COMPETITION & PRICING BETWEEN INLAND & SEA TRANSPORT: EVIDENCE FROM GREECE

1. Prof. Evangelos SAMBRACOS,Department of Economics, University of Piraeus, 80 Karaoli & Dimitriou Str. 18534, Piraeus, Greece

2. Maniati Marina, Phd. Cand., Department of Economics, University of Piraeus, 80 Karaoli & Dimitriou Str. 18534, Piraeus, Greece

ABSTRACT

The transport problems (such as congestion, environment, inefficiency and cost) have led to an examination of competition between different modes in Inland Regions. Particularly, there is a need nowadays to examine the issue of competition between short sea shipping and road freight transport, especially from the pricing aspect. The approach to the problem has mainly been focused on increasing urban supply to meet demand better. However, a failure to consider pricing, cost, and the subsidization physical restrictions affects the shape of supply systems.
The connection between Patra (a major Greek import area) with West Attica (the biggest Greek industrial centre) provides an appropriate case study as pricing issues, as well as other physical restrictions (i.e. due to Corinth Canal), have to be considered in order to both identify & estimate the factors that can make sea transport more competitive in comparison mainly with road transport. The paper also examines the externalities associated with both road & sea transport, i.e. the costs of transport modes' use, the revenues, and the relevant social cost / benefit, in order to provide a viable solution for the promotion of short sea shipping in the transport chain.

Keywords: Market Competition; Inland/ Sea transport; Short Sea Shipping

1. INTRODUCTION

During the recent years, the Greek-Italian (Adriatic) axis has evolved to a trade route of major significance in the region, in serving as one of the most prominent trade-lanes for cargo and passenger flows. This trend seems more significant if one also considers the ongoing eastbound EU enlargement process that will result in the integration of new markets with the European common market. The linkage between neighboring countries is provided by combinatorial use of inland road and seaborne transport modes. The seaborne leg connects Greek and Italian ports with each other (notably Patra and Igoumenitsa on the Greek side and several Italian ports on the other side of Adriatic). Cargoes are then

forwarded to inland markets via road transportation to complete the network. In this operational context, linking Patra with Athens-Attica -the latter being prominent as an industrial and commercial centre on the Greek side that generates substantial volumes of traffic-, naturally attracts much of interest.

Despite the everlasting works aiming to upgrade the Athens-Corinth-Patra road axis, significant difficulties and consequently, time delays in cargo dispatches are observed, mainly attributable to the poor state of the infrastructure on one hand and the multiplicity of usage modes of the existing infrastructure. Persistently strong demand of the road's capacity for a wide array of uses, along with several restrictions imposed on trade and transport traffic, especially during weekends, combined with congestion during peak hours, construction works and the existence of inhabited areas along the line, generate significant impediments for cargo road transport.

By the same token, arguable is also the efficiency and effectiveness of truck operations on this route, given the fact that trucks remain idle during the seaborne leg of a typical trade flow to and fro Italy. Trailer cargoes could be loaded aboard without their tractors and be shipped through the Adriatic, thereby avoiding inefficient use of road trucks and thus, delivering increased value to transport consumers at the same or less cost.

In this context, the present paper examines seaborne transport alternatives for commuting shipments and cargoes between Athens and Patra, which involve the ports of Patra on one side and Eleusis on the other. The relevant discussion assumes major significance, if one takes into account the broad promotion of Short Sea Shipping in the European transport context. .

2. MARKET CHARACTERISTICS AND DEMAND FOR TRANSPORT

In Greece, road transport constitutes the most common mode in cargo movements, as evident by its relative contribution to the country's total transport production which amounts to 41.55% (international trade transport in terms of volume). In what concerns national commercial transport, this contribution tops at an overwhelming 98%. It seems as if the trade route from Eleusis to Patra is largely monopolized by truck road transport and given the relatively high upfront cost of railroad investments needed to upgrade the existing rail network, it follows that the only alternative to truck road transport is to develop seaborne routes that scan substitute road transport in an efficient and effective manner.

The analytical context of the present paper employs data concerning volume and synthesis of transported cargoes in order to assess the size of the market but also the potential for redirecting part of transport volumes from road transport modes to seaborne trade routes. Moreover, an attempt is made to identify the number, the relevant types and generic characteristics of the typical truck loads embarked on Ro-Ro ships and also to define potential maritime routes and ports involved in the process subject to physical/geographical restrictions (e.g. the Corinth Canal) in order to assess a workable minimum array of technical characteristics of typical ships to be deployed in the most appropriate maritime leg.

Data suggests that trailer and truck flows to and fro Italy (generated mainly from Attica and Athens through the port of Patra) shows strong signs of mean reversion behavior, thus

constituting a considerable critical mass of cargoes to support the economic feasibility of establishing seaborne trade routes from Athens to Patra and vice versa. What is more, demand for transport shows a definite upward trend during the third quarter year 2006 (as evident from figure 1) thereby solidifying the economic rationale for creating a seaborne leg of transportation from Eleusis to Patra (See Annex, Map of Greece). The existence of cargo abundance could significantly affect (in a positive manner) not only the efficient routing of ships on the line but also levels of capacity utilization and therefore, financial performance key measures.

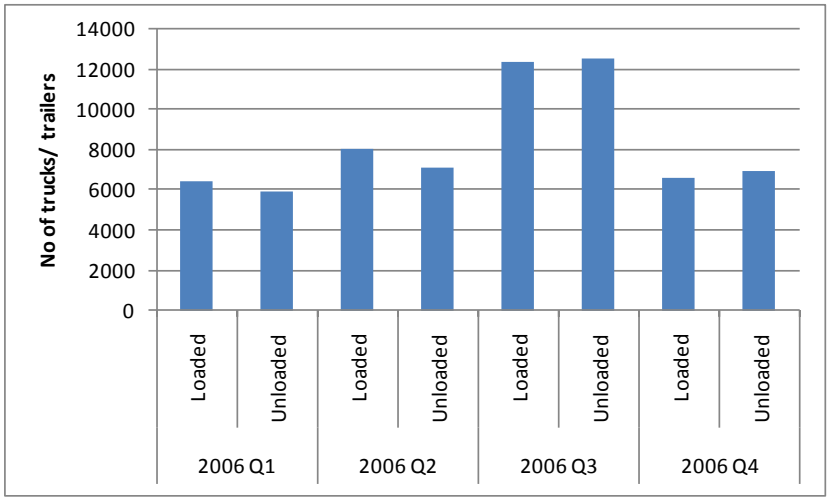

Figure 1 – Loaded/ Unloaded trucks/ trailer at the Port of Patra

In what concerns the types of cargo transported through the port of Patra, the most prominent category is that of perishable goods such as fruits and vegetables, that make a rough one third of total cargo volume transported, with “Minerals and related products”, “Food and Beverages” and “Grouped Cargoes” each making a rough 10% of total cargo volume exported to Italy. In a similar fashion, the eastbound trade involves “Grouped Cargoes” (25%), “Fruits and Vegetables” (20%), “Food and Beverages” and “Livestock Products” about 10% of transported cargo. Noteworthy is the fact that an overwhelming percentage of eastbound traffic ends up in the region of Athens-Attica either for consumption or for transshipment.

Regarding the infrastructure of ports involved in the Greek-Italian transport lane, it is worth to note that the port of Patra has a total quay length of approximately 3,000 m, with docks that have a depth ranging from 8.50 to 10.50 meters. The port of Patra also has the potential to serve cargo ships up to 25,000 tons and a length of 220 meters. The port of Patra also comprises warehouses covering a total area of 8,000 square meters and outdoor storage areas of 80,000 sq.m total. The entry-exit points of the port comprise 7 gates, which are located along the coastline.

The Port of Eleusis extends to a 50,000 square meters area and has a throughput of about 2 million tons of cargo, while the port handles 5000 ship calls annually on an average basis. It has a total quay length of 1037 meters and the dock dimensions are 300x80 meters. The depth ranges from 8- to 10 meters. The Port of Eleusis is strategically situated in the center of a region with booming industrial and commercial activity which includes business units of relatively high capitalization. The commercial significance, but also its proximity to major road

axes and railway terminals, equips the port with considerable advantages and makes it attractive for a wide variety of trade flows in the region, thus contributing to a rapid growth in demand for transport services. Additionally, the port's connectivity with other major ports of Greece (in course of developing an integrated and efficient transport network) is becoming increasingly important.

