities and insights for port policy making and operations.

Our analysis and the theoretical propositions are approached as follows: first, the analysis outlines core factors of the contemporary port governance, in terms of its important institutional, structural, and organisational constituents, so as to yield insights into possible evolutionary paths of port entities and networks governance. These port governance elements provide the "hooks" upon which port actors may hang elements of enacted technology. Resembling an electronic markets typology, the competing influences on port network formation and the variety of interorganisational networks, render the technology enactment process outcomes uncertain. To overcome this unstable condition, this paper presents a set of observations and guiding propositions for theory-building towards a policy framework of knowledgeable port actors, in particular port authorities, trying to pursue their interests in enacting

technology. The emerging port interorganisational networks may be composed of equals, or may have one powerful central actor coupled with other actors relying on the central organisation for resources and exchange. In the case of port sector, the key actor responsible for cluster management is the port authority. Against this background, the paper also illustrates the possible rationales and underpinnings for a port-authority centred e-Governance network, based on features of electronic markets typologies.

CONTEMPORARY PORT GOVERNANCE CHALLENGES

The changing market context in which ports operate has played a key role in transforming the contemporary port product and inducing major port governance and policy reforms. Fundamental changes in the production and distribution of goods, industrial networks development, unitisation, short product lifecycles, and short time-to-market periods, are all variables that reduce the advantages of proximity to the port and increase the role of logistics (Helling and Poister 2000). Users' demand is characterised by a high level of differentiation. The responsiveness of ports to this differentiation conditions their competitiveness. Market shares depend on the provision of complementary, user-driven, value-added, port-related services, which are efficiently supplied in wider geographical areas. The efficient supply of these complementary services does not require the location of the production units within the port zone. Freight corridors expand further and many ports are creating the necessary conditions and infrastructure for setting up networks dedicated solely to multimodal transportation.

Product, Process, Actors

All these developments have led to port product variation and new organisational strategies. Ports provide both generic services with a standardised process defined in advance and dedicated services responding to individual demand and based on the mobilisation of specialised resources. Some parts and types of port operations continue to focus on standardised services, strong price competition and increased volumes of services, while others focus on increased range of services, concentrate on economics of variety and competition based on superior quality of products and services. So the port sector exhibits organisation structures that incorporate elements of different worlds of services provision (Chlomoudis *et al* 2003): along with the provision of services within the traditional (a) *industrial world*, port services are provided with reference to (b) an *interpersonal world*, based on dedicated specialised services, economies of variety, competition centred on quality, skilled labour, and uncertainty; and (c) the *market world*, based on dedicated but standardised services, economies of scale and differentiation, competition centred on price and response to demand, semi-skilled labour, and conditions of uncertainty.

With the overall port product becoming a chain of (specialised) interlinking functions (Suykens and Van de Voorde 1998), flexible (post-fordist) operational methods stand as a means to face the adjustment pressures (Notteboom and Winkelmans 2001). The large comprehensive port organisation, which is commonly based on large standardised processes, is outdated. The number of actors within a port complex multiplies both because more types of services are provided and because the same type of services is provided by more than one entity. Competition takes the forms of intra-port and intra-terminal competition. The former is a situation where two or more different terminal operators within the same port are vying for the same market and the terminal operator has jurisdiction over an entirely terminal area, for berth to gate, and competes with other terminal operators. The latter refers to companies competing to provide the same services within the same terminal (World Bank n.d.). Apart from preventing monopoly pricing, those responsible for port policy design and port authorities (cf. Pallis and Vaggelas 2005) advance the introduction of such competition between a plurality of providers of port products/services/facilities, as an engine of innovation and specialisation (De Langen and Pallis 2006). The monopolistic market structure of port services provision and any single corporate hierarchy are replaced by a network of organizations operating in different worlds of production.

With the advent of ICT enabled network business models, port product and processes are considered as "augmented" products and processes, as their traditional, physical nature is overplayed with an informational and electronics transactions component.

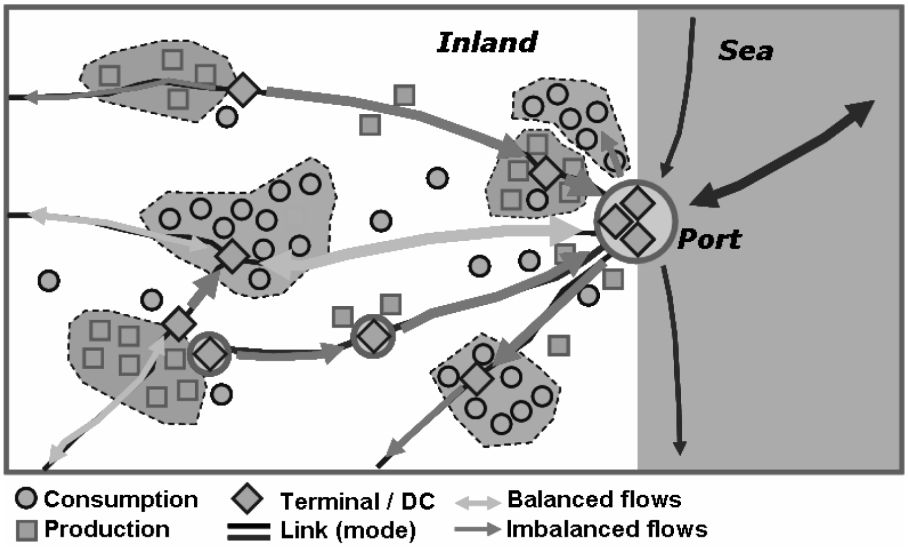
Regionalisation, Supply Chains Integration, Synchronisation

These developments are inextricably linked with the expansion of port hinterlands, and the emerging port regionalisation (Notteboom and Rodrigue 2005), that is the geographical and functional integration of ports in wider regions. To serve a specialised commercial and transportation context, ports use the comparative advantage of effective spatially fragmented locations that insure a better access to space, markets, labour, parts and resources. The resulting growing transport flows and spatially fragmented operational chains induce the need for functional integration. Ports attempt to link more efficiently the elements of the supply chain in order to insure that the needs of the customers are closely met by the suppliers in terms of costs, availability and time. The outcome is the transformation of ports to nodes of complex transportation networks, searching for means to be functionally and geographically integrated systems of locations and flows with the purpose of generating value (Figure 1).

With the rapid and pervasive restructuring of supply chains and of the logistics pathways in which ports are embedded, ports are now elements in value-driven

chain systems not simply places with particular, if complex, functions (Robinson 2003). The port captures value for itself and for the chain (i.e. shippers, third party service providers), while maritime companies demand further services specialization within the port area, and firms providing port services are interested in developing strategies to succeed in hugely complex environment and uncertainty. In the emerging flow-based system, demand needs to be synchronized more closely with supply, imposing a reorganization of freight distribution. There are multiple actors within the port complex and a number of actors that are involved within the wider supply chain, and the operation of all of them conditions port competitiveness. The overall context results in port policy reforms, aiming to redefine port governance and the role of the involved actors, within the new paradigm of ports as elements in value-driven chain systems.

Figure 1: Port regionalisation & intra-port competition: a multi-actors sector



Source: Based on Notteboom and Rodrigue (2005).

Governance Reforms and Actors' co-ordination

For all the reasons stated above, port planning is restructured, with new approaches implying a new role to be played by the port authority and a reassessment of the public sector involvement (cf. Mogli and Sanguineri 2003). Most of the port policy reforms have taken the form of port devolution, which is the transfer of functions or responsibility for the delivery of programs and services from the government to other autonomous port level entities (Brooks 2004). Within this alternative service delivery process, governments seek to become more customer-driven. This new public management is client-focused, entrepreneurial, innovative, and

intends to: (1) lessen centralized bureaucratic control and heighten the use of decentralized quasi-market mechanism; (2) decouple the government's policy-making function from operations; and (3) increase participation by non-government entities in the design and delivery of government programs and services (Brooks and Cullinane 2007). Several European (i.e. Italy, Spain, Greece) and non-European countries (i.e. Australia, Canada) have endorsed such policy, reforms searching for the 'one best way' to manage and organise a competitive port system.

