LA FATTIBILITÀ ECONOMICA DEI SERVIZI DI TRASPORTO MERCI DEPERIBILI DI MEDIO RAGGIO

Francesco Russo, Giovanna Chilà

Dipartimento di Ingegneria dell’Informazione, delle Infrastrutture e dell’Energia Sostenibile Mediterranea University of Reggio Calabria
francesco.russo@unirc.it, giovanna.chila@unirc.it, www.last.unirc.it
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• Introduction

• State of the art on modal choice models

• Database

• Modal choice model specification, calibration and validation

• Speed ship properties

• Evaluation and transport scenarios

• Conclusions
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• Introduction
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  • Conclusions
The European freight transport in recent years has been characterized by a prevalent use of road transport mode. Lower level of service on road results in higher accident risk and higher air pollution. Why road transport mode is chosen? What factors can produce a readjustment among modal choices, encouraging sustainable and efficient development?
**Introduction**

Demand of goods between Sicily and Europe is about 45000 t in a day, net of liquid and dry bulk by sea (which are early 205000 t). National quota is about 73 %, international quote is about 27 % (Advisor, 2001).

<table>
<thead>
<tr>
<th>Daily demand of goods</th>
<th>Growth trend (trend % 99-95)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26511 t</td>
<td>+ 43 %</td>
</tr>
<tr>
<td>8068 t</td>
<td>+ 27 %</td>
</tr>
<tr>
<td>10500 t</td>
<td>+ 110 %</td>
</tr>
</tbody>
</table>
OBJECTIVES

- to construct a consignment model in order to simulate modal choice for national and international freight transport
- to assess variation in demand caused by the introduction of combined road-sea high speed mode

Introduction
**Introduction**

- **2001**
  - White Paper *European Transport Policy for 2010*
    - European Commission introduced the concept of motorways of the sea in its 2001 transport White Paper

- **2003**
  - Van Miert Report
    - Motorway of the Sea European Transport is included in TEN priority projects

- **2004**
  - Approvazione orientamenti comunitari per lo sviluppo Reti Ten - T
    - Motorway of the Sea European Transport is passed as priority projects

- **2011**
  - Logistic Plan is passed
    - Role of road transport is confirmed

- **2013**
  - Proposal TEN-T
    - Motorway of the sea is not considered in the Proposal TEN-T (29 may)
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State of the art on modal choice models

Modal choice model classification

- **Aggregation level**
  - Aggregation data
  - Disaggregation data
- **Unit of choice**
  - Single shipment
  - Total amount shipped
- **Statistical and probabilistic aspects**
  - Descriptive model
  - Behavioural model
- **Decision maker**
  - Sender
  - Receiver
  - Shipper
State of the art on modal choice models

- **Aggregation level**
  - Nationale scale
  - European scale

- **Unit of choice**
  - Single shipment
  - Total amount

- **Functional form**
  - Behavioural model

- **Decision maker**
  - Sender

- **Consignment models**
- **Logistic models**

- **Disaggregate data**
- **Aggregate data**

**State of the art on modal choice models**
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- Introduction
- State of the art on modal choice models
- Database
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  - Speed ship properties
  - Evaluation and transport scenarios
- Conclusions
**Road Transport**

**Statistical analysis in respect of O/D and kind of freight (NST/R classification)**

<table>
<thead>
<tr>
<th>NST/R</th>
<th>Description</th>
<th>NST/R</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Agriculture products and live animals</td>
<td>5</td>
<td>Metal products</td>
</tr>
<tr>
<td>1</td>
<td>Foodstuffs and animal fodder</td>
<td>6</td>
<td>Crude and manufacture minerals</td>
</tr>
<tr>
<td>2</td>
<td>Solid mineral fuels</td>
<td>7</td>
<td>Fertilizers</td>
</tr>
<tr>
<td>3</td>
<td>Petroleum products</td>
<td>8</td>
<td>Chemicals</td>
</tr>
<tr>
<td>4</td>
<td>Ores and metal waste</td>
<td>9</td>
<td>Machinery</td>
</tr>
</tbody>
</table>
### Database