3. A COMPARISON OF TRANSPORT MODES IN PATRA-ELEUSIS TRADE ROUTE

Based on demand, capacity of potential market and restrictions imposed by existing transport infrastructure, Table 1 exhibits the typical vessel's minimum technical and functional characteristics that could provide the basis for achieving competitiveness and enhanced efficiency contrasted with truck road transport service between Patra - Eleusis.

Table 1 – Typical vessel characteristics (Patra- Eleusis maritime transport lane)

Vessel Type	Ro-Ro
Minimum length	110 m
Maximum beam	17m
Maximum draft	4 m
GRT	6.500
Engines	2*4.500 HP
Carrying capacity	60 trucks
Operational Speed	14-17 Knots
Crew (No)	18
Frequency	1 trip/ day for each destination

Similarly, given that the comparison of transport modes is intended to assess the actual potential of international freight transport, the present paper considers the type of Large Goods Vehicles (over 7.5 tons) Articulated Truck (with detachable trailer). Worth to mention is that the type of trailer is mainly dependent on the type of cargo being transported. For most trailer types, the size and function/intended use are rather common. For this reason, the following analysis considers the closed type of trailer for general/palette cargo as the benchmark unit of reference.

3.1. Financial Scorecard

In the proposed analytical context, profitability and viability of alternative proposals for transport between Patra - Athens (and vice versa) are examined. Also, the analysis employs classical assessment methodologies such as the Internal Rate of Return, Net Present Value and Break-Even Point Analysis. The viability of the investment is also investigated under different financing scenarios.

Cost of road freight transport in the Patra – Athens Link

In order to estimate the cost of a typical road freight business operating a truck to transport cargoes in the Athens - Patra leg of the route, we take into account that the length of the distance from Athens to Patra amounts to 220 km, whilst under the effective speed limits (80 km per time), the average speed is constrained down to 70 km/h. so the one way trip needs 4 hours approximately for completion. The acquisition and operation of trucks, involves the following types of investment and operating costs:

Cost of acquisition. The cost of acquiring a truck varies inversely with the age of the vehicle (new and used), the manufacturer and the relevant technical characteristics of the vehicle. For the purposes of this paper, we have identified an average price of a new and a used vehicle 5 years age truck, totalling 81000 € and 43,000 € respectively. We then consider two different scenarios: a) The acquisition of a new vehicle to be financed by owned equity and b) The acquisition of a used truck with a loan financing. Furthermore, the overall cost of acquiring a ready to operate truck is further charged with the cost of buying a publicly administrated License (Operating License), which amounts to 80000 € per vehicle.

Operating costs. We distinguish between two main cost categories: a) Fixed and b) variable operating costs. The fixed cost of road transport service provision includes:

- Driver's Basic salary. The salary is calculated on a monthly basis and comprises a 1200 € pay for the driver plus 606 € for pension fund and medical insurance.
- Insurance Premiums. Premium payments refers to the vehicle's insurance and are estimated at 1000€ per semester. Add insurance for any damage to transported goods, approximately 500€ per semester to estimate a total 1500 € insurance costs per vehicle.
- Vehicle State Fees. These are annually estimated and amount to 205.40 € per vehicle.
- Cost of vehicle's compulsory technical survey. Amounts to 60 € per vehicle per annum.
- General Costs. Refers to costs related to communication of the driver with the firm, handling, etc. And are estimated at 200 € a month for each vehicle.

In order to estimate variable costs of truck transportation services the following cost categories were taken into account:

1. ***Fuels.*** Fuel costs depend on distance and fuel consumption. Fuel consumption is associated with both average speed and the technical capabilities and state of the engine. With estimated an average hourly speed of 70 km on the route Athens – Patra, and an average fuel consumption equivalent to 1 litre of fuel per 3 km for new vehicles. Given that the older a vehicle is, the less engine performance is (and therefore fuel consumption is generally higher). Fuel consumption for a used vehicle is estimated at 1 Littre per 2km. The cost of fuel is normalized to 1.25 € per Littre.
2. ***Lubricants.*** Estimated at 1000 € per 10000 km of distance made***.***
3. ***Tires.*** The cost of tires replacement is estimated at 2000 € on average per year.
4. ***Maintenance costs.*** On average, we estimated the annual maintenance cost for each vehicle at 2.000 € per year.

5. Travel allowance. Compensation for truck driver, that on average, amounts to 40 € per round trip (Athens - Patra - Athens).

6. Tolls. The cost of toll fees is 20.2 € only for a one way pass at the section Athens - Patra.

Table 2 presents the overall annual operating cost that a typical transport company faces, for maintaining a regular transport service on the Athens-Patra route (320 round trips on average per annum), if operating a new and a secondhand truck.

Table 2 – Annual operational cost for road transport (1 truck, Athens – Patra – Athens 1st year)

	NEW	**SECONDHAND**
	Fixed Cost (in €)	
Driver cost	23026.51 €	23026.51 €
Insurance cost	3000.00 €	3000.00 €
Traffic fees	205.40 €	205.40 €
Technical inspection (Ministry of Transport)	60.00 €	60.00 €
Other cost	2400.00 €	2400.00 €
Sub-total 1	**28691.91 €**	**28691.91 €**
	Variable Cost (in €)	
Petrol	58666.67 €	70400.00 €
Lubricants	14080.00 €	14080.00 €
Wheel replacement	2000.00 €	2000.00 €
Maintenance	1000.00 €	1000.00 €
Driver mileage	12800.00 €	12800.00 €
Toll fees	12928.00 €	12928.00 €
Subtotal 2	101474.67 €	113208.00 €
Total (1+2)	**130166.57 €**	**141899.91 €**

Cost of seaborne transport in Patra-Athens route

For the purposes of the present paper, we assessed the feasibility and economic viability / profitability of establishing a regular maritime transport service on the leg of Patra-Eleusis for transporting trucks and loaded trailers. The distance between the two ports is estimated at 130 nm at an average operational speed of 17[1] knots, and the required journey shall have an expected completion time of 7.65 hours one way and 15 hours for a round trip. At an operational speed of 14 knots, the trip duration is estimated at approximately 9.3 hours each direction and 18.6 hours for a round trip. The cost related, can be categorized as follows: **Acquisition cost**: We consider two different scenarios: a) Acquisition of new ship which will be launched for regular service in the proposed route (Scenario 1), b) Purchase of a second hand vessel (Scenario 2) which satisfies the proposed technical specifications that are sufficient to adequately meet demand for transport of trucks and loaded trailers from Patra, to Eleusis and vice versa. The cost of the new ship is estimated at 6,500,000 €, while the cost of a second hand is estimated at 6,000,000€[2].

[1] We use the upper limit of the operational speed interval (14-17 Knots) set out at table 1, so as to assess the maximum potential of the service's competitiveness.

[2] Secondhand prices appear to be somewhat slightly lower than that required for new builds mainly due to the availability of the former for entering into service in an immediate fashion. Build times for a typical Ro-Ro ship may vary up to two years from order to completion so availability is a valued parameter during a ship acquisition decision.

Cash Flow Capital. Cash flow capital is roughly estimated at 1/3 of total operating expenses of the proposed service. Noteworthy is the fact that the underlying relationship between demand for cash flow capital and the frequency of the regular service is straightforward, which by turn implies that as the service is offered on a more frequent basis, the demand for cash flow capital shall increase.

Operating cost

1. Fuel Costs

The calculation of the cost of fuel per hour cruising can be derived from the following relationship:

$$C = aNQP \quad (1)$$

where:

a: denotes the real horse power capacity of the engine

N : denotes the horse power of main engines

P: price of fuel

Q: special consumption of main engines

In the special case of a new built ship we take into consideration the following figures/assumptions:

The real horse power capacity is defined at an average 0.85 of its theoretical counterpart given the fact that operating the engines at their limits is not generally advisable[3].Thus, substitute a=0.85 in (1).The engine power is calculated from the sum of powers of operated engines that move the shaft. A typical Ro-Ro ship combines two 4500HP main engines, such that P=9000HP.The price of fuel for a typical Ro-Ro ship (average prices of 2010) is estimated at 0.62 € per Kg/cruise Hr/used HP (a total of 620 € per ton of fuel). The special consumption coefficient represents fuel consumption in gram per cruise hour. For the typical Ro-Ro ship to operate in the proposed route (Patra-Eleusis), consumption should not exceed 80gr./used hp/cruise hr. Thus, daily fuel consumption for a roundtrip is expected to amount to 11 tons in total such that Q=0.08 Kgr/Hp.h.