The range of devolution alternatives adopted within the global ports sector varies (Cullinane and Song 2002), with the literature avoiding to make assumptions about the inherent superiority of one environment-strategy-structure configuration over any other (Baltazar and Brooks 2007). More important for this study is the post-reform role of the public sector. In public ports, where all regulator and landlord functions fall to the public sector, some, or all, operator functions may be undertaken under contract by the private sector, the control of the conditions of operation resides with the government. In the, most commonly observed, partial privatisation case, some operator and/or landlord functions are privatized, usually with the public sector retaining full control of the regulator function. In the less frequently observed case of full privatisation, all of the operator and landlord functions are transferred from the public to the private sector, but the government opts to provide regulator functions. There is widespread agreement that property rights, the existence of public goods, and the presence of externalities stand as valid causes of the existence of some form of public controlled port authority, even when port privatisation policies prevail.

As a result, hybrid port organisations exist in the intersection of two distinct spheres, the public and the private. Governments move away from the direct delivery of port services, yet they retains policy-making responsibilities, as its autonomous executive organisations (port authorities) establish long term relationship with private port operators performing services on the basis of management contracts. Limiting the conventional interventionist role, the state operates to a certain extent, as an external agent, which intervenes in the workings of the port economy from a position outside and above the situation of operations and with a view to maximising the common good, even in the context of a private sector port system (Gilman 2003).

Within this context, port stakeholders expect a minimum intervention in order to rectify problems associated with the workings of the sector. Still, there is a distinct role that public actors, in most cases port authorities, assume. This role is not restricted to 'effacing' the barriers to the operation of the market mechanism. The decentralised port development system demand port authorities to deploy strategies that produce adaptability, and direct systemic economic coordination towards interconnection, technical interoperability, and various forms of operational (intra-port, local, regional, hinterland, strategic) networking and integration (Newman and Walder 2003).

The sector is in a situation in which a variety of actors need autonomy to develop whatever worlds of production they find compatible. Those involved in the provision of port services are in a locked-in situation wherein they need a situated governor to ensure that their services are well coordinated. If this philosophy prevails, firms act to the best of their abilities allowing the inherently favourable possibility of multiple frameworks of action in port operations. When port governors favour the idea of allowing several independent enterprises to operate within a single port, operational networking results in significant competitive advantages, for the cooperation of firms who act within transportation chains. With ports being embedded in value driven systems, the providers of port services are increasingly competing not as individual firms but as parts of chains whose ultimate success depends on networking and integration of operating relationships, rather than on ownership and control of critical supply assets and consequent dominance of operations (Robinson 2003).

Against this background public and private actors, as well as public or quasi-public port authorities, are in the search of an efficient and effective networking that creates a competitive port community spirit that minimises difficulties in integrating ports with logistics and supply chains and help to establish the essential proactive approach to satisfy user demands.

For the port authority this search is important in order to function as the 'smart' institution that governs the implementation of network organisational forms, rather than as the 'conventional' port operator, or just as 'regulator'. It can undertake initiatives that redefine the operational framework and develop action frameworks that help to overcome inefficient operations and advance the co-operation of the several stakeholders, including service providers, third parties, or port users. Via networking, port authorities have the potential to overcome decisional and operating fragmentation generated by individual self-interest actions by firm(s) and coordinate actions towards customer-oriented structures of integrated port services according to users' context and situations.

ELECTRONIC PORT GOVERNANCE: THE FRAMEWORK

The e-Government wave has caught the attention of not only the software and consultant industry, but also the policy institutions, the public administration, and a constantly increasing number of researchers. Although there was solid research on ICT in government during the 1970s, 1980s, and 1990s fundamental new research perspectives have been introduced with the current e-Government wave.

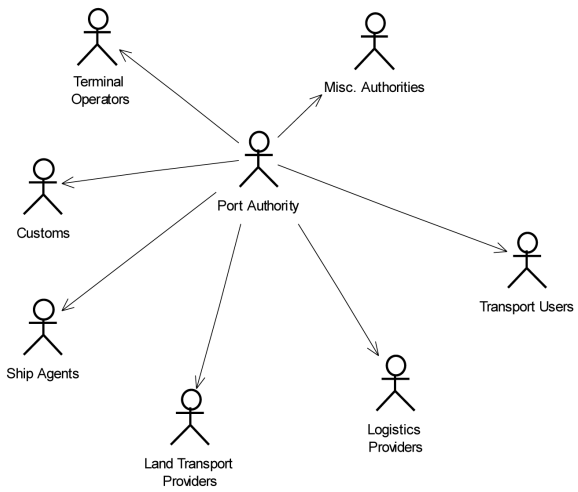
E-Government defined as the facilitation or transformation of governmental and public administrative functions and activities enabled by ICTs, entail applications that range from general front-end services (i.e. ministry of transportation one-stop portal) to back-office automation (i.e. public ports document management systems) and intergovernmental services integration. Emerging are also ICT applica-

tions directed towards policy input and citizen/customer involvement. In essence, as national e-Government strategies are implemented, strategic public management priorities, such as transparency, accountability, anti-corruption and enhanced citizen participation are promoted, transactions are becoming faster and more effective and information quality improves (Fountain 2001; Wimmer 2002; OECD 2005).

Public agencies need to move beyond the concept of separate and distinct entities by starting to see themselves as one holistic government that collaborates, shares information, and leverages on the collective knowledge, with the aim being to provide the general public or particular constituencies with better and integrated services in a convenient, continuous, agile and adaptive manner that enhances innovative and collaborative practices (Ke and Wei 2004).

Successful inter-organisational collaborations (as illustrated in Figure 2) in e-Government require due respect for the interests and expectations of each participating entity, without introducing obvious threats or unnecessary speculations that challenge its existence or autonomy (Fountain 2001). In this vein, adjustments are inevitable for balancing the respective organisations' objectives and constraints and can be better reached with an adequate institution structure in place.

Figure 2. Port value chain stakeholders



The significance of cross-agency collaborations in e-Government singles out the importance of an institutional framework for explicitly stipulating the collaborative (working) relationships among autonomous entities, public or private that participate in an e-Government initiative (Dawes and Prefontaine 2003). To provide and deliver online one-stop services, the participating actors have to collaborate, streamline, and integrate the respective services and operations, which historically have

been departmentalised, or in the case of sectors as ports were provided by a single organization rather than multiple due to the application of the linear mass services production system. 'One-stop service' is not a novel concept (Wimmer 2002; Lambrou 2003). In fact it has been exploited in the e-Government domain, as an innovative model, in particular within a framework that supports (a) leadership and management control at all different levels, and provides (b) defined rules and procedures to the overall decision making, and (c) the mutual adjustments of the participating actors (Jen-Hwa Hu *et al* 2006). The preceded elements are required for reaching and enhancing consensus and building trust among participants.