#### Railway

**Transport, Spatial Organization and Sustainable Economic Development** Venice - September 18-20, 2013

**The High Speed Potentiality in the Motorway of the Sea: A Modal Choice Model**

<table>
<thead>
<tr>
<th>NST</th>
<th>Total number of wagons</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEHICLES</td>
<td>274</td>
</tr>
<tr>
<td>FERTILIZERS</td>
<td>15</td>
</tr>
<tr>
<td>FOODSTUFFS AND ANIMAL FODDER</td>
<td>534</td>
</tr>
<tr>
<td>MACCH.,VEHICLES, HAND-MANUFACTURES, SPEC. TRANSACT.</td>
<td>3447</td>
</tr>
<tr>
<td>MINERALS AND METAL WASTE</td>
<td>1375</td>
</tr>
<tr>
<td>CRUDE AND MANUFACTURE MINERALS</td>
<td>450</td>
</tr>
<tr>
<td>AGRICULTURE PRODUCTS AND LIVE ANIMALS</td>
<td>482</td>
</tr>
<tr>
<td>CHEMICALS</td>
<td>1337</td>
</tr>
<tr>
<td>METAL PRODUCTS</td>
<td>3420</td>
</tr>
<tr>
<td>PETROLEUM PRODUCTS</td>
<td>1675</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>13009</strong></td>
</tr>
</tbody>
</table>

**NST**

- **LOADED SWAP BODY**
  - **Total number of wagons**: 6347

- **LOADED CONTAINERS**
  - **Total number of wagons**: 143

- **LOADED SEMITRAILERS**
  - **Total number of wagons**: 328

- **TOTAL**
  - **Total number of wagons**: 6818

Statistical analysis in respect of O/D and kind of freight (NST/R classification)
### Arrival - Railway

#### Statistical analysis in respect of O/D and kind of freight (NST/R classification)

<table>
<thead>
<tr>
<th>NST</th>
<th>Total number of wagons</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEHICLES</td>
<td>1543</td>
</tr>
<tr>
<td>FERTILIZERS</td>
<td>17</td>
</tr>
<tr>
<td>FOODSTUFFS AND ANIMAL FODDER</td>
<td>22</td>
</tr>
<tr>
<td>MACCH., VEHICLES, HAND-MANUFACTURES, SPEC. TRANSACT.</td>
<td>8174</td>
</tr>
<tr>
<td>MINERALS AND METAL WASTE</td>
<td>8807</td>
</tr>
<tr>
<td>CRUDE AND MANUFACTURE MINERALS</td>
<td>699</td>
</tr>
<tr>
<td>AGRICULTURE PRODUCTS AND LIVE ANIMALS</td>
<td>384</td>
</tr>
<tr>
<td>CHEMICALS</td>
<td>193</td>
</tr>
<tr>
<td>METAL PRODUCTS</td>
<td>499</td>
</tr>
<tr>
<td>PETROLEUM PRODUCTS</td>
<td>3808</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>24146</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NST</th>
<th>Total number of wagons</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOADED SWAP BODY</td>
<td>16241</td>
</tr>
<tr>
<td>LOADED CONTAINERS</td>
<td>437</td>
</tr>
<tr>
<td>LOADED SEMITRAILERS</td>
<td>645</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>17323</strong></td>
</tr>
</tbody>
</table>
Database

Hypothesis

Database related to different time dimensions

- Road
- Railway
- Combined Road/Railway
- Traditional
- Combined Road/Sea

Expansion Factors extending all the information available to a period of a year

Number of sendings = (Total of interviews*100/Rate of sampling)*2

Number of sendings = Number of wagons

Number of sendings = Number of wagons

CMVP (Average of load for heavy vehicles) = 15 t
Number of sendings = Total tons in a year/CMVP

Database related to different time dimensions
Since unaccompanied combined road–sea transport is an important share of the transport by sea, particularly if the distance between origin/destination ports is longer than 200–250 sea miles, we obtained information about this transport mode by conducting a survey of Sicilian firms in July 2006.