Based on the underlying assumptions, the annual cost of fuel for a round trip on the proposed route, is estimated at 2,113,101.36 €, for an average of 5569 cruise hours and 379.44€ average fuel cost per cruise hour.

In what concerns the fuel cost for the new built case in a twenty year projection, the following assumptions will be made:

1. For years 1-5 fuel cost is expected (roughly) to remain constant in the sense that consumption is not subject to significant variation.
2. For years 6-15 fuel cost is expected to show an increasing trend of 2% per annum.
3. Finally, for years 16-20 we expect an annual increase by 2.5% in total fuel consumption.

For the case of a secondhand ship, the relevant parameters in equation (1) are as follows:
a: 0,85, N: 9.000, P: 0.62 € and Q: 0.085.

[3] Running engines at their limits results in reduced operational lifespan and also in augmented maintenance and repair costs.

The special rate of consumption has increased in the case of a secondhand, given the aging engine (0.085 rather than 0.08). Moreover, the development of fuel costs in a twenty year projection varies as follows:

1. For years 1-10 fuel costs are expected to increase by 2% on annual basis.
2. For years 11-15 fuel costs are expected to increase by 2.5% on annual basis.
3. For years 16-20 το fuel costs are expected to increase by 2.5% on annual basis.

The annual fuel costs for a round trip Patra-Eleusis-Patra, is, in the case of the second-hand hand ship routing about 2,245,170.20 € per year. The fuel cost per hour of cruise 403.16 € (approximately 6.25% more, compared to the new built option that results in a cost of 379.44 € respectively).

2. Lubricant Cost

The cost of lubricants (new built and secondhand vessel) is estimated at 12% of fuel costs, since the relationship between the two is directly proportional. The development of lubricant cost through time follows the fuelling cost, since the two variables are directly interdependent.

3. Port charges

Port charges (for both the new built and the secondhand vessel) include: a) Anchorage fees: 14.70 € per 1000 GRT, b) Berth fees: 79.75 € per 1000 feet (ft) of length, c) Mooring fees: estimated at 1/3 of berthing fees. Given the cyclical nature of the trip on a daily basis, annual port dues for approximately 728 port calls (both ports) amounts to 141,620.3 € per year. It is assumed that over time, the cost of port charges remains constant given the anticipation of intense competition after deregulation of port services provision in the Greek market.

4. Berthing Fees

Port charges (for both cases) for a permanent berth position in involved ports are estimated on a monthly basis at an average cost/ port 170.8 €. Therefore, the total annual cost is the annual cost amounting to 4,099.2 € with an annual increase of 1%.

5. Corinth Canal Pass Dues

For calculating the Corinth Canal fees (for both cases), the following parameters are taken into account:

- The ship is under the Greek flag;
- The type of ship is Ro-Ro;
- Port of departure: Patra (and vice versa) - Port of call: Eleusis (and vice versa);
- Width: 17 m;
- Ship Depth: 4 m;
- Gross Registered Tonnage: 2000;
- Number of tug boats: 1;
- Number of pilots: 1.

Based on the data and the parameters listed above, and in accordance with advertised prices from the Corinth Canal managing Authority, the ship involved in the Patra-Eleusis route, is charged under provisions of category A, whose annual transit fees to be paid are presented in Table 3. Note that charges for transit ship on weekends and holidays are included, and also, that the regular 10% discount on frequent crossing is estimated in the final price that is subject to an annual increase of 1%.

Table 3 Transit fees & rights of Corinth Canal

Category of fees	Fee/ Transit	No of transits	Annual cost
Ordinary	1885.00 €	301	567385.00 €
Sundays & Holidays	2169.40 €	64	138841.60 €
Transit during night & Sunday/ Holiday	2216.8 €	64	141875.20 €
Transit during night	2122.00 €	301	638722.00 €
			1486823.80 €
		10% Discount	148682.38 €
		Total	**1338141.42 €**

Source: New invoice 2009 – 2010 of transit fees & rights of Corinth canal

6. Costs of Maintenance and Repair

Maintenance cost is related to size and type of the vessel but also, its age. Therefore, for a newly built ship or equivalently for a vessel of up to 5-years age, the relevant costs are calculated as a rate (percentage) of construction or purchase cost, respectively. The annual cost of maintenance and repair rate as projected over time is as follows:

1. For the first 5 years about 0.75% of construction or purchase value;
2. For 6-10 years approximately 1% of the value of construction or purchase;
3. For 11-15 years, about 1.5% of the value of construction or purchase and finally;
4. For years 16-20, about 2% of the value of construction or purchase.

In the case of a used vessel, the annual cost of maintenance and repair changes over time as follows:

1. For the first 5 years of operation, costs in this category are expected to amount to approximately 1% of the market value of the second-hand ship;
2. For years 6-10 of operation, the rate increases to 1.5% and finally;
3. 3. For 11-20 years the rate is 2% of the second-hand.

7. Insurance Costs

The insurance premiums are estimated as a percentage rate of the value of the ship. The appropriate rate has been defined at 2.0%.

8. Personnel Expenses

Under applicable laws in Greece, provided that crew composition shall be identical to the proposed as following (Table 4) and according to regulations, the monthly cost for personnel, under the existing collective union agreements, shall be likewise Table 4. The annual growth rate of wages equals 2.5%.

Table 4 Crew Cost Ro-Ro (Patra-Eleusis route)

	No	Monthly wages
Deck department (9 persons)		
Master	1	3607.77 €
2nd Deck Officer	1	2000.48 €
3rd Deck Officer	1	1743.34 €
Boatswain	1	1536.94 €
Seamen	5	1475.63 €
Engineering department (6 persons)		
Chief Engineer	1	3579.49 €
2nd Engineer Officer	1	2000.48 €
3rd Engineer Officer	1	1743.34 €
Engineering Cadet	1	1160.73 €
Chief Qualified Member of the Engine Dpt	1	1735.19 €
1st Chief Qualified Member of the Engine Dpt	1	1589.03 €
Steward's department (3 persons)		
Chief Cook	1	1644.01 €
Chief Steward	1	1536.94 €
Steward assistant	1	1160.73 €

9. Office expenses

General expenses related to office and administrative operations (rent, telecommunications, supplies, etc.) are estimated at 20.000 €. The cost of office staff is estimated at 30.000 € per year with an annual increase of 3.5%. Based on these assumptions, the annual operating cost (during the first year of operations) for operating the ship (round trip) on a daily schedule of service for the proposed route is presented in Table 5.

Table 5 Ro-Ro annual operational cost (Line Patra- Eleusis)

Cost category	New build	Secondhand
Variable Cost		
Diesel	2113101.36 €	2245170.20 €
Lubricants	253572.16 €	269420.42 €
Maintenance/ Repair	48750.00 €	60000.00 €
Port dues	4099.20 €	4099.20 €
Port fees	141620.30 €	141620.30 €
Transit fees & rights of Corinth Canal	1338141.42 €	1338141.42 €
Sub-total 1	**3899284.44 €**	**4058451.54 €**
Fixed Cost		
Insurance	130000.00 €	120000.00 €
Crew cost	453832.68 €	453832.68 €
Personnel cost (office)	30000.00 €	30000.00 €
Other cost	34000.00 €	34000.00 €
Subtotal 2	**647832.68** €	**637832.68** €
Total (1+2)	**4547117.12 €**	**4706284.22 €**

Comparing cost figures of road and maritime transport respectively (Tables 2 & 7), the annual costs of seaborne transport correspond to the total cost required for operating approximately 35 trucks, which make 320 round trips per year each, on the route Patra - Athens - Patra. Given that the capacity of these trucks is 7.5 tons, 4800 tonnes may be transported in total, provided that trucks commute on full load in both directions. The

equivalent cargo volume that can be transported by the Ro-Ro ship (based on its transport capacity) on the Patra - Eleusis - Patra route is 19,200 trucks (i.e. 288,000 tonnes). Given the assumption that the ship is operating with an average capacity utilization of 75%, the cargo volume transported, is equal to 216,000 tons, considerably higher than the transportation work carried out by 35 trucks a year.

Revenue Analysis for a typical maritime transport firm, operating in the Patra-Athens route.