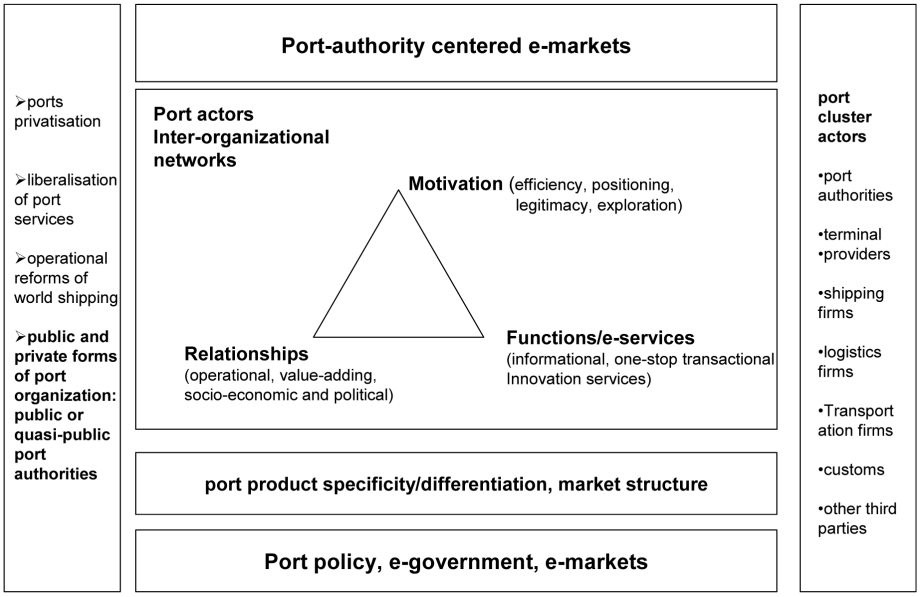
During the last decade, and in parallel with the development and spreading of ICT, government agencies have leveraged tools and new collaboration between agencies, to a considerable extent. A consolidation of paradigms is needed, however, in order to establish a clear baseline and wide consensus on concepts and terminology and good practices for e-Government in the near future. Against this background, future, innovative scenarios for e-Government initiatives are necessary. Deeper understanding of the complex interplay of technological, organizational, and social factors and processes in both e-Business and e-Government might lead to practice-relevant, cross-fertilization and improve our understanding of the nature and origins of both similarities and differences between the evolutionary trajectories of the two public-private spheres (Scholl, 2006).

Port authority centred e-markets

The available theory and empirical results on e-markets models (Fountain 2001) may serve as an appropriate policy-making basis and tool in order to rationalise and determine port inter-organisational networks centred on a revamped port authority role; actually this paradigm is in accord with the contemporary port governance and policy restructuring, where the simultaneous presence of both public and private forms of port operations, which are governed by public or quasi-public port authorities is emerging and port authorities are seen as the perfect 'cluster port manager' (De Langen 2003).

The proliferation of B2B e-markets has generated a growing academic interest in the phenomenon and although its applicability and ramifications are still not conclusively studied and understood, a plurality in design and operation options is apparent. An e-market is defined as a system that allows market participants to exchange information about prices and product offerings electronically and conduct business transactions (Granados et al 2007; Gottschalk and Abrahamsen 2002; Kaplan and Sawhney 2000; Chircu and Kauffman 2000; Malone *et al* 1987). As Le *et al* (2004) outline in a thorough overview of concepts, taxonomies and possible instances of e-markets, e-markets are designed to exploit certain market opportunities, while individual e-market types differ from one another with respect to their

Figure 3: Port centered e-markets framework.



target users, underlying market structures and respective ownership, product/service offerings, value propositions, and provided functionality.

Hence, based on established taxonomies and models one can envisage the existence of a port e-market paradigm where port supply and demand is aggregated, matched and facilitated via an institutional e-Governance infrastructure that ensures meaningful port inter-organisational network relationships between the various actors related to one port cluster.

A framework present by Gosain and Palmer (2004) conceptualises e-markets as network orchestrators that generate value by creating exchange opportunities and facilitating economic and social exchanges.

On these grounds a port-authority centred e-market might be the mean for orchestrating three types of network linkages that create value for their participating organisations in three distinct ways (Figure 3):

— Orchestration of information linkages (i.e. communication) that result in improving information exchange and the processing of port operation related information (such as vessel pre-arrival notifications, cargo handling information, customs declaration information etc).

— Orchestration of value linkages that result in improving transactional characteristics that drive change in port stakeholders' organisation and operational integration (such as electronic process integration, port based intermodal transportation and logistics services and transactions coordination and execution).

— Orchestration of relational (i.e. socio-economic integration) linkages that result in improving social, economic and political relationships and make available resources embedded in these port stakeholders relationships.

The expected benefits of using e-markets, or the underlying motivational factors, are seen for both the buyers and suppliers participating in an e-market.

Regarding the *intention to participate in inter-organizational networks*, Cheng *et al* (2006) explore in particular the moderating effect of intention to e-collaborate on governance mode. They argue that the intention to e-collaborate will moderate the effects of the three decision contexts, namely the threat of opportunism, the threat of commercial failure, and the opportunity for sustainable advantage, on the two identified governance modes (e-collaboration versus arms-length relationship).

Reviewing the literature on *motives for participating in e-markets* activities, Rask and Kragh (2004) conclude that there is a matrix with four types of motivating factors for using and/or participating — namely, efficiency, positioning, exploration and legitimacy — which are based upon the dimensions of drivers (internal versus external) and the nature of the decision (planned versus emerging).

Based on the aforementioned frameworks, one can adapt its postulation regarding port-authority centred e-markets models, in order to determine the possible port service providers' and port users' motives for taking up e-markets activities:

— More specifically, the *efficiency* motive accounts to a decision to participate in e-markets which is driven by an internal objective to obtain organisation-specific advantages and is made as a result of careful evaluation of the expected outcome. Port users can generally be highly motivated by process efficiency, particularly in terms of reducing time, increase reliability, deploy new strategies corresponding to a globalised trade environment (i.e. hub and spoke practices), but also in terms of achieving lower prices. Port service providers are expected also to show interest in reducing process, time, and costs, and increase services efficiency, in terms of specifying parts of the operation in which they should focus and implementing novel concepts (i.e. just-in-time, door-to-door services) demanding integration with spatially separated (regionalised) complementary entities.

— *Positioning* appears as a strong reason for both port service providers and port users to participate in e-markets. The port sector dynamic economic context and the continuous alteration of the port competitiveness hierarchy are driving forces towards participation in e-markets. Port authorities, public administrations, port service providers and port users, are all actors interested to increase their positioning within a port complex. At the same time they are interested in the overall positioning of this complex vis-à-vis other ports competing for the same region. The positioning motive is important in order to increase both market reach and potential.

— As regards the motive of *legitimacy*, e-market participation can be driven by external factors rooted in the relationships of an organisation in the port value chain with other organisations, and may occur as the result of ongoing negotiations between port governors, operators, and/or users. The legitimacy motive is very real for many port services providers, especially in terms of their eagerness to follow existing customers.
— *Exploration* is a possible motive for port actors as well. To some extent, port service providers, in particular, might base initial e-market participation on trial and error, with the decision to continue participation being a direct result of actual experiences.

Port e-markets typology

Caputo *et al* (2004) proposed an integrated model the allows to identify the more appropriate set of organizational structures, managerial criteria and critical activities, based on variables characterizing the environment in which an e-supply chain is embedded. Yang *et al* (2007), explore, in broader terms, the feasibility of applying an internet-based information system to facilitate business alliance activities, and they conclude that communication and information sharing are the most appropriate *activities* in business alliances for the application of an internet-based information system, whereas the decision to adopt an internet-based information system is dependent on the allied partners' support and the technological capabilities they possess.

As far as the transportation sector, in particular, is concerned, Song and Regan (2001) provided a general overview of the features, trends and the market situation regarding freight transportation e-markets/intermediaries. Li and Shue (2003) proposed a framework for developing an air cargo infomediary and outline the impact and benefits it accrues to the cargo logistics chain. Granados *et al* (2007) present a theoretical framework and apply it to the air travel industry, arguing that determinants such as public policy, product characteristics that favour electronic trading and competitive (market) and institutional forces that promote industry competitiveness enable the move to transparent (air travel) markets.

As Sharifi *et al* (2006) argue a strategic framework for the identification and selection of an appropriate e-marketplace approach can include a classification model, the key dimensions of which are the nature of the products/services to be traded, the ownership/formation of the marketplace and the level of functionality/relationships exhibited by the trading exchange.

Hence, based on the aforementioned arguments, it is argued that port authority centred e-markets can act as catalysts for efficient port product trading. The nature and complexity of the port product, in terms of its high degree of variation and specialization, as well as its time, price and brand sensitivity favour an e-marketplace appropriateness.