In this work we made the following assumptions:

- the combined road–sea transport is mainly accompanied (70%), and to a lesser extent unaccompanied (30%), of the global demand by combined road-sea transport mode, if the distance between origin/destination ports is shorter than 230 nautical miles;

- combined accompanied road–sea transport accounts for (10 %) and unaccompanied for the remaining 90 % of the global demand by combined road-sea transport mode, if the distance between origin/destination ports exceeds 230 nautical miles.
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- Conclusions
Model Specification

Sender

- Road (S)
- Rail (T)
- Combined Road/Rail (CF)
- Combined Road/Sea Accompanied (CMA)
- Combined Road/Sea Unaccompanied (CMnA)

Aggregation level

Disaggregate data for single shipment

Unit of choice

Single shipment

Territorial Scale

National

Functional form

Gumbel
### Model Specification

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P$</td>
<td>price of transport service;</td>
</tr>
<tr>
<td>$T$</td>
<td>travel time specified for each transport mode and sometimes subdivided, for the combined transport mode, into:</td>
</tr>
<tr>
<td></td>
<td>• amount of access/egress time and handling time at the terminals;</td>
</tr>
<tr>
<td></td>
<td>• run time between origin and destination terminals;</td>
</tr>
<tr>
<td>$NCD$</td>
<td>dummy variable which is 1 if combined transport mode is not direct available between origin and destination terminals, 0 otherwise;</td>
</tr>
<tr>
<td>$CD$</td>
<td>dummy variable which is 1 if $NCD=0$, 0 otherwise;</td>
</tr>
<tr>
<td>$PERISHABLE$</td>
<td>dummy variable which is 1 if the freight is perishable, 0 otherwise;</td>
</tr>
<tr>
<td>$P_{30}$</td>
<td>dummy which is 1 if the freight quantity is less than 30 tonnes, 0 otherwise;</td>
</tr>
<tr>
<td>$RAIL$</td>
<td>ASA for rail transport mode;</td>
</tr>
<tr>
<td>$INDUSTRIAL$</td>
<td>dummy variable which is 1 if freight is industrial, 0 otherwise;</td>
</tr>
<tr>
<td>$CF_{M30}$</td>
<td>dummy variable which is 1 for combined road – rail transport mode if freight exceeds 30 tonnes, 0 otherwise;</td>
</tr>
<tr>
<td>$CF_{M30ND}$</td>
<td>dummy variable which is 1 for combined road–rail transport mode if freight exceeds 30 tonnes and the combined road–sea transport mode is not directly available between origin and destination terminals, 0 otherwise;</td>
</tr>
<tr>
<td>$D_{AE}$</td>
<td>amount of access and egress distance to the terminals, in kilometres;</td>
</tr>
<tr>
<td>$CMnA$</td>
<td>dummy variable which is 1 for unaccompanied combined road-sea transport mode if the distance between origin and destination ports is higher than 230 nautical miles, 0 otherwise.</td>
</tr>
</tbody>
</table>
## Model Calibration

### Calibration method

- Software

### Likelihood

(Logit Multinomial Model)

### Database

- Level of service attribute

### Alogit

<table>
<thead>
<tr>
<th>Database</th>
<th>Num. Sendings</th>
<th>Period of reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road S</td>
<td>362</td>
<td>1 year</td>
</tr>
<tr>
<td>Rail T</td>
<td>37</td>
<td>1 year</td>
</tr>
<tr>
<td>Combined CF</td>
<td>24</td>
<td>1 year</td>
</tr>
<tr>
<td>Combined CMA</td>
<td>98</td>
<td>1 year</td>
</tr>
<tr>
<td>Combined CMnA</td>
<td>140</td>
<td>1 year</td>
</tr>
</tbody>
</table>

### Maximum Likelihood

\[
\ln L(\beta, \theta) = \sum_{i=1}^{n} \left[ \frac{\beta^T X^i_j}{\theta} - \ln \sum_{j \in I} \exp \left( \frac{\beta^T X^i_j}{\theta} \right) \right]
\]

- **Calibration method:** Maximum Likelihood

- **Software:** Alogit

---

Model Calibration

Level of service attributes

National road network

32022 links, 4854 nodes
Length
Class
Slope
Speed
Tortuosity
Travel time
Cost
Model Calibration

Level of service attributes

National railway network
960 links, 371 nodes
Class
Type
Travel time
Model validation

INFORMAL TESTS

SIGNS OF THE CALIBRATED PARAMETERS

VALUE OF TIME (V.O.T.)