Estimations of potential profits have made extensive use of data available from the Port of Patra and Eleusis, so as to determine the volume of transported cargo by truck and trailer that will be attracted by the Ro-Ro service between the two ports. The revenue to be generated, depends gravely on the amount of cargo that will be available for maritime transport, that is, the market share to be captured by the latter. The potential penetration rate may not be uniformly distributed across different categories of cargoes transported. These cargoes can be subcategorized into two distinct classes, defined in accordance to a criterion directly related to the desired speed of cargo's dispatch. It is in any case rational to expect that perishable products are expected to be transported to their destination as quickly as possible. Thus, transported cargoes can be assigned to two markets defined with respect to the speed of delivery: a) the high speed of delivery market, where low rates of penetration are expected for maritime transport, perhaps an average of 10% (Annex Table I) and, b) the low delivery speed market, where a high penetration rate is expected, of about 20% on a medium-long term (Annex Table II). Based on Tables I and II of Annex and also, the underlying assumptions, the following conclusions can be reached:

1. It is estimated that the maritime connection between Patra-Eleusis would capture about 10% of total trading volume of the low penetration (high speed) market of 10% in volume. This translates into 231,532 tonnes of cargo per year in both directions of the route.

2. In a similar fashion, it is estimated that a maritime connection for the proposed route could attract approximately 20% in volume of total trade in high penetration (low speed) market (see Table II), which is equivalent to about 152,617 tons of goods. The analysis above, strongly indicates that the relevant market is defined by the total volume of cargo throughput in the Athens-Patra segment, for which, estimates show that it amounts to roughly 400.000 tons per year for a round trip between the two ports. Accordingly, each single route can move about 200,000 tons of cargo on average. With the assumption that a typical ship operating in the line can transport truck load cargo of 7.5 tons (a unit selected to correspond to the analysis of inland transport), then we have that each daily one way trip on the route, may move 547 tonnes in each direction. This volume of transported cargo accounts for more than 70 lorries of 7.5 tonnes. Given that the typical vessel defined as a benchmark vessel to be launched in the Patra-Eleusis line, has capacity of 60 trucks of this type, it seems that the relevant market size is adequately large so as to justify, in an economic sense, such an undertaking.

The calculation of revenues involves a series of parameters such as:

- The type of cargo;
- The provided service level;
- The final freight level, commensurate with distance between ports of load and discharge (nautical miles) and pricing policy followed by the shipping company.

Total revenue is estimated at 2010 prices. Traditionally, seaborne transport attracts most of available cargo since it can provide high service levels with reliability and high quality of services throughout the year. The increase in transported volumes may be due to better exploitation of the ship's capacity combined with the implementation of discriminatory pricing policies. In the context of the present analysis, it is assumed that the shipping company's revenue is generated solely from transporting trailer cargoes and/or truck loads. In particular, for determining the maximum fare which we can be charged per truck (or trailer), in order to capture market share from the inland transport mode, we adopt the following estimation methodology:

1. We obtain the data derived from calculation of operating costs of road transport for the Patra-Eleusis route (Table 2).
2. We estimate the operating cost standardized on per day / round trip basis (320 days - trips of trucks). Operating costs range from 406.77 € to 443.44 €, depending on whether they refer to the operation of a new or used truck. For the operation to be competitive, one may charge fares ranging within these limits.
3. Finally, given the limits of the applicable fares that may be charged by the firm for each truck carried, we can now formulate alternative scenarios of ship's capacity utilization rates, and charged fares. We then set as an upper limit of seaborne transport fare imposed, the lower limit of inland transport mode fares (i.e. 406.77€.).

Based on the preceding remarks, we formulate a set of basic assumptions for generated revenue as follows:

1. Freight charged: 406,77 € for a full two-way trip per transported trailer/truck load.
2. Capacity Utilization rate: We get an average rate of capacity utilization of 75% based on the assumption that the line transports 90 trucks/trailer on a daily basis (that is, 45 per each way).
3. The scheduled service is offered on an undisrupted basis of 320 days per year.
4. We estimate an average annual rate of market expansion of about 2.5%.

The preceding assumptions do hold for both the cases of a new built and a secondhand ship in operation. Results obtained are presented in tables III and IV of the annex.

Financial Evaluation of the proposed setting

Depreciations

For the purpose of our study we consider that the typical Ro-Ro ship to be purchased will have an operation life span of 25 years. In the end of this period the salvage value is approximated by the price of scrap (tonnes of steel) for demolition of the ship. The annual depreciation is then determined by the following formula:

$$D = \frac{P - S}{L},$$

where: **D** stands for Annual Depreciation, **P** denotes the purchase value of the ship, **S** denotes the salvage value of the ship and last, **L** denotes the lifespan of the ship's operation. In this setting, we estimated the firm's constant rate annual depreciation for each case under investigation. As regards Scenario 1, the annual depreciation is estimated at 226,800 €, while for Scenario 2 (second-hand ship) the annual depreciation amounts to 206,880 €.

Salvage Value Estimation

In order to estimate the salvage value of the ship, we take into account the following: a) Price of shipbuilding steel, b) amount of steel after demolition of the ship, c) current market prices. Given the fact that the proportion of GRT and extracted steel (in tonnes) is ½ we estimate the final amount of steel to be about 4,000 tonnes for the typical Ro-Ro ship to operate in the line. Taking an average price of steel at 200€ per ton, we estimate the scrap/salvage value of the ship at the amount of 828,000 €[4].

Taxation

In financial analysis, the investor, seen as a source of private equity, is mainly interested in the net financial result -after tax profit-. Therefore, in what concerns the issue of profits taxation we take in to account that by applicable laws, corporate profits are taxed at 25%. The tax rate is not considered as an expense, but it is taken into account when calculating cash flow of each year, so as to obtain a reliable estimation of the after tax profit.

Cost of Capital

A basic assumption that is made, is that the company would cover the purchase cost of the ship in part by self-financing (equity) and the rest will be covered through borrowing from commercial banks under the following terms: a) at 5% interest rate b) 10 years payback period. To consider all options offered to the investor, the analysis includes almost every possible combination of two different sources of financing and lending rates, equity (Scenario 1 borrowed funds: 70%, Scenario 2 with borrowed fund: 50% and last, Scenario 3 where borrowed funds equal 30% of ship's purchase cost).

Feasibility Assessment

In order to assess the economic feasibility of the investment project, we employ two common criteria, namely the NPV and IRR. In due course we consider a discount rate based on the standard interbank offer rate (e.g. LIBOR, EURIBOR) plus a premium adjusted for the range of payback period and risk of the project (spread of 1-4% approximately). We then calculate NPV as follows:

[4] The scrapping value cannot be considered as a fixed amount, since the situation of the markets at each given time have substantial effect on the demolition value of the ship. To meet the purpose of this paper, we consider the average scrap value during 2009.

$$NPV = \sum_{t=0}^{n} \frac{CFI_t - CFO_t}{(1+i)^t},$$

where $t \in \{0,1,....n\}$,

CFI denotes indexed Cash flow inputs, and
CFO: indexed cash flow outputs respectively.
The IRR (internal rate of return) is then defined as the interest rate such that NPV=0. Thus, *NPV=f(i) : IRR$^+$ → IRR ; f(IRR) = 0*.
We estimated the above measures for i=0.05 and n=20, such that the project is financially sound if NPV>0 or equivalently, IRR>0.05.
Based on the cash flow analysis performed for each different scenario as set out previously (new built or secondhand ship under different levels of financial leverage), we obtained the following results, as presented in Table 6.

Table 6 Cash Flows Analysis for Ro-Ro (Line Patra- Eleusis

% of equity in the capital cost	New build		Secondhand	
	NPV	IRR	NPV	IRR
30%	8485457.69 €	12.78%	5460334.34 €	10.78%
50%	8705627.64 €	13.04%	5663568.14 €	11.04%
70%	8925797.59 €	13.31%	5866801.95 €	11.31%

The investment project is considered as profitable in both cases (newly built and second hand ship) under both criteria (i.e. NPV - Net Present Value, IRR - Internal Rate of Return).

Break-Even Point Analysis
In order to assess the degree of sensitivity of the project's financial performance measures with respect to basic assumptions made so far, we investigate the break-even point with respect to the freight charged and the cargo throughput of the line in terms of quantities. In this context, Table 7 presents the break-even arguments that make the NPV function equal to 0.