In terms of ownership, a market can be characterised as independent (vendor led), sector coalition (sector led) or privately owned (Sharifi *et al* 2006). Lee at al (2004) determine certain features of particular e-market types, including the industry-sponsored e-markets (ISMs), the third-party exchanges (3PXs) and private e-marketplaces.

Against this background, two applicable models can be considered as e-hubs for port sectoral operations execution: *(i) port industry-sponsored e-markets* defined as consortia e-markets co-founded by port sector leaders (such as private terminal operators and public port authorities) and *(i) port third-party exchanges* defined as neutral e-markets founded by a port authority, where a number of participants both at the supply and the demand side (many-to-many) are performing information exchange and electronic port transactions, centred on aggregating fragmented supply and demand for greater market efficiency (Table 1).

Table 1: Port authority centered e-markets.

Electronic Port Governance models	**Port authority centered e-markets Functions**	**Port authority centered e-markets value proposition**
port industry-sponsored e-markets	• Cargo and passenger handling e-services • Pilotage and towage e-services • Customs and immigration e-services • Vessel traffic services and safety e-services • Maintenance and repair services e-services • Waste disposal • Landside and berth e-services • Logistics and hinterland e-services • Facilities, freight , passenger security e-services • Emergency services e-services • E-marketing of operations	❖ Port services supply and demand aggregation/integration ❖ Port services demands and offers matching ❖ Market transparency ❖ Trust, facilitation and interests settlement ❖ Efficiency ❖ Reach ❖ Protection of public interest on behalf of the port community ❖ Determination of port policy, and safety and environment policies applicable ❖ Negotiation capabilities and participatory modes of port governance
port third-party exchanges	➢ port service search ➢ port service reservation/order ➢ status tracking ➢ port service catalogue ➢ port service negotiations and auctions ➢ port service provider search ➢ back-end integration ➢ port supplier buyer rating ➢ RFQ ➢ collaborative planning	

Port industry-sponsored e-markets and port third-party exchanges can operate either as public e-marketplaces or on a mixed mode basis offering both public e-markets services, open to all qualified participants, and private e-markets services, available to a closed set of participants; this model is in contrast to a third type of e-market that is a private e-market which is built by a leading port service supplier (i.e. terminal operator) or a port service buyer (i.e. shipping company) to link itself with its own group of port business partners.

Port industry-sponsored e-markets may emerge where a few large port service providers or port users can bring along substantial volume of business (Le *et al* 2004). Their presence can make a port industry-sponsored e-market appear one sided and less appealing to other port market participants. Port industry-sponsored e-markets hold an advantage not available to port third party exchanges: ready access to the large trading volume of their founders that can help them build market liquidity. A bigger advantage for port industry-sponsored e-markets may lie in their position in the supply chain. When industry leaders are among their founders, port industry-sponsored e-markets seem well placed to facilitate the development of uniform standards for transmitting data, describing products and coordinating business processes, as well as to gain wide commitment to a common information platform.

Taking into account these postulations, when the public port authority assumes the role of a port cluster manager interested in investing and promoting port innovation and efficiency, it is worth considering and developing port authority centred e-markets, following a hybrid port industry-sponsored e-market or port third-party exchanges model as a platform for supply chain integration that fosters port cross-organisational collaboration for strategic advantage, depending on the actual embeddedness of port actors' networks in political, structural, economic and institutional factors.

Regarding the functionality of a port-authority centred e-market, it comprises e-services whereby port supply chain actors can be informed, communicate, and transact, thus including informational, transactional and value-adding, innovative port e-services, namely port service search, port service reservation/order, status tracking, port service catalogue, port service negotiations and auctions, port service provider search, back-end integration, port supplier buyer rating, request for proposal/quotation, and collaborative planning.

CONCLUSIONS

The paper provides a conceptual framework for electronic port e-Governance integrating arguments from two different strands and theories (a) the contemporary policy, organisational, operational and technological issues and trends in the port sector and (b) the converging elements of e-Government and e-markets. The emerging hybrid form of port organisation, involving a plurality of port actors provides a dynamic sectoral paradigm that creates incentives for inter-organizational

collaboration and operational synchronisation. Specific e-market models work towards this direction, whilst a public port authority is situated in a central role for promoting in practice the efficiency of a port cluster.

A port might benefit if the port authority employs new ICTs and operational models, in specific e-market typologies like the proposed port industry-sponsored e-market and port third-party exchange, and act as the 'smart' institution that governs the implementation of network organisational forms. This development would redefine the operational framework and help to overcome inefficient operations, and advance the co-operation of the several port stakeholders. Port-authority centred e-markets contribute to overcome decisional and operating fragmentation and coordinate actions towards customer-oriented structures of integrated port value chains.

The presence of multiple service providers leads to the expansion of the geographically concentrated, mutually related, business units, associations and public-private organisations that are centred on a port complex. Relationships become perplexing and port governance demands the management of numerous (internal, external, public policy, and community) stakeholders' relations.

Overall, 'networking' as based on the advancement of a rational coordination, for operating and strategically developing a port, with core features as outlined in the port authority centred e-market paradigm, can revamp port authorities in a new blended virtual agency role, that is a combined physical and electronic mode of operation. The port authority centred e-market paradigm supports the role of the port authority as a 'network orchestrator' that acts with positive network externalities for its participants.

Given that the port authority performance is by definition related to the performance of the whole port cluster, the authority has incentives to invest in action frameworks that enhance the performance of the network, in particular the enactment of port authority centred networks supported by ICTs and the proposed port e-markets models.

The present paper proposes a theoretically robust framework and offers a basis for diagnosing applicable modes in port governance choice. The proposed framework does not present any prescription of how to enact ICTs in port settings, develop port e-markets and initiate a strategic alliance or how to succeed in such a relationship. Instead, it guides the attention to the question of applicability of innovative e-Governance modes, in particular the port-authority e-markets types examined.

The next step is to empirically examine the motives, relationships, important functions and value propositions specified in the model by means of an empirical survey, in varying port market settings. The present research contributes to the existing port policy and e-Government literature by developing an integrated model for port actors' e-collaboration and ports e-Governance. By empirically supporting the proposed relationships and modes of operation, one can identify possible mechanisms to improve port actors' performance and competitiveness, via ICT enacted reciprocity.

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Journal of Maritime Research, Vol. IV. No. 3, pp. 87-104, 2007

ISSN: 1697-4840

BEHAVIOUR OF SEA FREIGHT TRAFFIC MODEL

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Received 5 April 2007; received in revised form 30 April 2007; accepted 15 September 2007

Abstract

The difficulty in determining the exogenous variables of sea traffic, both global and national, arising mainly from its complex relation with the economy, makes it necessary to turn to a theoretical analysis tool which is not always available in the required spatial area. The present paper models the behaviour of Spanish sea freight traffic in order to verify the variables which define it. To do this, we first formalise a theory on the demand for sea transport of a country, which provides useful references for the process of selection of exogenous variables. In the configuration of Spanish sea traffic the decisive factors are the GDP, the Exchange Rate, inflation and industrial production.

Keywords: Maritime traffic , Maritime economic, Sea traffic demand.

INTRODUCTION

The temporary coincidence of the world economy cycles and the sea transport market points to a clear relation between global economic activity, international trade and sea transport (Isserlis, 1938). This relation seems to be beyond all doubt since the global economy generates most of the sea traffic through the trading of raw and manufactured materials (Stoptfor, 1997). Moreover, the growth rates of the

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world's sea traffic and the industrial production of the countries of the OCDE follows a similar pattern. However, several aspects of the global economy bring about substantial changes in the dimensions of sea traffic, converting this obvious relation into a complex one.

In 'maritime' countries, the volume of freight transported by sea and the national economy are also related; but the factors which determine the complexity of this link do not coincide completely with those which intervene on an international level.

Thus, the evolution of sea transport traffic does not always follow the same pattern in the national and international areas. Some of the variables which determine the international magnitude of sea transport traffic clearly have an influence on the levels of traffic in certain countries, but other factors on a national level must be taken into account.