<table>
<thead>
<tr>
<th>TRANSPORT MODE</th>
<th>V.O.T. (€/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road S</td>
<td>245.0</td>
</tr>
<tr>
<td>Rail T</td>
<td>2.0</td>
</tr>
<tr>
<td>Combined Road/Rail CF</td>
<td>70.0</td>
</tr>
<tr>
<td>Combined Road/Sea Acc. CMA</td>
<td>225.0</td>
</tr>
<tr>
<td>Combined Road/Sea Uncc. CMnA</td>
<td>95.0</td>
</tr>
</tbody>
</table>

Key

- Very good test
- Fairly good test
- Very bad test
Model validation

**T-STUDENT**

\[ t = \frac{\beta^\text{ML}_k}{\text{Var}[\beta^\text{ML}_k]^{1/2}} \]

**RHO - square**

\[ \rho^2 = 1 - \frac{\ln L(\beta^\text{ML})}{\ln L(0)} \]

**RHO2 – square bar**

\[ \rho^2 = 1 - \frac{\left(\ln L(\beta^\text{ML}) - N_\beta\right)}{\ln L(0)} \]

Key

- Very good test
- Fairly good test
- Very bad test

TEST

0.683

TEST

0.668
HYPOTHESIS

DIRECT ELASTICITY

\[ E_{kj}^{p(j)} = \frac{\Delta p(j)}{p(j)} \frac{\Delta X_{kj}}{X_{kj}} \]

CROSSED ELASTICITY

\[ E_{kh}^{p(j)} = \frac{\Delta p(j)}{p(j)} \frac{\Delta X_{kh}}{X_{kh}} \]

Elasticity evaluation
with regard to road transport price increasing

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road S</td>
<td>-0.312</td>
</tr>
<tr>
<td>Rail T</td>
<td>0.318</td>
</tr>
<tr>
<td>Combined Road/Rail CF</td>
<td>0.318</td>
</tr>
<tr>
<td>Combined Road/Sea Accompanied CMA</td>
<td>0.318</td>
</tr>
<tr>
<td>Combined Road/Sea Unaccompanied CMnA</td>
<td>0.318</td>
</tr>
</tbody>
</table>
Model validation

**TEST 1**

sum of the mode choice probabilities regarding all users, for each mode, divided by total users

**TEST 2**

sum of value 1 for the mode with the maximum probability, of value 0 for the other modes, regarding all users, for each mode, divided by total users.

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>Num. of sendings</th>
<th>% aggregate of real choices</th>
<th>TEST 1</th>
<th>TEST 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>362</td>
<td>54.77</td>
<td>55.12</td>
<td>54.77</td>
</tr>
<tr>
<td>Train</td>
<td>37</td>
<td>5.60</td>
<td>5.26</td>
<td>6.35</td>
</tr>
<tr>
<td>Combined CF</td>
<td>24</td>
<td>3.63</td>
<td>3.14</td>
<td>0.00</td>
</tr>
<tr>
<td>Combined CMA</td>
<td>98</td>
<td>14.83</td>
<td>11.26</td>
<td>8.17</td>
</tr>
<tr>
<td>Combined CMnA</td>
<td>140</td>
<td>21.17</td>
<td>25.22</td>
<td>30.71</td>
</tr>
<tr>
<td>TOTAL</td>
<td>661</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>
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• Conclusions
Ship equipped with two propelling engines with a peak speed of 38 kn. This has been used by Balearia Eurolíneas Maritimes on runs between Denia and Ibiza and Ibiza and Palma.

- Building year: 2001
- Lenght: 115.25 m
- Beam: 17.0 mt
- Propelling Machinery: Caterpillar
- Capacity: 210 cars
- Maximum number of trucks: 300 m
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We propose the introduction of the combined road-sea high speed unaccompanied transport mode (CMnAHS), supposing that it is available in the same ports, with new specialized terminals, considering the current Italian motorways of the sea as routes.