Table 7 Break Even Analysis for Ro-Ro (Line Patra- Eleusis)

	New build	Secondhand
Break Even (Quantity)	3181	3264
Break Even (Freight)	236.83 €	244.60 €

According to the figures in Table 7, the freight is estimated at 236.83 € & 244.60 € for the newly built and second hand vessel, respectively. These figures are well below the threshold level of 406.77 €, identified as the minimum cost of road transport ant the maximum freight the shipping company can charge so as to be competitive. We reach the conclusion that, there is a significant profit margin for the shipping line operator.
The level of capacity utilization of the break-even point amounts to 3,181 trucks a year - round trip- for the case of newly built ship and 3,264 trucks in the case of second-hand ship. Given that the capacity of the ship is approximately 19,200 trucks, we conclude that there is a quite considerable potential for launching an optimal price discriminatory policy such that the shipping company can extract more end user surplus and thus, realize significantly larger profit.

The operation of a ferry link between the two ports of Patra and Eleusis, seems as a profitable investment as indicated by the analysis. This conclusion is also robust under the less favorable set of assumptions as indicated by the break even analysis. It should also be noted that the ports Eleusis and Patra meet sufficiently the needs of the proposed project in what concerns the existing infrastructure. However, given the frequency of congestion periods that occur at the two ports, which results in increased waiting times for load and discharge, but also longer handling times for the cargo, sufficient action must be taken towards the upgrading of existing infrastructure. Investing in additional port infrastructure and also in warehousing, hub and logistics facilities shall have favorable effects to the attractiveness and financial/operational performance of the shipping line between the two ports.

3.2. External cost estimation

The external cost estimation between the proposed freight transport modes focuses on the analysis of accidents costs, environmental costs, as well as on costs related to climate change (global warming impacts) and to nature & landscape (Habitat loss, habitat fragmentation and habitat quality loss). These cost components are treated as external costs of transport according to the welfare-theory approach. The study uses the estimated unit values of external cost according to the EU Handbook on estimation of external costs in the transport sector (2008). Table 8 presents the unit values that are used per external cost component for both road & SSS freight transport between Patra – Eleusis (Attica). For example, the marginal costs for air pollutions for both road & SSS freight transport are 9.1 €ct/vkm[5] (average for trucks of 7.5 tn, Euro-0 Class) and 240 €/vessel -km[6]. Furthermore, to generate comparable external cost estimates of accidents involving road transport, unit values (marginal costs) for accidents for different network types in €ct/vkm are used. For Greece, the relevant values are: 13.48 €ct/vkm for urban roads, 0.38 €ct/vkm for motorways and, 3.4 €ct/vkm for other roads. Accidents in maritime and inland waterways are almost zero[7].

Table 8 Marginal external costs for road & SSS freight transport (Patra-Eleusis-Patra)

Cost component (interurban)	**Road freight transport** *(€ct/vkm)*	**SSS freight transport** *(€/vessel –km)*
Accidents	0.38	0
Air pollution	7.5	360
Noise	0.2	N/A
Climate change	4.3	141
Congestion	7	N/A
Nature & Landscape	1.2	92

Sources/ Explanation by cost category:

Noise Costs**:** a) Road Transport: INFRAS/IWW, 2004, Max: thin traffic situations during night time, b) SSS freight transport: N/A

[5] Vkm, Vehicle-kilometre: One kilometre travelled by a single vehicle
[6] Vessel-km: One kilometre travelled by a single vessel (1 km=0.539956 n.m.)
[7] Impact assessment on the internalisation of external costs, {COM(2008) 435}, {COM(2008) 436}, {SEC(2008) 2209}

Congestion: a) Road Transport: UNITE case Studies, Interurban Max, b) SSS freight transport: N/A
Accident costs: a) Road Transport: Handbook on estimation of external costs in the transport sector, b) SSS freight transport: Impact assessment on the internalisation of external costs, {COM(2008) 435}, {COM(2008) 436}, {SEC(2008) 2209}
Air pollution: a) Road Transport: UNITE Case Studies (D11) for different cities, Values based on HDVS, Max: higher values form case studies (higher pop. density), b) SSS freight transport: UNITE D11, €ct per vessel-km, Max: marginal costs per vessel-km upstream
Climate change: Road Transport & SSS freight transport: INFRAS/IWW, 2004, Max: Shadow value of 70€/t CO_2
Nature& Landscape: Road Transport & SSS freight transport: INFRAS/IWW, 2004, Max: long run marginal costs

Based on the estimated unit values presented in Table 8, the relevant external cost for both road & SSS freight transport per round trip (Patra- Eleusis-Patra), as well as per ton is presented in Table 9.

Table 9 External costs per round trip and per ton (Patra – Eleusis-Patra)

Cost component (interurban)	**Road freight transport** *(€/round trip)*	**SSS freight transport** *(€/round trip)*	**Road freight transport** *(€/tn)*	**SSS freight transport** *(€/tn)*
Accidents	1.67 €	0.00 €	0.22 €	0.00 €
Air pollution	33.00 €	1733.47 €	4.40 €	2.57 €
Climate change	18.92 €	678.94 €	2.52 €	1.01 €
Nature & Landscape	5.28 €	443.00 €	0.70 €	0.66 €
Total	**58.87 €**	**2855.42 €**	**7.85 €**	**4.23 €**

The following major conclusions can be drawn for the results comparing SSS freight transport with road transport:

- Air pollution: SSS transport shows savings of 41.63% compared to road freight transport.
- Climate change: SSS transport has significant lower CO_2 emissions per ton transported that leads to savings of 60.13%.
- Nature and landscape: The relevant external cost is almost equal; savings in SSS freight transport compared to road freight transport are 6.78%.
- Accident costs account only for road freight transport.

SSS transport shows lower external costs. For freight trucks, the total external cost is 7.85 € per ton transported per round trip (Patra-Eleusis-Patra), whereas for SSS, external costs are substantially smaller (4.23 € per ton).

4. COCLUSION

The purpose of this article is to combine the best available sources of information pertaining to private and external costs that arise from sea (SSS) and road freight transport between Patra – Eleusis. Based on full cost accounting calculations for both road and SSS freight transport between Patra – Eleusis, including external costs, the SSS transport has important

financial and environmental advantages over road. The main question that arises is why such a transport solution has not yet been developed. Road transport is fast and flexible, providing a great benefit to relevant users of freight transport through the reduction of warehousing and other logistics costs. Moreover, lack of infrastructure, double handling costs, congestion in the ports referred (Patra, Eleusis) and the low quality of the current road network that connects Eleusis port with the rest of Attica increases not only the time, but also the relevant cost for a door-to-door delivery transport. Thus, SSS transport seems to be efficient only when infrastructure investment priorities change, focusing on the development of intermodal transport, which contributes to the reduction of both time and relevant cost.

The main conclusion of our research is that even if the external costs are internalised in the freight transport, infrastructure investment policies in relation with transportation policy may affect the promotion of short sea shipping in the transport chain. Considering the general cargo load factor (which is very low compared to bulk cargo), "just-in-time" delivery seems to be more important than the relevant transport cost, making the road transport more appropriate in the case of connecting areas with limited transport infrastructure and network. Nevertheless, further research is needed on comparing congestion external costs between SSS and road freight transport in the case of developed infrastructures & networks.

5. REFERENCES

Blonk Wim A. G. (1994). Short Sea Shipping and Inland Waterways as Part of a Sustainable Transportation System. Marine Pollution Bulletin, 29 (6-12), 389-392.

Calthrop E., B. D. Borger, S. Proost (2010). Cost-benefit analysis of transport investments in distorted economies. Transportation Research Part B, doi:10.1016/j.trb.2009.12.011.

Campisi D. and G. Massimo (1996). Environmental protection, economic efficiency and intermodal competition in freight transport. Transpn Res.-C, 4 (6), 391-406.

Essen H.P., B.H. Boon M. Maibach and C. Schreyer (2007). Methodologies for external cost estimates and internalization scenarios. Discussion paper for the workshop on internalisation on March 15, 2007.

Ferrari P. (2009). The effect of the competition between cars and trucks on the evolution of the motorway transport system. Transportation Research Part C, 17, 558–570.

Forkenbrock, D. (2001). Comparison of external costs of rail and truck freight transportation. Transportation Research Part A, 35, 321-337.