However, the total demand for sea transport of a country does not correspond to its total sea traffic. The volume of sea traffic is determined by the tonnes of freight transported by sea in the import, export and national coastal trading. In contrast, the demand is given by the product of the tonnes transported (sea traffic) and the distance covered (Tm x miles).

At the same time, the variables which condition demand can be applied to those which define traffic, as long as they refer to the same spatial area. Thus, the theory of national sea transport demand can help to establish the relevant variables for national see traffic.

The works which analyse the demand for sea traffic generally approach the task in the context of the economic theory of sea transport. Most tend to establish relations between the economy and sea transport. Some of the most important works are those of Tinbergen (1959), Maizels (1963), Kindleberger (1967), Metaxas (1971), Goss (1982), Chrzanowski (1985), Stopford (1988), Evangelista and Morvillo (2000), Ishiguro and Inamura (2001), Tvedt (2003), Yap and Lam (2004), Kavussanos et al. (2004), Button (2005), Laulajainen (2006), Glen (2006), Scarsi (2007) and Thoma and Wilson (2007).

In the literature on sea transport, some of the most important are those which deal with the phenomenon of prediction and among the more recent of these are the works of Li and Parsons (1997), Cullinane et al (1999), Babcock et al., (1999), Kavussanos and Nomicos (2000), Veenstra and Haralambides (2001), Babcock and Lu (2002), Mostafa (2004) and Batchelor et al. (2007).

The aims of the present work are twofold: firstly, to formalise a theory on the demand for national sea traffic as an element of general reference; secondly, to model empirically Spanish sea traffic, defining the exogenous variables determining it.

The availability of a behaviour model for Spanish sea traffic enabling predictions to be made about this traffic in the future is of great benefit both for the public and the private sectors. The Spanish Port Authorities, knowing the magnitude of this traffic and its evolution, will have at their disposal a tool to help them in their planning for

future port services and infrastructure needs. The private sector will be able to organise their activity better since the information on the predicted volume of traffic will allow them to estimate the foreseeable volume of trade. Transport companies will be able to improve the design of their marketing strategies. Stevedore companies will be able to establish the needs for loading and unloading equipment. In short, all of the operators involved will be able to adjust their offer to the real needs for their services.

THE DEMAND FOR SEA FREIGHT TRANSPORT OF A COUNTRY

Although there is, in the maritime sector, a wide range of loads which operate in the different markets (special, general and bulk), this work will consider only the overall demand for sea freight transport (Pinacho, 1978). On a national level, this is made up of those national and/or foreign sea transport services which the various operators wish to use for transporting goods, as imports, exports or coastal trading, at a specified price. Since one very important factor in sea transport is the distance covered, sea freight transport is often expressed in Tm x Mile (product of tonnes transported and miles covered).

At first sight, it might be stated that the demand for sea transport of a country will be determined mainly by the price of the service (chartering), that of the secondary services (alternative means of transport), that of complementary goods and services (transported goods and port infrastructure services), by income levels (production and consumption) and by the average distance which the freight needs to cover. Each of these factors will be analysed separately, except for production, consumption and transported goods, which will be considered in a section on the national economy.

Chartering Costs

The influence of chartering costs on the demand for national sea transport, as is the case in the worldwide context, is minimal, and thus the demand curve will behave very rigidly with respect to the service price factor. Charters usually add up to only a small amount of the final price of the goods in the port of destination. High charters (rates) are sometimes established in the context of regular lines and protected and/or guarded traffic. However, the lack of relevance of this variable in relation to the demand for sea transport is widely recognised by all authors. In any case, the response to the demand for transport of a country to the variations in charters is negative.

Alternative Services

Global sea transport is, to a large extent, irreplaceable and the various degrees of 'substitution' can normally be pinned down to the various maritime subsectors. This situation, however, is not true of the national arena. In the internal transport of freight, t rail and road transport constitute replacements for sea transport. The degree of

replacement, in import and export traffic, depends both on the position and distance to the countries with which we are trading and on the characteristics of the load. A rise/fall in the prices of alternative services (rail and road) leads to an increase/fall in the demand for sea transport. The relation between these two variables is positive.

National Economy

The demand for sea transport services is derived mainly from the demand for goods destined for production and consumption. This relation between sea transport and the national economy is obvious for any 'maritime' country, since a large part of its trading in raw materials and manufactured products will be done by sea. This is not, however, a simple relation, since certain highly diverse factors, both internal and external, which affect the national economy can also affect the demand for sea transport. We shall study three factors related with national trading levels: national production and that of the countries with which commercial relations exist, exchange rate and inflation. When analysing each of these, it will be assumed that the rest of the factors which affect the demand for sea transport remain constant.

National Production and production of countries traded with

National production makes a significant contribution to the generation of transport, both external and internal. Part of this will be channelled through sea transport in the form of importing, exporting or coastal trading, affecting the demand for national sea transport. The demand for raw materials and intermediate goods destined for production requires external flows (imports) and internal flows (coastal trading) of goods. The output needs to be transported to the distribution and consumption centres abroad (exports) and inside the country (coastal trading).

The production of those countries with which commercial relations are maintained will contribute to the generation of external transport. The part made by sea will be in the form of importing and exporting. If we are suppliers/customers of these countries, we will contribute to/require of their production exporting/ importing goods to/from them.

In keeping with the above, the increases/reductions both in national production and in that of the countries traded with will lead to rises/falls in the demand for national sea transport (always under the condition established above, that the distance does not vary). The relation between these two variables is, in both cases, of the same direction (positive or negative).

Exchange Rate

Variations in the exchange rate affect a country's foreign trade and, as a consequence, the demand for national sea transport. Exchange rate increases will promote exports and discourage imports, while reductions will produce the opposite effects.

The final ratio between imports and exports and, thus, the nature, whether positive or negative, of the repercussions on the demand for national sea transport will depend on the elasticity of the national/foreign demand for import/export products.

Several different situations may arise. In the case of a rise in the exchange rate, the fall in imports (∇I) may be greater, equal to or less than the increase in exports (ΔE) so that foreign trade will be reduced, will remain invariable or will increase, respectively. But, what percentage of these trade flows are channelled by sea, affecting the demand for sea transport? In each of the above cases, it may occur that the percentage of import trade channelled by sea (%Im) will be greater, equal to or less than the same concept in the export trade (%Em).

Bearing in mind these possibilities, we have elaborated the Table 1 to show the nature (positive or negative) of variations in demand for national sea transport in response to an exchange rate increase.

Table 1. Responses of demand for sea transport to an increase (Δ) in the exchange rate

VARIATIONS IN FOREIGN TRADE		FOREIGN TRADE CHANNELLED BY SEA		
		1	2	3
		$\%Im^c > \%Em^d$	$\%Im^c = \%Em^d$	$\%Im^c < \%Em^d$
A	$\nabla I^a > \Delta E^b$	a_1 (<0)	a_2 (<0)	a_3 (?)
B	$\nabla I^a = \Delta E^b$	b_1 (<0)	b_2 (=0)	b_3 (>0)
C	$\nabla I^a < \Delta E^b$	c_1 (?)	c_2 (>0)	c_3 (>0)

Developed by authors

^{a} = fall in imports
^{b} = increase in exports
^{c} = percentage of import trade channelled by sea
^{d} = percentage of export trade channelled by sea

A) Reduction in foreign trade of a country (∇I > ΔE)

a_1) If the percentage of trade transported by sea is greater in imports than in exports, the demand for sea transport will be reduced. Thus, it is to be expected that the variations in the demand for sea transport in response to a modification in the exchange rate should be negative.

a_2) If the percentage transported by sea is the same for both traffics, a reduction in the demand for sea transport will be expected, but in this case, the variation will be somewhat less in absolute values. The response will be negative (reasoning as in a_1).

a_3) In this case, we do not know what will happen with the demand for sea transport, as this will depend on the total trade figures. In some cases, it will

grow and in others it will fall and thus in general the nature of the influence in this case is unknown.