In particular, we analyzed the Messina-Salerno link, seeking to ascertain whether a combined high speed transport system can give a more reasonable distribution of freight transport.

In order to test the combined road-sea high speed unaccompanied transport mode in different conditions, we defined four speed scenarios according to cruising speed VHS:

- Scenario speed 30
- Scenario speed 32
- Scenario speed 35
- Scenario speed 38
Evaluation and transport scenarios

Motorway of the Sea Messina - Salerno

Input Data

Distance Original/Destination: 156.10 miles
Distance low speed $D_{LS}$: 20.00 miles
Distanza high speed $D_{HS}$: 136.10 miles
Low Speed $V_{LS}$: 16 noded
High Speed $V_{HS}$:
Scenario speed 30 nodes;
Scenario speed 32 nodes;
Scenario speed 35 nodes;
Scenario speed 38 nodes.
Evaluation and transport scenarios

We supposed that, for every scenario, the low-speed distance is 10.0 nautical miles from the origin port and 10.0 nautical miles from the destination port; the high-speed distance is the remaining 136.1 nautical miles. Moreover, the cruising speed $V_{LS}$ is the same for every scenario, namely 16 kn.

Regarding the ship’s fuel consumption, we plotted the consumption curve according to nautical miles covered and propelling machinery used, knowing the following characteristics: electrical power and efficiency of engines, fuel density, unit consumption of engines, travel time.

The cost of the high speed service was obtained by considering several attributes, related to ship acquisition and management, port charges, ship consumption, number of trips per day, etc. Some attributes can be considered exogenous in respect of this work, others can be considered endogenous, as they result from exogenous or other endogenous attributes.
**Evaluation and transport scenarios**

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Unit of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>( E ) Crew members</td>
<td>num</td>
</tr>
<tr>
<td>( COE ) Hourly wages of crew members</td>
<td>€/h</td>
</tr>
<tr>
<td>( CA ) Ship acquisition cost</td>
<td>( 10^6 ) €</td>
</tr>
<tr>
<td>( AA ) Depreciation period</td>
<td>years</td>
</tr>
<tr>
<td>( CM_a ) Ship annual maintenance cost</td>
<td>( 10^6 ) €/year</td>
</tr>
<tr>
<td>( CC ) Capacity</td>
<td>40 ft - containers</td>
</tr>
<tr>
<td>( V_{LS} ) ( D_{LS} ) speed</td>
<td>kn</td>
</tr>
<tr>
<td>( V_{HS} ) ( D_{HS} ) speed</td>
<td>kn</td>
</tr>
<tr>
<td>( GL_m ) Monthly working days of ship</td>
<td>days</td>
</tr>
</tbody>
</table>
### Evaluation and transport scenarios

#### ENDOGENOUS ATTRIBUTES

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Expression</th>
<th>Unit of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T$ Travel time</td>
<td>$(\frac{D_{LSO}+D_{LSD}}{16.0}+\frac{D_{HS}}{v_{HS}})$</td>
<td>h</td>
</tr>
<tr>
<td>$MNV_g$ Maximum number of trips a day</td>
<td>$int(24/T)$</td>
<td>num/day</td>
</tr>
<tr>
<td>$NV_g$ Number of trips a day</td>
<td>$[1 ; MNV_g]$</td>
<td>num/day</td>
</tr>
<tr>
<td>$OL_g$ Daily working hours</td>
<td>$NV_g \cdot T$</td>
<td>h</td>
</tr>
<tr>
<td>$CE_m$ Crew’s monthly salary</td>
<td>$COE \cdot OL_g \cdot GL_m$</td>
<td>€</td>
</tr>
<tr>
<td>$GL_a$ Yearly working days</td>
<td>$12 \cdot GL_m$</td>
<td>days</td>
</tr>
<tr>
<td>$CE_v$ Crew’s cost per trip</td>
<td>$CE_m/(GL_m \cdot NV_g)$</td>
<td>€/trip</td>
</tr>
<tr>
<td>$CA_v$ Ship acquisition cost per trip</td>
<td>$CA/(AA \cdot GL_a \cdot NV_g)$</td>
<td>€/trip</td>
</tr>
<tr>
<td>$CM_v$ Ship maintenance cost per trip</td>
<td>$CM_a/(GL_a \cdot NV_g)$</td>
<td>€/trip</td>
</tr>
</tbody>
</table>
Evaluation and transport scenarios

