

Port marginal cost case study

Hilde Meersman
Feliciana Monteiro
Tom Pauwels (presenter)
Eddy Van de Voorde
Thierry Vanelslander



7^e PLATOS colloquium
"Mobiliteit = Geld"

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Universiteit Antwerpen 

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Overview presentation

1. Description Grace project
2. Methodology for the construction of (marginal) cost functions
3. The simulation tool
4. Concluding remarks

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1. Description Grace project

- Project in progress
- EU funded project (6th Framework Programme)
- Generalisation of Research on Accounts and Cost Estimation
- Partners from Belgium, UK, Sweden, Germany, Italy, Greece, Hungary, Switzerland, Netherlands, Spain and Poland
- Information: www.grace-eu.org

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1. Description Grace project

- 2 Main topics in Grace:
 - Marginal (infrastructure) costs: road, rail, inland navigation, ports, airports
 - Pricing: e.g. complexity of pricing
- University of Antwerp:
 - Focus on marginal (infrastructure) costs and pricing in ports.

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The Project - Microsoft Internet Explorer

Address: http://www.grace-eu.org/deliverables.htm

GRACE
GENERALISATION OF RESEARCH ON ACCOUNTS AND COST ESTIMATION

:: HOME
 :: THE PROJECT
 :: DELIVERABLES
 :: CONSORTIUM
 :: DISSEMINATION
 :: LINKS
 :: CONTACT
 :: SEMINARS
 :: RESERVED AREA
 :: DATABASE

DELIVERABLES

Del. 1. Information requirements for monitoring implementation of marginal social cost pricing. This Deliverable will present a full set of marginal cost estimates in order to monitor the implementation of marginal social cost pricing.

Del. 2. Information requirements for examining optimal complexity of transport pricing. This Deliverable will include a number of issues ranging from a review of technological issues relevant for complex price structures, reviews on tariff structures of different degrees of complexity in ports, airports and rail transport up to new empirical work.

Del. 3. Marginal cost case studies for road and rail transport. This Deliverable will pull together the results from the various case studies to produce a deliverable advising on the valuation of marginal social cost for road and rail.

Del. 4. Marginal cost case studies for air and water transport. This Deliverable will pull together the results from the various case studies to produce a deliverable advising on the valuation of marginal social cost for ports, airports and inland waterways.

Del. 5. Monitoring pricing policy using accounts. This Deliverable will improve and further develop the accounts methodology to enable the use of accounts as a monitoring instrument.

Del. 6. Optimal complexity of transport pricing. This Deliverable will seek to provide evidence on the optimal degree of complexity of the charges presented to users.

Del. 7. Generalisation of marginal social cost estimates. This Deliverable will aim at testing the transferability/generalisation methodology in the context of charge determination.

Del. 8. Software for above. A dedicated software tool will estimate the order of magnitude of transport external costs in different contexts.

→ PORT PRICING

→ PORT MARGINAL COST

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- Research questions University of Antwerp
 - When a ship enters (part of) a logistic chain, what are the marginal costs?
 - Which costs are (should be) relevant for the port authority?
 - Pricing in ports
- Marginal cost: the cost associated with the last ('marginal') unit.
 - One additional tonnage
 - One additional container
 - One additional vessel

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2. Methodology for the construction of (marginal) cost functions

- General identification of (marginal) costs (1)
- Typology of ports and their maritime access (2)
- Typology of vessels (3)
- Combination of (1), (2) and (3)
- Available database: simulations

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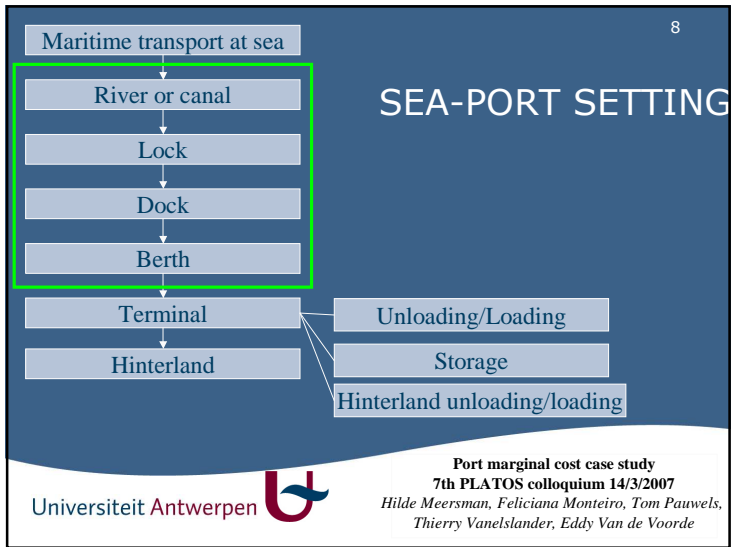
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MARGINAL PORT COST PRICING