Geurs K. T. and B. van Wee (2004). Accessibility evaluation of land-use and transport strategies: review and research directions. Journal of Transport Geography, 12, 127-140.

Giannopoulos G. A. (2005). Main transport challenges in South Eastern Europe, after enlargement. European Transport \ Trasporti Europei, 30, 3-13.

Janic M. (2007). Modelling the full costs of an intermodal and road freight transport network. Transportation Research Part D, 12, 33-44.

Kågeson P (2003). Efficient charging of heavy goods vehicles - A critical review of the Commission's proposal for amending the Eurovignette Directive. Swedish Institute for Transport and Communications Analysis, SIKA. ISBN 91-89586-35-2.

Kapros S. and C. Panou (2007). Coastal shipping and intermodality in Greece: the weak link. Research in Transportation Economics, 21, 323-342.

Maibach M., C. Schreyer, D. Sutter, H.P. van Essen, B.H. Boon, R. Smokers, A. Schroten, C. Doll, B. Pawlowska, and M. Bak (2008). Handbook on estimation of external costs in the transport sector. ec.europa.eu/transport/sustainable/.../2008_costs_handbook.pdf

Menaz B., C. Nash and G. Lindberg (2008). Pricing reforms in the inter urban road sector. Project contract no. 006293. IMPRINT-NET - Implementing pricing reforms in Transport – Networking. Deliverable 2.

Nam, Ki-Chan (1997). A study on the estimation and aggregation of disaggregate models of mode choice for freight transport, Transpn Res.-E (Logistics and Transpn Rev.), 33 (3), 223-231.

Nash C., T. Sansom and B. Still (2001). Modifying transport prices to internalise externalities: evidence from European case studies. Regional Science and Urban Economics, 31, 413-431.

Paixao A.C. and P.B. Marlow (2002). Strengths and weaknesses of short sea shipping. Marine Policy, 26, 167–178.

Periandros A.E. (2009). New invoice 2009 – 2010 of transit fees & rights of Corinth canal. (www.corinthcanal.com)

Rich J., P.M. Holmblad and C.O. Hansen (2009). A weighted logit freight mode-choice model. Transportation Research Part E, 45, 1006–1019.

Roman C., R. Espino, and J. C. Martın (2007). Competition of high-speed train with air transport: The case of Madrid–Barcelona. Journal of Air Transport Management, 13, 277-284.

Sambracos E. (1999). The role of Greece in the Inland Transport of the Central and East Europe. 1st European Inland Waterway Navigation Conference, 9-11 June 1999, Balatonfuered, Hungary.

Sambracos E. (2000a). Small containers a new challenge to optimize door to door transport chains in Europe. The case of the Greek Islands. European Commission EUCO-COST/339/1/00. Barcelona- Spain, 8-14.

Sambracos E. (2000b). Exploring Operational problems of the good supply chain in the Greek Islands: Towards a reengineering of the system. 16th SOLE International Logistics Congress, Versailles 4-6 October.

Sambracos E. (2001). Investment Evaluation of a Suburban Coastal transport system. 10th IFORS Conference, International Federation of Operation Researches Societies, Athens Greece, 1-3 April.

Sambracos E. (2003). Market analysis and pricing policies for sea canals: the case of the Greek Corinth Canal. Journal of Maritime Policy and Management, 30 (2), 175-190.

Sambracos E. (2007). The Development of Short Sea Shipping in the Eastern Mediterranean Region: Towards a rational E.U. Freight Transport Policy. Proceedings of 10th International Maritime Conference MARDCON, Ain Sokhna, Egypt, 4-5/11, 1/8-8/8.

Sambracos E., MG Karlaftis and K. Kepaptzoglou (2009). Containership Routing with time deadlines and simultaneous deliveries and pick-ups: Metaheuristic Approach. Transportation Research Part EQ Logistics & Transportation Review, 45 (1), 210-221.

Snaddon, D.R. (2001). Competition in transportation — a literature analysis. Technovation, 21, 375–383.

UNCTAD Secretariat (2009). Review of maritime transport 2009 – Chapter 5. United Nations Conference On Trade And Development, Geneva.

Annex

Map of Greece – Ports of Eleysis & Patras

Table I Commodities with low penetration rate

	DEPARTURE		ARRIVAL		TOTAL	
Commodities	**In tn**	**%**	**In tn**	**%**	**In tn**	**%**
Animals – Derived Products	19178	2.06%	265736	19.20%	284914	12.31%
Vegetables/ fruits & derived products	463997	49.81%	121969	8.81%	585966	25.31%
Olive oil	81376	8.74%	18681	1.35%	100057	4.32%
Food products - Drinks	128097	13.75%	177120	12.80%	305217	13.18%
Chemical & related products	22145	2.38%	70958	5.13%	93103	4.02%
Groupage cargo	122715	13.17%	670598	48.46%	793313	34.26%
Medicines & Pharmaceutics	3849	0.41%	11788	0.85%	15637	0.68%
Tobacco & derived products	5209	0.56%	4349	0.31%	9558	0.41%
Fish & derived products	45279	4.86%	19809	1.43%	65088	2.81%
Other cargo	12542	1.35%	22418	1.62%	34960	1.51%
Olives	27178	2.92%	337	0.02%	27515	1.19%

Table II Commodities with high penetration rate

	DEPARTURE		ARRIVAL		TOTAL	
Commodities	**In tn**	**%**	**In tn**	**%**	**In tn**	**%**
Plastic materials	47443	3.64%	101476	5.71%	148919	4.84%
Timber materials	5102	0.39%	6478	0.36%	11580	0.38%
Paper products	8365	0.64%	33021	1.86%	41386	1.34%
Textiles & related products	74728	5.74%	20361	1.15%	95089	3.09%
Construction materials	41710	3.20%	62232	3.50%	103942	3.38%
Metals & derived products	146074	11.22%	18268	1.03%	164342	5.34%
Machinery / electrical equipment	18039	1.39%	65057	3.66%	83096	2.70%
Cars- spare parts	15951	1.23%	64052	3.61%	80003	2.60%
Furniture	1072	0.08%	11089	0.62%	12161	0.40%
Household equipment	4123	0.32%	5213	0.29%	9336	0.30%
Leather products	6758	0.52%	2731	0.15%	9489	0.31%
Bathroom equipment	460	0.04%	389	0.02%	849	0.03%
Toys	487	0.04%	2399	0.14%	2886	0.09%