\[
CV_{BE} = \frac{(CA_v + CM_v + CE_v + CT + CP)}{CC}
\]

with
- \(CV_{BE}\): value of break even cost
- \(CA_v\): ship acquisition cost per trip
- \(CM_v\): ship maintenance cost per trip
- \(CE_v\): crew cost per trip
- \(CT\): fuel consumption per trip
- \(CP\): port charges
- \(CC\): ship’s capacity

for combined road/sea unaccompanied high speed mode
Evaluation and transport scenarios

We compare the cost of the combined road-sea high speed mode and the real transport price (traditional combined road-sea mode) for a 14-metre semitrailer on the Messina–Salerno motorway of the sea, which is nearly €340.30.

The increase in the cost of the combined high speed mode varies between 46 and 54% if the trip number per day varies from 2 to 4.

| Scenario speed | Ticket (€) | Percentage increasing of the break even cost $NV_q=4$
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>340.30</td>
<td>45.92</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>48.83</td>
</tr>
<tr>
<td>35</td>
<td>340.30</td>
<td>53.15</td>
</tr>
<tr>
<td>38</td>
<td></td>
<td>53.52</td>
</tr>
</tbody>
</table>

*Increase in the break-even cost in respect of real cost on Messina – Salerno motorway of the sea for a semitrailer*
Evaluation and transport scenarios

In order to estimate the demand variation in the Messina–Salerno motorway of the sea, the choice probabilities are evaluated among six modal alternatives
Evaluation and transport scenarios

**Combined Road/Sea Unaccompanied High Speed CMnAHS**

is defined by:

- cruising speed
- percentage rise in service price in comparison with the current combined road – sea transport.

We considered several *speed.price scenarios*, for which we determined the choice probability variations of the sample survey.

Each *speed.price scenario* is defined according to the service attributes of the combined road – sea high speed unaccompanied transport mode, that is:

- cruising speed *VHS*, which varies between 30 kn and 38 kn;
- increase in transport price, which varies between 20 and 70 % in comparison with the current price of the combined road–sea unaccompanied transport mode.
Evaluation and transport scenarios

**HYPOTHESIS**

- Users do not perceive considerable differences between current and high speed combined road-sea transport alternatives.

- Choice probabilities of the combined road – sea high - speed transport mode have been evaluated using the same specification and parameters as those of the unaccompanied combined road – sea transport mode.

- The high-speed ship makes four trips per day, then the increase in the CHS cost varies between 45 and 55 % (45.92, 48.83, 53.15 and 53.52 % for cruising speeds of 30, 32, 35 and 38 kn, respectively). These values are comparable to cruising speed and percentage rise in service price supposed in the speed.price scenarios 30.45, 32.50, 35.55, 38.55.
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CONCLUSIONS

In this paper we have proposed a modal choice model with choice set which includes, for the first time in literature (in the author’s knowledge), the combined road-sea transport subdivided into accompanied and unaccompanied transport.

The results obtained by model experimentation confirm that by introducing the high speed combined road-sea mode:

- a variation among modal choices is obtained, because the road choice probability decreases, thereby reducing road traffic;

- a new rate of freight demand is produced, due to travel time reduction, with equal travel cost, or, alternatively, to travel cost reduction, with equal travel time.

The results obtained by model experimentation confirm that the high speed combined road-sea mode is a very competitive alternative to road.

Therefore, the model proposed can be considered a useful support for shipping company policies, guiding investments and the nature of services supplied.
LA FATTIBILITÀ ECONOMICA DEI SERVIZI DI TRASPORTO MERCI DEPERIBILI DI MEDIO RAGGIO

Francesco Russo, Giovanna Chilà

Dipartimento di Ingegneria dell’Informazione, delle Infrastrutture e dell’Energia Sostenibile
Mediterranea University of Reggio Calabria
francesco.russo@unirc.it, giovanna.chila@unirc.it, www.last.unirc.it