- Sea-port definition
- Cargo types
- Price = marginal cost of a vessel call
- Starting off with short-run marginal costs

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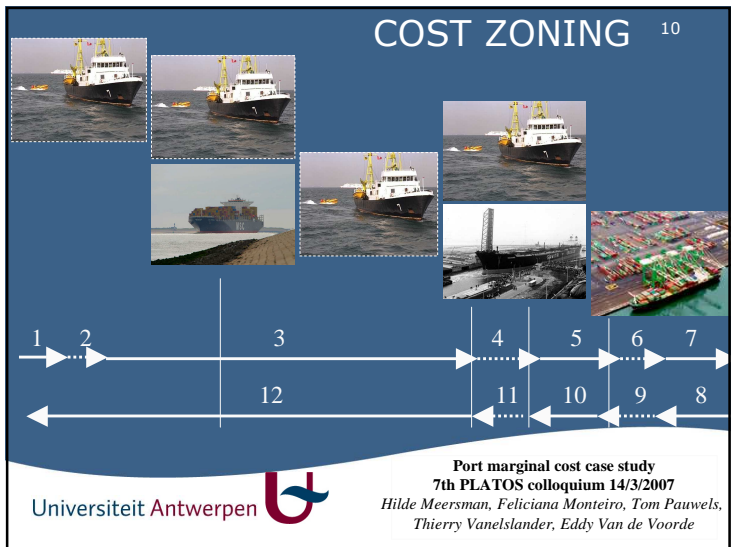
COST CONSIDERATION

Main objective: to assess marginal costs for different port and vessel types, according to a well-defined typology

Port typology	Type 1 . . . Type X
Ship typology	
Type 1	
⋮	
Type X	

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- ## COST COMPOSITION
- General idea: sum of
 - Infrastructure costs
 - Transport user costs
 - Supplier/operating costs
 - External costs
 - For a ship on a specific link
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PORT TYPOLOGY

- Factors:
- Security
- Scope activities
- Sea-port organization
- Port lay-out
- Location
- Traffic

PORT TYPOLOGY (ctd)

- Antwerpen
- Felixstowe
- Bordeaux
- Genova
- Gdynia

VESSEL TYPOLOGY

Cargo types	Vessel size
Container	200 TEU, 600 TEU, 3000 TEU
General cargo, dry bulk, tanker	2500 dwt, 8000 dwt, 45000 dwt
Passenger	200 passengers, 700 passengers, 1500 passengers