Table III Financial results of sea transport (Line Patra – Eleusis- New build, Loan percentage 70%, 50%, 30%)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Capital Cost																				
Initial capital cost	6.500.000																			
Working capital	2.166.667																			
Operational Cost																				
A. Variable Cost																				
Diesel	2.113.101	2.113.101	2.113.101	2.113.101	2.113.101	2.155.363	2.198.471	2.242.440	2.287.289	2.333.035	2.379.695	2.427.289	2.475.835	2.525.352	2.575.859	2.627.376	2.693.060	2.760.387	2.829.397	2.900.131
Lubricants	253.572	253.572	253.572	253.572	253.572	258.644	263.816	269.093	274.475	279.964	285.563	291.275	297.100	303.042	309.103	315.285	323.167	331.246	339.528	348.016
Maintainance	48.750	48.750	48.750	48.750	48.750	65.000	65.000	65.000	65.000	65.000	97.500	97.500	97.500	97.500	97.500	130.000	130.000	130.000	130.000	130.000
Port fees	4.099	4.140	4.182	4.223	4.266	4.308	4.351	4.395	4.439	4.483	4.528	4.573	4.619	4.665	4.712	4.759	4.807	4.855	4.903	4.952
Port dues	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620
Transi fees & rights of Corinth Canal	1.338.141	1.351.523	1.365.038	1.378.688	1.392.475	1.406.400	1.420.464	1.434.669	1.449.015	1.463.506	1.478.141	1.492.922	1.507.851	1.522.930	1.538.159	1.553.541	1.569.076	1.584.767	1.600.614	1.616.621
Total A	**3.899.284**	**3.912.707**	**3.926.263**	**3.939.956**	**3.953.785**	**4.031.336**	**4.093.723**	**4.157.217**	**4.221.838**	**4.287.608**	**4.387.048**	**4.455.180**	**4.524.526**	**4.595.109**	**4.666.953**	**4.772.581**	**4.861.731**	**4.952.875**	**5.046.062**	**5.141.340**
B. Fixed Cost																				
Insurance	130.000	125.462	120.925	116.387	111.850	107.312	102.774	98.237	93.699	89.162	84.624	80.086	75.549	71.011	66.474	61.936	57.398	52.861	48.323	43.786
Manning cost (crew)	453.833	465.178	476.808	488.728	500.946	513.470	526.307	539.464	552.951	566.775	580.944	595.468	610.354	625.613	641.254	657.285	673.717	690.560	707.824	725.520
Personnel cost (office)	30.000	31.050	32.137	33.262	34.426	35.631	36.878	38.168	39.504	40.887	42.318	43.799	45.332	46.919	48.561	50.260	52.020	53.840	55.725	57.675
Other cost	34.000	35.190	36.422	37.696	39.016	40.381	41.795	43.257	44.772	46.339	47.960	49.639	51.376	53.175	55.036	56.962	58.956	61.019	63.155	65.365
Total B	**647.833**	**656.881**	**666.291**	**676.073**	**686.237**	**696.794**	**707.754**	**719.127**	**730.926**	**743.162**	**755.847**	**768.992**	**782.612**	**796.718**	**811.324**	**826.443**	**842.091**	**858.280**	**875.027**	**892.345**
Total A+ B	**4.547.117**	**4.569.588**	**4.592.555**	**4.616.029**	**4.640.022**	**4.728.130**	**4.801.476**	**4.876.344**	**4.952.764**	**5.030.770**	**5.142.894**	**5.224.172**	**5.307.138**	**5.391.827**	**5.478.277**	**5.599.024**	**5.703.821**	**5.811.155**	**5.921.089**	**6.033.686**
Annual Turnover																				
Freight	5.857.488	6.003.925	6.154.023	6.307.874	6.465.571	6.627.210	6.792.890	6.962.713	7.136.780	7.315.200	7.498.080	7.685.532	7.877.670	8.074.612	8.276.477	8.483.389	8.695.474	8.912.861	9.135.682	9.364.074
Residual value	0	0	0	0		0		0	0	0	0	0	0	0	0	0	0	0	0	828.000
EBITDA	1.310.371	1.434.337	1.561.469	1.691.845	1.825.549	1.899.080	1.991.414	2.086.369	2.184.016	2.284.430	2.355.186	2.461.360	2.570.533	2.682.785	2.798.200	2.884.365	2.991.653	3.101.705	3.214.593	4.158.388
Interest (Loan 70%)	226.161	207.705	188.303	167.904	146.458	123.911	100.206	75.284	49.084	21.538	0	0	0	0	0	0				
Interest (Loan 50%)	161.543	148.361	134.502	119.931	104.613	88.508	71.576	53.775	35.060	15.384										
Interest (Loan 30%)	96.926	89.017	80.701	71.959	62.768	53.105	42.945	32.265	21.036	9.230										
Earnings before Tax, Depreciation (Loan 70%)	1.084.210	1.226.632	1.373.166	1.523.941	1.679.091	1.775.170	1.891.208	2.011.084	2.134.933	2.262.892	2.355.186	2.461.360	2.570.533	2.682.785	2.798.200	2.884.365	2.991.653	3.101.705	3.214.593	4.158.388
Earnings before Tax, Depreciation (Loan 50%)	1.148.828	1.285.977	1.426.967	1.571.914	1.720.936	1.810.573	1.919.838	2.032.594	2.148.956	2.269.046	2.355.186	2.461.360	2.570.533	2.682.785	2.798.200	2.884.365	2.991.653	3.101.705	3.214.593	4.158.388
Earnings before Tax, Depreciation (Loan 30%)	1.213.445	1.345.321	1.480.768	1.619.886	1.762.781	1.845.976	1.948.468	2.054.104	2.162.980	2.275.200	2.355.186	2.461.360	2.570.533	2.682.785	2.798.200	2.884.365	2.991.653	3.101.705	3.214.593	4.158.388
Depreciation	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**	**226.880**
Earnings Before Tax (Loan 70%)	**857.330**	**999.752**	**1.146.286**	**1.297.061**	**1.452.211**	**1.548.290**	**1.664.328**	**1.784.204**	**1.908.053**	**2.036.012**	**2.128.306**	**2.234.480**	**2.343.653**	**2.455.905**	**2.571.320**	**2.657.485**	**2.764.773**	**2.874.825**	**2.987.713**	**3.931.508**
Earnings Before Tax (Loan 50%)	**921.948**	**1.059.097**	**1.200.087**	**1.345.034**	**1.494.056**	**1.583.693**	**1.692.958**	**1.805.714**	**1.922.076**	**2.042.166**	**2.128.306**	**2.234.480**	**2.343.653**	**2.455.905**	**2.571.320**	**2.657.485**	**2.764.773**	**2.874.825**	**2.987.713**	**3.931.508**
Earnings Before Tax (Loan 30%)	**986.565**	**1.118.441**	**1.253.888**	**1.393.006**	**1.535.901**	**1.619.096**	**1.721.588**	**1.827.224**	**1.936.100**	**2.048.320**	**2.128.306**	**2.234.480**	**2.343.653**	**2.455.905**	**2.571.320**	**2.657.485**	**2.764.773**	**2.874.825**	**2.987.713**	**3.931.508**
Tax (Loan 70%)	214.333	249.938	286.572	324.265	363.053	387.072	416.082	446.051	477.013	509.003	532.076	558.620	585.913	613.976	642.830	664.371	691.193	718.706	746.928	982.877
Tax (Loan 50%)	230.487	264.774	300.022	336.258	373.514	395.923	423.240	451.428	480.519	510.542	532.076	558.620	585.913	613.976	642.830	664.371	691.193	718.706	746.928	982.877
Tax (Loan 30%)	246.641	279.610	313.472	348.252	383.975	404.774	430.397	456.806	484.025	512.080	532.076	558.620	585.913	613.976	642.830	664.371	691.193	718.706	746.928	982.877
Earnings (Loan 70%)	**642.998**	**749.814**	**859.715**	**972.796**	**1.089.158**	**1.161.217**	**1.248.246**	**1.338.153**	**1.431.039**	**1.527.009**	**1.596.229**	**1.675.860**	**1.757.739**	**1.841.929**	**1.928.490**	**1.993.114**	**2.073.579**	**2.156.119**	**2.240.785**	**2.948.631**
Earnings (Loan 50%)	**691.461**	**794.322**	**900.065**	**1.008.775**	**1.120.542**	**1.187.770**	**1.269.719**	**1.354.285**	**1.441.557**	**1.531.625**	**1.596.229**	**1.675.860**	**1.757.739**	**1.841.929**	**1.928.490**	**1.993.114**	**2.073.579**	**2.156.119**	**2.240.785**	**2.948.631**
Earnings (Loan 30%)	**739.924**	**838.831**	**940.416**	**1.044.755**	**1.151.926**	**1.214.322**	**1.291.191**	**1.370.418**	**1.452.075**	**1.536.240**	**1.596.229**	**1.675.860**	**1.757.739**	**1.841.929**	**1.928.490**	**1.993.114**	**2.073.579**	**2.156.119**	**2.240.785**	**2.948.631**
NPV (Loan 70%)	**8.485.457,69**		**NPV (Loan 50%)**		**8.705.627,64**		**NPV (Loan 30%)**		**8.925.797,59**											
IRR (Loan 70%)	**12,78%**		**IRR (Loan 50%)**		**13,04%**		**IRR (Loan 30%)**		**13,31%**											