B) Foreign trade does not vary ($\nabla I = \Delta E$)

b_1) In the case where the percentage of participation of sea transport is greater in the import trade than in the export trade, there will be a reduction in the demand for sea transport. Thus, the demand will respond negatively to an increase in the exchange rate.

b_2) If the percentages of participation of sea transport in both trades is the same, the variations in traffic in a positive or negative direction will be compensated by variations in the opposite direction in the other traffic. Neither the trade nor the demand for sea transport will vary. As the exchange rate has no influence, the relation will be neutral, neither positive nor negative.

b_3) If the percentage of imports transported by sea is lower than that of exports, there will be an increase in the demand for sea transport, and thus the influence will be positive (this case is the opposite of al b_1).

C) Growth of a country's foreign trade ($\nabla I < \Delta E$)

c_1) When the percentage of imports channelled by sea is greater than that of the exports, we do not know what the effects will be on the demand for sea transport. This will depend on the total trading figures.

c_2) If the percentages transported by sea are the same, there will be an increase both in trade and in the demand for sea transport. The relation between the two variables is positive.

c_3) If the percentage of trade undertaken by sea is greater for imports than for exports, there will be an increase in the national sea traffic, so that it will respond to demand in a positive way (it is different from c_2 in that the variations will be more profound in absolute terms).

As well as the above, an increase in the exchange rate will favour the substitution of import products with internal products, which will promote coastal trading.

Inflation

When analysing the effects of inflation on the demand for the sea transport of a country, two possible origins are contemplated which give rise to what is known as demand inflation and cost inflation. Demand inflation will lead to an increase in internal production and imports. In both cases, an increase in the national internal and foreign sea trade can be expected, and thus, so can a rise in demand for sea transport. Cost inflation will lead to a reduction in exports, through loss in competitiveness of our products, with the consequent deterioration in the national production and an increase in imports. Moreover, there will also be repercussions in consump-

tion, probably with a substitution of the demand for national goods with a demand for foreign goods, which will make imports increase.

In keeping with the above, the rise in the internal prices of a country will boost its imports (ΔI) and reduce exports (∇E). The different situations which may arise and the nature of the relation between inflation and demand for sea transport are formalised in the Table 2, using similar reasonings as those used for the case of exchange rates.

Table 2. Responses of demand for national sea transport to inflation

VARIATIONS IN FOREIGN TRADE	FOREIGN TRADE CHANNELLED BY SEA		
	$\%Im^c > \%Em^d$	$\%Im^c = \%Em^d$	$\%Im^c < \%Em^d$
$\Delta I^a > \nabla E^b$ Foreign trade grows	(>0)	(>)	(?)
$\Delta I^a = \nabla E^b$ Foreign trade does not vary	(>0)	(=0)	(<0)
$\Delta I^a < \nabla E^b$ Foreign trade drops	(?)	(<0)	(<0)

Developed by authors

^{a} = increase in imports
^{b} = fall in exports
^{c} = percentage of import trade channelled by sea
^{d} = percentage of export trade channelled by sea

Port Services and Infrastructures

The services and infrastructures of commercial sea ports can be considered as complementary economic goods of sea transport.

Port services make up a part of the cost of sea transport and that of the goods in the port of destination. The cost of all port operations is usually distributed between shipowners and stevedores/receivers. Thus, the services lent to the ship affect the cost of transport. Those services corresponding to the handling of the goods can be charged to the shipowners and/or the owners of the freight. This choice depends on the type of market in which the operation takes place (regular line or tramp) and, finally, on the conditions of chartering. In any case, irrespective of the question of who pays for the port services, a reduction in tariffs will have positive effects on the demand for sea traffic, provided that this reduction is reflected in the price of the services and the port traffic is not guarded traffic. Bearing in mind these aspects and assuming the opposite effects to those indicated for the case of an increase in tariffs, the relation between demand for sea transport and the price of port services is negative.

Investments in port infrastructures (e.g. the creation of specialised terminals), if these are carried out in response to a potential demand, can help to capture and/or

generate new traffic. The question here is not one of diverting traffic from other national ports, as this would be of no relevance to the total sea traffic of a given country, but rather of diverting traffic from other alternative means of transport and even from the ports of other countries. Thus, such investments will have a positive effect on the demand for sea transport on a national level, a positive relation being established between these two factors. Due to the time that elapses between the beginning of the works to the actual opening of services of the infrastructures, there may well be a time gap. Thus, the port investments of today will have a positive influence on the future demand for sea transport.

Mean Distance

Demand is also a function of the distance (measured in miles) over which the freight is transported. The same load, transported over a greater distance, generates more demand for transport than the same tonnage transported to closer destinations. The distance may vary due to the opening or closing of canals, changes in the locations of suppliers or consumers, trade agreements, and so on. In response to an increase/reduction in distance, an expansion/contraction of the demand for sea transport can be expected, so that the relation between these two factors is positive.

THEORETICAL MODEL OF DEMAND FOR SEA TRANSPORT OF A COUNTRY

In keeping with the above section 2 (The demand for sea freight transport of a country), we have formalised a theoretical model which establishes the variables which determine the sea transport of a country, as follow

$$D_t = f\,(F_t, AS_t, PIn_t, PEx_t, TC_t, IPC_t, TP_t, IP_{t-d}, M_t) \quad (1)$$

Where:

D	Demand for sea transport of a country
F	Prices of services of sea transport (charters)
AS	Prices of alternative services (rail and road)
PIn	Production of country
PEx	Production of countries with which commercial relations exist
TC	Exchange rate
IPC	Inflation
TP	Tariffs of port services
IP	Investment in ports
M	Distance covered in transporting freight(miles)
t	Time
d	Delay or Time Gap

The variations in demand for national sea transport will be positive or negative in response to variations in above concepts:

$$\frac{\partial D_t}{\partial F_t} \leq 0 \qquad \frac{\partial D_t}{\partial AS_t} \geq 0 \qquad \frac{\partial D_t}{\partial PIn_t} \geq 0$$

$$\frac{\partial D_t}{\partial PEx_t} \geq 0 \qquad \frac{\partial D_t}{\partial TC_t} \gtrless 0 \qquad \frac{\partial D_t}{\partial IPC_t} \gtrless 0$$

$$\frac{\partial D_t}{\partial TP_t} \leq 0 \qquad \frac{\partial D_t}{\partial IP_{t-d}} \geq 0 \qquad \frac{\partial D_t}{\partial M_t} \geq 0$$

VARIABLES CONDITIONING SPANISH SEA TRAFFIC

In the search and selection of the variables which define Spanish sea traffic, both the theory of demand for sea traffic of a country outlined in the section above and the works[1] of Marlow and Gardner (1980) and Blanco (1994) have been taken into account.

Table 3. Selection of variables which determine Spanish sea traffic

SECTORIAL	SPATIAL	
	World	**National**
GENERAL	❑ Global exports ❑ Gross Domestic ❑ Product (GDP) both Industrial and Developing countries ❑ Industrial production of industrialised countries	❑ Imports-Exports ❑ GDP ❑ Industrial Production ❑ Industrial Price Index ❑ Consumer Price Index ❑ Exchange rate
ALTERNATIVE TRANSPORT		❑ Prices ❑ Public Administration Expenses
MARITIME	❑ Charters per voyage (oil and dry load)	❑ Investment in Infrastructures ❑ Public Administration Expenses in sea transport ❑ Maritime service tariffs (Transmediterranean)

Developed by authors

The national economic variables considered were general (production, trade and prices) related with alternative transport by road and rail (prices and expenses) and

[1] Marlow and Gardner build a supply-demand model on a global level for the bulk loading subsector. Formalising demand, they establish as exogenous variables the index of charters per journey, the GDP of the developed countries, (OCDE) and an index which reflects the efficiency of the developed countries in the conversion of raw materials into finished products. Blanco analyses the Spanish sea transport sector and, studying demand, builds an empirical model of the behaviour of Spanish sea traffic.

maritime (investments, expenses and prices). Similarly, some variables of an international nature have been considered, such as 'proxi' variables of the foreign trading relations of Spain, both general (production and exports) and sectorial (charters), as most Spanish foreign trade is channelled through foreign shipping companies which apply international charters. In keeping with the above, Table 3 groups together the exogenous variables which will later be used in the empirical model.