VESSEL TIME DATABASE: Antwerp

Naam schip	Scheepstype	Lengte- overalles	Grootste breedte	Tonnen maat	Laadvermo- gen	Soot beweging	Tijdstip activatie	Diepgang	Ligplaats ontmeerd	Tijdstip ligplaats ontmeerd	Ligplaats gemeerd	Tijdstip ligplaats gemeerd
aachen	general cargo	106,12	14,4	3.930	5.780	Aankomst	16-jul-05 20:05:00	4,7			253	17-jul-05 6:14:00
aachen	general cargo	106,12	14,4	3.930	5.780	Vertrek	20-jul-05 11:34:00	6,5	363	20-jul-05 17:00:00		
aachen	general cargo	106,12	14,4	3.930	5.780	Aankomst	1-dec-05 7:40:00	5,8			118	1-dec-05 17:23:00
aachen	general cargo	106,12	14,4	3.930	5.780	Verhaal	2-dec-05 16:55:00	4,8	118	2-dec-05 18:31:00	265	2-dec-05 19:03:00
aachen	general cargo	106,12	14,4	3.930	5.780	Vertrek	5-dec-05 10:52:00	4,2	265	5-dec-05 18:17:00		
aalmmeegracht	general cargo	129,8	19,01	7.949	12.150	Aankomst	14-nov-05 17:36:00	5,6			726	15-nov-05 3:06:00
aalmmeegracht	general cargo	129,8	19,01	7.949	12.150	Vertrek	15-nov-05 9:55:00	5,7	726	15-nov-05 15:17:00		
asli	general cargo	100,7	15,95	3.968	6.630	Aankomst	27-sep-05 19:17:00	4,21			510	28-sep-05 3:49:00
asli	general cargo	100,7	15,95	3.968	6.630	Vertrek	28-sep-05 14:29:00	7,1	510	28-sep-05 21:57:00		
astun	general cargo	94,42	15,42	3.136	4.240	Aankomst	28-dec-05 9:26:00	4,5			507	30-dec-05 5:22:00
astun	general cargo	94,42	15,42	3.136	4.240	Vertrek	31-dec-05 6:13:00	6,6	507	31-dec-05 6:54:00		
a.b.amsterdam	general cargo	89,9	13,17	2.844	4.250	Aankomst	5-sep-05 18:37:00	3,8			160	6-sep-05 5:14:00
a.b.amsterdam	general cargo	89,9	13,17	2.844	4.250	Verhaal	6-sep-05 10:36:00	3,8	160	6-sep-05 10:15:00	158	6-sep-05 10:30:00
a.b.amsterdam	general cargo	89,9	13,17	2.844	4.250	Vertrek	7-sep-05 19:22:00	6,1	158	7-sep-05 17:46:00		
abdul	bulk carrier	160	24,44	14.031	23.821	Aankomst	10-nov-05 5:13:00	6,6			518	10-nov-05 15:29:00
abdul	bulk carrier	160	24,44	14.031	23.821	Verhaal	18-nov-05 14:15:00	8,5	518	18-nov-05 20:30:00	345	18-nov-05 22:16:00
abdul	bulk carrier	160	24,44	14.031	23.821	Vertrek	24-nov-05 9:36:00	9,7	345	24-nov-05 14:14:00		
abdul	bulk carrier	160	24,44	14.031	23.821	Aankomst	25-nov-05 1:37:00	9,9			356	25-nov-05 9:50:00
abdul	bulk carrier	160	24,44	14.031	23.821	Vertrek	26-nov-05 18:39:00	9,8	356	27-nov-05 6:20:00		
ability	general cargo	91,09	14,26	2.822	4.245	Aankomst	19-sep-05 12:35:00	3,6			514	19-sep-05 23:04:00
ability	general cargo	91,09	14,26	2.822	4.245	Vertrek	20-sep-05 3:34:00	6,4	514	20-sep-05 9:55:00		
ability	general cargo	91,09	14,26	2.822	4.245	Aankomst	6-okt-05 10:16:00	6,5			332	6-okt-05 19:55:00
ability	general cargo	91,09	14,26	2.822	4.245	Verhaal	9-okt-05 21:16:00	6,7	332	10-okt-05 10:08:00	119	10-okt-05 11:21:00
ability	general cargo	91,09	14,26	2.822	4.245	Verhaal	10-okt-05 16:35:00	6,1	119	10-okt-05 21:35:00	255	10-okt-05 22:39:00
ability	general cargo	91,09	14,26	2.822	4.245	Vertrek	11-okt-05 11:12:00	3,8	255	11-okt-05 16:55:00		

VESSEL TIME DATABASE SPECIFICS

- 📌 Vessel name: important to know container ships' TEU size, through Lloyd's List
- 📌 Cargo type:
 - 📌 First stage: aggregated
 - 📌 Later: detailed, since difference in draught
 - 📌 Deleted: special types like army vessels,...
- 📌 Length: important to extent that in locks, number of ships and therefore waiting time may be limited

VESSEL TIME DATABASE (ctd)¹⁷

- 📌 dwt size: important to know cargo vessels' size class
- 📌 Draught: determines tide-dependence and therefore waiting time
- 📌 Quay number: quay location makes a difference with respect to distance and costs incurred; first stage: per block
- 📌 Cleaning out for errors

COST DATABASE

- 📌 For each element from the cost zoning and from the composing elements: unit costs
- 📌 Based on previous and current research and contacts with port and maritime authorities and companies
- 📌 Selection is made for the cases studied
- 📌 2 steps: engineering build-up and simulation

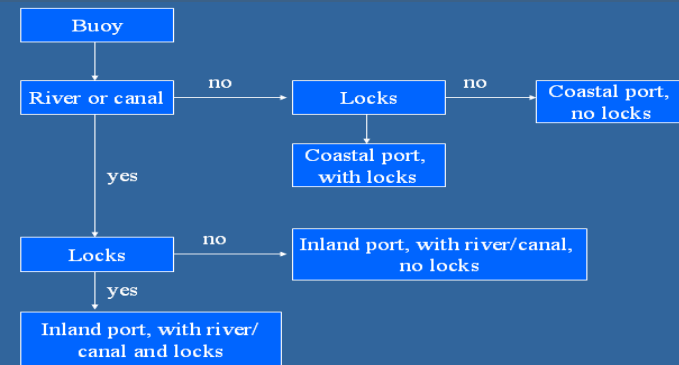
COST DATABASE (ctd)

- 📌 First stage: vessel only
- 📌 Second stage: other vessels and other actors also (pilots, towage services, handling services,...)