Table IV Financial results of sea transport (Line Patra – Eleusis –Secondhand, Loan percentage 70%, 50%, 30%)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Capital Cost																				
Initial capital cost	6.000.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working capital	2.000.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operational Cost																				
A. Variable Cost																				
Diesel	2.245.170	2.290.074	2.335.875	2.382.593	2.430.244	2.491.001	2.553.276	2.617.107	2.682.535	2.749.599	2.818.338	2.888.797	2.961.017	3.035.042	3.110.918	3.188.691	3.284.352	3.382.883	3.484.369	3.588.900
Lubricants	269.420	274.809	280.305	285.911	291.629	298.920	306.393	314.053	321.904	329.952	338.201	346.656	355.322	364.205	373.310	382.643	394.122	405.946	418.124	430.668
Maintainance	60.000	60.000	60.000	60.000	60.000	90.000	90.000	90.000	90.000	90.000	120.000	120.000	120.000	120.000	120.000	120.000	120.000	120.000	120.000	120.000
Port fees	4.099	4.140	4.182	4.223	4.266	4.308	4.351	4.395	4.439	4.483	4.528	4.573	4.619	4.665	4.712	4.759	4.807	4.855	4.903	4.952
Port dues	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620	141.620
Transi fees & rights of Corinth Canal	1.338.141	1.351.523	1.365.038	1.378.688	1.392.475	1.406.400	1.420.464	1.434.669	1.449.015	1.463.506	1.478.141	1.492.922	1.507.851	1.522.930	1.538.159	1.553.541	1.569.076	1.584.767	1.600.614	1.616.621
Total A	**4.058.452**	**4.122.166**	**4.187.020**	**4.253.036**	**4.320.235**	**4.432.249**	**4.516.104**	**4.601.844**	**4.689.514**	**4.779.159**	**4.900.828**	**4.994.568**	**5.090.430**	**5.188.463**	**5.288.720**	**5.391.254**	**5.513.977**	**5.640.070**	**5.769.631**	**5.902.761**
B. Fixed Cost																				
Insurance	120.000	115.862	111.725	107.587	103.450	99.312	95.174	91.037	86.899	82.762	78.624	74.486	70.349	66.211	62.074	57.936	53.798	49.661	45.523	41.386
Manning cost (crew)	453.833	465.178	476.808	488.728	500.946	513.470	526.307	539.464	552.951	566.775	580.944	595.468	610.354	625.613	641.254	657.285	673.717	690.560	707.824	725.520
Personnel cost (office)	30.000	31.050	32.137	33.262	34.426	35.631	36.878	38.168	39.504	40.887	42.318	43.799	45.332	46.919	48.561	50.260	52.020	53.840	55.725	57.675
Other cost	34.000	35.190	36.422	37.696	39.016	40.381	41.795	43.257	44.772	46.339	47.960	49.639	51.376	53.175	55.036	56.962	58.956	61.019	63.155	65.365
Total B	**637.833**	**647.281**	**657.091**	**667.273**	**677.837**	**688.794**	**700.154**	**711.927**	**724.126**	**736.762**	**749.847**	**763.392**	**777.412**	**791.918**	**806.924**	**822.443**	**838.491**	**855.080**	**872.227**	**889.945**
Total A+ B	**4.696.284**	**4.769.447**	**4.844.111**	**4.920.309**	**4.998.072**	**5.121.043**	**5.216.258**	**5.313.771**	**5.413.640**	**5.515.921**	**5.650.675**	**5.757.961**	**5.867.841**	**5.980.380**	**6.095.644**	**6.213.698**	**6.352.468**	**6.495.150**	**6.641.858**	**6.792.707**
Annual Turnover																				
Freight	5.857.488	6.003.925	6.154.023	6.307.874	6.465.571	6.627.210	6.792.890	6.962.713	7.136.780	7.315.200	7.498.080	7.685.532	7.877.670	8.074.612	8.276.477	8.483.389	8.695.474	8.912.861	9.135.682	9.364.074
Residual Value	0	0	0	0		0		0	0	0	0	0	0	0	0	0	0	0	0	828.000
EBITDA	1.161.204	1.234.479	1.309.912	1.387.565	1.467.498	1.506.167	1.576.632	1.648.941	1.723.140	1.799.279	1.847.405	1.927.571	2.009.829	2.094.231	2.180.834	2.269.692	2.343.006	2.417.710	2.493.824	3.399.368
Interest (Loan 70%)	208.764	191.728	173.818	154.988	135.192	114.379	92.498	69.493	45.308	19.881	0	0	0	0	0	0				
Interest (Loan 50%)	149.117	136.949	124.156	110.706	96.565	81.699	66.070	49.638	32.363	14.201										
Interest (Loan 30%)	89.470	82.169	74.493	66.423	57.939	49.020	39.642	29.783	19.418	8.520										
Earnings before Tax, Depreciation (Loan 70%)	952.440	1.042.751	1.136.094	1.232.577	1.332.307	1.391.788	1.484.135	1.579.448	1.677.832	1.779.398	1.847.405	1.927.571	2.009.829	2.094.231	2.180.834	2.269.692	2.343.006	2.417.710	2.493.824	3.399.368
Earnings before Tax, Depreciation (Loan 50%)	1.012.087	1.097.530	1.185.757	1.276.859	1.370.933	1.424.468	1.510.563	1.599.303	1.690.778	1.785.078	1.847.405	1.927.571	2.009.829	2.094.231	2.180.834	2.269.692	2.343.006	2.417.710	2.493.824	3.399.368
Earnings before Tax, Depreciation (Loan 30%)	1.071.734	1.152.309	1.235.419	1.321.141	1.409.559	1.457.147	1.536.990	1.619.158	1.703.723	1.790.758	1.847.405	1.927.571	2.009.829	2.094.231	2.180.834	2.269.692	2.343.006	2.417.710	2.493.824	3.399.368
Depreciation	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**	**206.880**
Earnings Before Tax (Loan 70%)	**745.560**	**835.871**	**929.214**	**1.025.697**	**1.125.427**	**1.184.908**	**1.277.255**	**1.372.568**	**1.470.952**	**1.572.518**	**1.640.525**	**1.720.691**	**1.802.949**	**1.887.351**	**1.973.954**	**2.062.812**	**2.136.126**	**2.210.830**	**2.286.944**	**3.192.488**
Earnings Before Tax (Loan 50%)	**805.207**	**890.650**	**978.877**	**1.069.979**	**1.164.053**	**1.217.588**	**1.303.683**	**1.392.423**	**1.483.898**	**1.578.198**	**1.640.525**	**1.720.691**	**1.802.949**	**1.887.351**	**1.973.954**	**2.062.812**	**2.136.126**	**2.210.830**	**2.286.944**	**3.192.488**
Earnings Before Tax (Loan 30%)	**864.854**	**945.429**	**1.028.539**	**1.114.261**	**1.202.679**	**1.250.267**	**1.330.110**	**1.412.278**	**1.496.843**	**1.583.878**	**1.640.525**	**1.720.691**	**1.802.949**	**1.887.351**	**1.973.954**	**2.062.812**	**2.136.126**	**2.210.830**	**2.286.944**	**3.192.488**
Tax (Loan 70%)	186.390	208.968	232.304	256.424	281.357	296.227	319.314	343.142	367.738	393.129	410.131	430.173	450.737	471.838	493.488	515.703	534.031	552.708	571.736	798.122
Tax (Loan 50%)	201.302	222.662	244.719	267.495	291.013	304.397	325.921	348.106	370.974	394.549	410.131	430.173	450.737	471.838	493.488	515.703	534.031	552.708	571.736	798.122
Tax (Loan 30%)	216.213	236.357	257.135	278.565	300.670	312.567	332.528	353.070	374.211	395.970	410.131	430.173	450.737	471.838	493.488	515.703	534.031	552.708	571.736	798.122
Earnings (Loan 70%)	**559.170**	**626.903**	**696.911**	**769.273**	**844.070**	**888.681**	**957.941**	**1.029.426**	**1.103.214**	**1.179.388**	**1.230.394**	**1.290.519**	**1.352.212**	**1.415.514**	**1.480.465**	**1.547.109**	**1.602.094**	**1.658.123**	**1.715.208**	**2.394.366**
Earnings (Loan 50%)	**603.905**	**667.987**	**734.157**	**802.484**	**873.040**	**913.191**	**977.762**	**1.044.317**	**1.112.923**	**1.183.648**	**1.230.394**	**1.290.519**	**1.352.212**	**1.415.514**	**1.480.465**	**1.547.109**	**1.602.094**	**1.658.123**	**1.715.208**	**2.394.366**
Earnings (Loan 30%)	**648.640**	**709.072**	**771.404**	**835.696**	**902.009**	**937.700**	**997.583**	**1.059.209**	**1.122.632**	**1.187.909**	**1.230.394**	**1.290.519**	**1.352.212**	**1.415.514**	**1.480.465**	**1.547.109**	**1.602.094**	**1.658.123**	**1.715.208**	**2.394.366**
NPV (Loan 70%)	5.460.334		**NPV (Loan 50%)**		5.663.568		**NPV (Loan 30%)**		5.866.802											
IRR (Loan 70%)	10,78%		**IRR (Loan 50%)**		11,04%		**IRR (Loan 30%)**		11,31%											