In our selection, we have used only independent variables for which there is statistical data gathered autonomously[II], and have disregarded other data related with the sector, both on a worldwide and a national level, considered to be of questionable reliability. The price of the service, despite what has been indicated above as to its lack of relevance in the configuration of demand, has been included for the purposes of the empirical comparison.

SPANISH SEA TRAFFIC BEHAVIOUR MODEL

The model formalised to establish which variables determine the behaviour of Spanish sea traffic, are designed to verify the following hypothesis:

1ª) National production, as a measurement of the economic activity of a country, is closely related with the level of the total national sea traffic (foreign and coastal traffic).

2ª) The production of the countries with whom commercial relations are maintained affects the dimension of a country's foreign sea trade.

3ª) The national currency exchange rate has an influence on the volume of the Spanish sea traffic of imports and exports.

It should be noted that in the estimates presented[III] some of the variables which had been previously selected proved not to be significant. These variables were the prices of the various means of transport (sea, road and rail) and the expenditure of the Public Administrations on these means.

The Model

The model established for the period 1960-2003, presents the results shown in Table 4 and Fig.1. In the estimates made, the Spanish GDP, at market prices,

[II] Consulted sources of Data: ANAVE Informe anual. Asociación de Navieros Españoles, Yearbooks 1977-1991. Banco de España Informe anual. Apéndice estadístico. Yearbooks 1980-1991. Data Service(2005). DSI Data Service & Information [online], Xantener Str. 51a . D-47495 Rheinberg . Germany . Available from: http://195.145.59.167/ISAPI/LogIn.dll/login?lg=e - [Accesed 1 February 2005]. Instituto Nacional de Estadística: Anuario estadístico. Yearbooks 1960-1991; Contabilidad Nacional de España. Yearbooks 1964-1990. International Monetary Fund International, Financial Statistics: Yearbooks 1986 and 1990- 2000; Data Base in CD-ROM (2005). Ministerio de Fomento Secretaría General Técnica. Madrid: Yearbooks 1970-1975 and 1999-2003. Ministerio de Hacienda Estadística del comercio Exterior de España. Memoria de Tráfico de cabotaje (Origen y destino de mercancías). Yearbooks 1974-1987. Ministerio de Obras Publicas y Urbanismo Memoria General de Puertos: Yearbooks 1967-1989, Yearbooks 1992-93. Ministerio de Transportes, Turismo y Comunicaciones Estadísticas de transportes: Series cronológicas (1950-80), Yearbooks 1973-1977, 1978-1983 and 1984-1998. O.C.D.E. (1972) Maritime Transport 1971-1974 and 1987-1992.

[III] Other econometric models have been estimated for the behaviour of Spanish sea traffic. In all cases, the positive influence of inflation has been pointed out. An increase in inflation will lead to an increase in Spanish sea traffic, through the increase in imports (to the detriment of exports and internal production) is verified with greater intensity in the maritime sector.

behaved in isolation more significantly than industrial production. However, we have chosen the latter as it adapts better to the introduction of exogenous variables in the modelling.

Table 4. Behaviour Model for Spanish Maritime Traffic.

Dependent Variable: TNCABIE2
Method: Least Squares
Sample(adjusted): 1960-2003 Included observations: 44

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5 304.039	25 578.04	-0.207367	0.8368
PROIND00	1 314.676	1.997.445	6.581.791	0.0000
TCEFEC00	-8.182.875	8.251.306	-0.991707	0.3276
PIBPIN00	1 608.000	2.584.531	6.221.632	0.0000
F2001	27 592.30	5 809.732	4.749.325	0.0000
MA(1)	0.545830	0.139379	3.916.165	0.0004

R-squared	0.994676	Mean dependent var	165 415.5
Adjusted R-squared	0.993976	S.D. dependent var	76 952.75
S.E. of regression	5 972.726	Akaike info criterion	2.035.392
Sum squared resid	1.36E+09	Schwarz criterion	2.059.722
Log likelihood	-4.417.862	F-statistic	1 419.984
Durbin-Watson stat	1.777.257	Prob(F-statistic)	0.000000
Inverted MA Roots	-.55		

Meaning of variables:

TNCABIE2 = Total Spanish sea traffic. Developed by authors. Tcab + TL. Units in thousands of tonnage.

Tcab = Spanish coastal trading traffic. Thousands of tonnes. Source: MTTC y MOPT.

TL = Spanish import and export sea traffic. Thousands of tonnes. Source: MTTC and MOPT

PIBPIN00 = Index of the GDP of industrialised countries at constant prices. Base year 2000. Source: IMF.

PROIND00 = Index of Spanish industrial production. Base year 2000. Source: IMF.

TCEFEC00 = Index of Nominal Effective exchange rate. Base year 2000. Source: IMF.

F2001 = Dummy variable: =0 for sample 1960-2000. =1 for sample 2001-2003

MA = Moving Average

t = Period

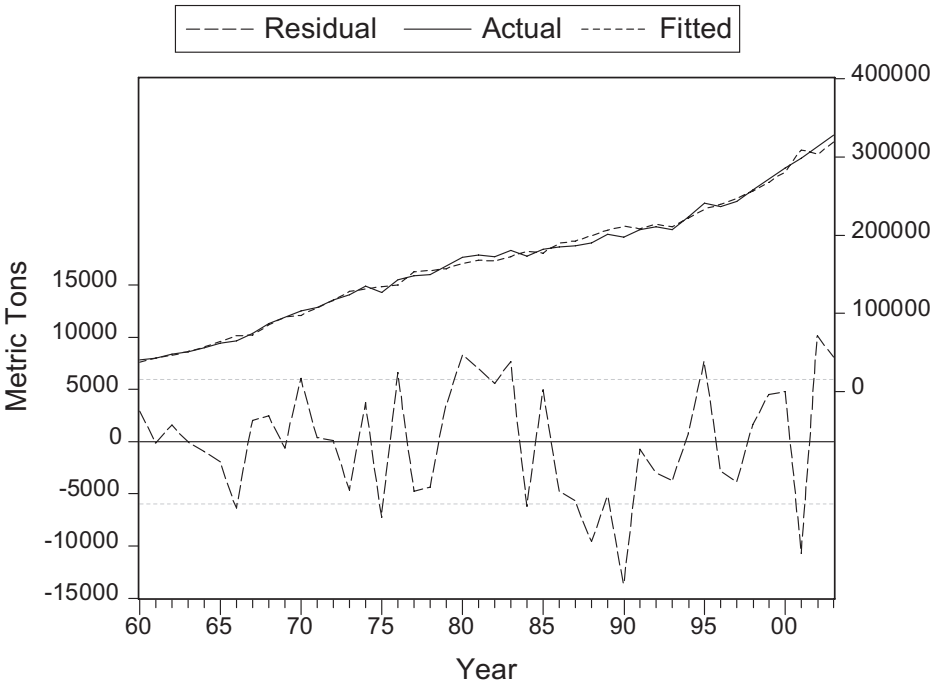

Fig.1. Spanish sea traffic model.

The values obtained from the estimation are generally correct, both with respect to the individual significance of the parameters of each variable and to the overall comparisons. With the exception of a few errors, quite high for some years, the model fits satisfactorily the real evolution of the variable. The Durbin Watson coefficient rules out the autocorrelation at the significance level of 1%.

The influence of Spanish industrial production (proind00) on the sea traffic of the country is positive (hypothesis 1 is accepted). Expansions/contractions in national production will generate an increase/reduction in sea traffic in two directions:

a) Towards the centres of national production (sea traffic in coastal trading and imports).
b) Towards the centres of distribution and consumption of national products (sea traffic in coastal trading and exports).