3. SIMULATION TOOL ²⁰

- Existing sub-costs for each category, for example:
 - Marginal crew cost of a vessel on a link;
 - Marginal fuel cost of a vessel on a link;
 - Marginal operating and maintenance cost of a vessel on a link;
 - ...
- Each sub-cost is function of typology

THE DECISION PROCESS FOR THE SIMULATION TOOL ²¹



SUB-COSTS: EXAMPLES ²²

- Vessel operating costs:
 - Crew $f(\text{flag, vessel type and size, time, ...})$
 - Fuel $f(\text{vessel type and size, distance, speed, cargo load, ...})$
 - Stores $f(\text{vessel type and size, time, ...})$
 - Lubricants $f(\text{vessel type and size, distance, speed, ...})$
 - Spare parts $f(\text{vessel size and type, distance, speed, ...})$
 - Oil $f(\text{vessel size and type, distance, speed, ...})$
- Accidents $f(\text{flag, total traffic, conditions, ...})$
- Noise, air pollution, water pollution $f(\text{vessel size and type, speed, ...})$
- Pilotage operating costs

THE SIMULATION TOOL ²³

- Compiled in Excel
- Possibility to link to a specific port's context
- Possibility to link to the database of a specific port
- Reference scenario: zero time loss
- Alternative scenarios: time loss: direct and indirect

PORT MARGINAL COST PRICING			
Type of vessel	3	Container vessel (2000 TEU)	Press to clean values
Gross tonnage	35598		
Dwt	43270		
Cargo loaded in port	10000 ton	Containers loaded in port	1000 TEU
Cargo unloaded in port	5000 ton	Containers unloaded in port	500 TEU
Cargo on board at arrival	20000 ton	Containers on board at arrival	2000 TEU
Cargo on board at departure	25000 ton	Containers on board at departure	2500 TEU
Crew	1	According minimum crew	
Port setting	1	Typology without locks	
Type of goods	1	Iron and steel	
Value of goods	611 EURO/MT	611 Indication	
		Time in hours	Time in minutes % valid for crew wage
Step 1	River-canal to berthing at terminal, cruising time	4	0 100
Step 2	River-canal to berthing at terminal, waiting time	0	0 100
Step 3	Total time in lock (arriving vesse)	5	0 100
Step 4	Unberthing terminal to river-canal, cruising time	5	30 100
No step 5		0	0 100
No step 6		0	0 100
No step 7		0	0 100
No step 8		0	0 100
Total time for selected typology and valid for crew wage:		14 hours	30 minutes

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PORT MARGINAL COST PRICING			
Port setting	2	Typology with locks	
Type of goods	1	Iron and steel	
Value of goods	611 EURO/MT	611 Indication	
		Time in hours	Time in minutes % valid for crew wage
Step 1	River-canal to berthing in lock, cruising time	4	0 100
Step 2	River-canal to berthing in lock, waiting time	0	0 100
Step 3	Total time in lock (arriving vesse)	0	30 100
Step 4	Lock to berthing at terminal	0	30 100
Step 5	Total time at terminal	2	0 100
Step 6	Unberthing terminal to berthing in lock	0	30 100
Step 7	Total time in lock (departing vesse)	0	30 100
Step 8	Lock to river-canal, cruising time	5	0 100
Total time for selected typology and valid for crew wage:		13 hours	0 minutes

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Exchange rate:	1 euro =	1.2812	dollar
	1 dollar =	0.780518264	euro
Fuel price crude oil (380 cSt)		313	\$ per ton
		244	€ per ton
Fuel price diesel (MDO)		586	\$ per ton
		457	€ per ton
Average value of 1 TEU container itself		1373	€
1 TEU contains on average		10	ton
Minor injury:			
Average loss of working days for one worker		36	days
Average hourly wage rate		8.43	€
Average working hours per day		8	hours
Marginal human cost of work		2428	€
Severe injury:			
Average loss of working days for one worker		36	days
Average hourly wage rate		8.43	€
Average working hours per day		8	hours
Marginal human cost of work		2428	€
Value of a statistical life		1500000	€
% of SL in case of minor injury		1	%
% of SL in case of severe injury		13	%
% of SL in case of deadly accident		100	%
Operating and maintenance costs of locks in port per period:			
		21028800	€
Number of locks in port:		5	

	Fuel vessel	Distance in sea-miles	Towage vessels	Accident rate (cargo loss)	Accident rate (minor injury)	Accident rate (severe injury)	Accident rate (deadly accident)
Step 1	Crude oil	44	1	per 1000 TEU	per 1000 TEU	per 1000 TEU	per 1000 TEU
Step 2	Crude oil		0	per 1000 TEU	per 1000 TEU	per 1000 TEU	per 1000 TEU
Step 3	Crude oil	0.5	1	per 1000 TEU	per 1000 TEU	per 1000 TEU	per 1000 TEU
Step 4	Crude oil	44	1	per 1000 TEU	per 1000 TEU	per 1000 TEU	per 1000 TEU
No step 5	Crude oil		0	per 1000 TEU	per 1000 TEU	per 1000 TEU	per 1000 TEU
No step 6	Crude oil		0	per 1000 TEU	per 1000 TEU	per 1000 TEU	per 1000 TEU
No step 7	Crude oil		0	per 1000 TEU	per 1000 TEU	per 1000 TEU	per 1000 TEU
No step 8	Crude oil		0	per 1000 TEU	per 1000 TEU	per 1000 TEU	per 1000 TEU

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Year 2006		3 Container vessel (3000 TEU)			
Code	Minimum crew	Monthly wage US \$	Monthly wage €	Hourly wage €	Hourly total ship cost €
1	Master	4920	3840	16.0	16.0
2	Deck officers	3221	2514	10.5	31.4
3	Bosun	1715	1339	5.6	5.6
4	A.B.	1560	1210	5.0	15.1
5	O.S. / junior / entry rating / deck ratings	1185	925	3.9	3.9
6	chief engineer	4483	3499	14.6	14.6
7	engineer officers	3221	2514	10.5	31.4
8	electrician / electrical engineer officer	2604	2032	8.5	8.5
9	repairman	2604	2032	8.5	8.5
10	engine room rating	1715	1339	5.6	16.7
11	radio officer	2604	2032	8.5	8.5
12	chief steward / cook	2604	2032	8.5	8.5
13	steward(esses)	2604	2032	8.5	16.9
Total					per hour per ship in euro in 185.5.2006

Absolute values	Per vessel	Per gt	Per dwt	Per cargo loaded	Per cargo unloaded	Per cargo on board at arrival	Per cargo on board at departure
Marginal infrastructure cost	0	0	0	0	0	0	0
Marginal transport user cost							
Vessel:							
Marginal crew cost	5909	0.122713	0.118173	7.878806	7.878806	2.188557	2.188557
Marginal operating and maintenance cost	8573	0.178041	0.171454	11.43117	11.43117	3.175326	3.175326
Marginal supplier/operator cost							
Tugboats:							
Marginal operating and maintenance cost	646	0.013424	0.012927	0.861864	0.861864	0.239407	0.239407
Pilotage boat or helicopter:							
Marginal operating and maintenance cost	103	0.002136	0.002057	0.137115	0.137115	0.038087	0.038087
Marginal external cost							
Marginal accident cost: cargo	4.837917318	0.0001	9.68E-05	0.006451	0.006451	0.001792	0.001792
Marginal accident cost: minor injury	130.7088	0.002714	0.002614	0.174278	0.174278	0.048411	0.048411
Marginal accident cost: severe injury	1.307088	2.71E-05	2.61E-05	0.001743	0.001743	0.000484	0.000484
Marginal accident cost: deadly accident	0.01125	2.34E-07	2.25E-07	0.000015	0.000015	4.17E-06	4.17E-06
Marginal noise cost	0	0	0	0	0	0	0
Marginal air pollution cost	13473.33333	0.279797	0.269445	17.96444	17.96444	4.990123	4.990123
Total	28842	0.60	0.58	38.46	38.46	10.68	10.68

CASE-STUDIES

- In Deliverable 4 and appendix: illustration of tool for 5 ports.
 - Antwerp
 - Bordeaux
 - Genova
 - Felixstowe
 - Gdynia

4. Concluding remarks

- Simulation tool shows the complexity of marginal cost calculation in ports
- Existing barriers to introduce efficient cost based port pricing:
 - Lack of transparency
 - Lack of harmonisation of pricing principles
 - Companies preventing changes
 - Ports not eager to collect additional data
 - Different market players with possibly conflicting interests