In recent years, the participation of sea transport in the movement of Spanish freight has decreased, both for internal and for external traffic. In the former case, this is due to the improvement in internal infrastructures and in the latter case, to the closer links with Europe as the origin and destination of our trade. Coastal trading makes up over 10% of the internal movement of freight, while in external freight

traffic, sea transport accounts for 68% of the total, its participation in imports being around 77% and in exports around 47%. Moreover, in Spanish sea traffic, the participation of coastal trading is around 12%, the remaining 88% corresponding to external traffic. Thus, any variation in national production will affect mainly external Spanish sea traffic.

The relation between the production of the countries with which we maintain commercial links (pibpin00) and Spanish sea traffic (tncabie2) is positive. An expansion/contraction in the production of these countries will increase/reduce our foreign trade sea traffic (hypothesis 2 is accepted). In the estimates made, Spanish sea traffic has generally responded more to changes in production that to changes in trade. Thus, the GDP, whether global, of the industrialised countries or developing countries has proven to be more significant than global exports.

The TCEFEC00 variable indicates the response of Spanish foreign trade sea traffic to the relative variations in the prices of goods. Similarly, in the short term, the exchange rate promotes speculative movements. The negative effect of the exchange rate responds to a structural characteristic of the country's sea traffic. In Spain, as outlined above, the percentage transported by sea is greater in the import trade than in the export trade. A rise in the exchange rate, which boosts exports and reduces imports, will result in a reduction in Spanish sea traffic. The effects produced by a fall in the exchange rate will be the opposite of the above (hypothesis 3 is accepted).

F2001 is a dummy variable. It has been enclosed in the model because the currency change from peseta to euro affects the exchange rate.

CONCLUSIONS

The prices of sea transport services and their replacements (road and rail) have not proven to be decisive factors in the evolution of the levels of Spanish sea traffic. This traffic, it seems, will evolve in the same direction as the general trend in the country's economy, leading to expansion/contraction according to this trend.

The sea traffic will depend positively on industrial production, both Spanish and that of the countries with which Spain maintains economic relations. The positive or negative nature of the variations in sea traffic in response to the exchange rate is derived from the structural characteristics of Spanish sea traffic, in that its participation in the imports trade is greater than in that of exports.

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MODELO DE COMPORTAMIENTO DEL TRAFICO MARÍTIMO

Resumen

La dificultad para determinar las variables exógenas del tráfico marítimo, tanto mundial como nacional, principalmente originada por su compleja relación con la economía, plantea la necesidad de recurrir a una herramienta teórica de análisis no siempre disponible en el ámbito espacial requerido. En el presente trabajo, cuyo objetivo es la modelización del comportamiento del tráfico marítimo español de mercancías, se ha creído preciso previamente formalizar una teoría sobre la demanda de transporte marítimo de un país, como referencia necesaria en la selección de las variables.

LA DEMANDA DE TRANSPORTE MARÍTIMO DE MERCANCÍAS DE UN PAÍS

En una primera aproximación, de acuerdo con la teoría económica, se puede afirmar que la demanda de transporte marítimo de un país va a estar determinada principalmente por el precio del servicio (flete), el de los servicios sustitutivos (modos alternativos de transporte), el de los bienes y servicios complementarios (mercancías transportadas y servicios e infraestructuras portuarias), por el nivel de renta (producción y consumo) y por la distancia media que deben recorrer las mercancías. Se analizan dichos factores por separado salvo la producción, el consumo, y las mercancías transportadas, que serán abordados en un apartado denominado economía nacional.

VARIABLES CONDICIONANTES DEL TRÁFICO MARÍTIMO ESPAÑOL

En la búsqueda y selección de las variables explicativas del tráfico marítimo español se han tenido en cuenta la teoría de la demanda del transporte marítimo de un país y los trabajos de Marlow y Gardner (1980) y Blanco (1994). Marlow y Gardner, construyen un modelo de oferta-demanda a nivel mundial del subsector de carga seca a granel. Al formalizar la demanda establecen como variables exógenas el índice de fletes por viaje, el Pib de los países desarrollados (OCDE) y un índice que refleja la eficiencia de los países desarrollados en la conversión de materias primas en productos elaborados. Blanco, analiza globalmente el sector del transporte marítimo español y, en el ámbito de la demanda, construye un modelo empírico de comportamiento del tráfico marítimo español.

Se han seleccionado variables económicas nacionales de carácter general (producción, comercio y precios), relacionadas con los transportes alternativos por car-

retera y ferrocarril (precios y gastos) y marítimas (inversiones, gastos y precios). Asimismo se han tenido en cuenta algunas de ámbito internacional, como variables "proxi" de nuestras relaciones comerciales con el exterior, tanto generales (producción y exportaciones) como sectoriales (fletes), ya que la mayoría del comercio exterior español es canalizado a través de navieras extranjeras que aplican fletes internacionales.

MODELO DE COMPORTAMIENTO DEL TRÁFICO MARÍTIMO ESPAÑOL: HIPÓTESIS Y RESULTADOS

El modelo formalizado para establecer qué variables determinan el comportamiento del tráfico marítimo español, pretenden contrastar las siguientes hipótesis:

1ª) a producción nacional, como medida de la actividad económica del país, está estrechamente relacionada con el nivel de tráfico marítimo nacional total (exterior y cabotaje).
2ª) La producción de los países con los que mantenemos relaciones comerciales afecta a la dimensión del comercio exterior marítimo nacional.
3ª) El tipo de cambio de la peseta influye en el volumen de tráfico marítimo español de importación y exportación.

En las estimaciones realizadas no se han mostrado significativas algunas variables que habían sido previamente seleccionadas. Se trata de los precios de los distintos modos de transporte (marítimo, carretera, y ferrocarril) y de los gastos de las Administraciones públicas en los mismos.

La influencia de la producción industrial española en el tráfico marítimo del país es de signo positivo (se acepta la hipótesis 1). Expansiones/contracciones de la producción nacional generarían un incremento/reducción del tráfico marítimo en dos sentidos:

a) Hacia los centros de producción nacionales (tráficos marítimos de cabotaje e importación).
b) Hacia los centros de distribución y consumo de productos nacionales (tráficos marítimos de cabotaje y exportación).

La relación entre la producción de los países con los que mantenemos vínculos comerciales y el tráfico marítimo español es positiva. Una expansión/contracción de la producción de dichos países incrementará/reducirá nuestro tráfico exterior marítimo (se acepta la hipótesis 2). En las estimaciones realizadas, el tráfico marítimo español ha respondido, en general, más a movimientos de la producción que del comercio. Así se ha mostrado más significativo el PIB ya sea mundial, de los países industriales o en vías de desarrollo, que las exportaciones mundiales.

La variable Tipo de Cambio muestra la respuesta del tráfico marítimo exterior español a las variaciones relativas de los precios de las mercancías. Asimismo a corto plazo el tipo de cambio favorece movimientos especulativos. El signo negativo del tipo de cambio obedece a una característica estructural del tráfico marítimo del país. En España, el porcentaje que se transporta por mar es mayor en el comercio de importación que en el de exportación. Una subida del tipo de cambio, que favorece las exportaciones y reduce las importaciones, tendría como resultado un deterioro del tráfico marítimo español. Los efectos originados por una bajada del tipo de cambio serían contrarios a los indicados (se acepta la hipótesis 3).

CONCLUSIONES

Los precios de los servicios de transporte marítimo y de sus sustitutivos (carretera y ferrocarril) no han resultado ser factores determinantes en la evolución de los niveles de tráfico marítimo español. Al parecer dicho tráfico va a evolucionar en el mismo sentido que la dinámica general de la economía del país, produciéndose expansiones o contracciones según sea el signo de dicha evolución.

El tráfico marítimo dependerá positivamente del índice de la producción industrial, tanto española como de los países con los que mantenemos relaciones comerciales, y negativamente de la evolución de los tipos de cambio. El signo de las variaciones del tráfico marítimo en respuesta al tipo de cambio se deriva de las características estructurales del tráfico marítimo español. En concreto, por ser mayor su participación en el comercio de importación que en el de exportación.

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Chapters of books

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