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UNITE

UNIfication of accounts and

marginal costs for Transport Efficiency

UNITE Case Studies 7J: Mohring Effects for Freight Transport

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Table of Contents **Page:**

1. CONTEXT OF THE CASE STUDY

Morhing (1972) brought together the demand for public transport and the quality of service, expressed in user's waiting time. In the short run the crowding (and scarcity) costs are in the foreground, while in the medium and long run the investment policy of the operator gets relevant. Additional demand induces investments, which improve the system performance for all users.

In freight transport, Morhing effects are only relevant for scheduled transport, which implies that freight services for single customers, where the shipper has a great influence on the service provision are out of scope because the Morhing effect is hence purely internal.

The objective of the case study is to estimate the external benefits resulting of an increased demand generated by increasing the service frequency in freight intermodal transport. The key relationship in the determination of whether external benefits per consignment exist is the response of operators to increased demand; external benefits only exist if operators respond to increased demand by increasing the service frequency (larger/ longer vehicles, duplication of overnight services etc. do not lead to a frequency benefit).

The case study is based on a stated preference survey on the value of modifying the frequency of the service. This stated preference survey has been carried out for the IIT study (Integration of the Intermodal Transport in the supply chain) in 1998-1999, in collaboration with PriceWaterHouseCoopers on behalf on DGTREN.

The case study is dealing with three modes (rail, inland waterways and short sea shipping) and four industrial sectors (Automotive & Machineries, Chemicals, FMCG, Heavy metals). The stated preference survey has been carried on five different geographical corridors of which four bi-directional and one one-directional (Rotterdam-Vienna-Rotterdam, Rotterdam-Basel-Rotterdam, Antwerp-Milan-Antwerp, Antwerp-Bilbao-Antwerp and Lyon-Antwerp).

The sample has been composed of 12 segments based on these modal, sectorial and geographical scopes. There are provided on the figure 1 here below.

Segment	Corridor / Route	Industrial sector	Alternative mode
Seg 1	Antwerp-Bilbao	Chemicals	Short Sea (SS)
Seg 2	Antwerp-Milan	Automotive & Machineries	Rail (R)
Seg 3	Antwerp-Milan	Heavy Metals	Rail (R)
Seg 4	Rotterdam-Basel	Chemicals	Inland Waterways (IW)
Seg 5	Rotterdam-Basel	Fast Moving Consumer Goods	Inland Waterways (IW)
Seg 6	Rotterdam-Vienna	Fast Moving Consumer Goods	Rail (R)
Seg 7	Rotterdam-Vienna	Heavy Metals	Rail (R)
Seg 8	Bilbao-Antwerp	Fast Moving Consumer Goods	Short Sea (SS)
Seg 9	Lyon-Antwerp	Automotive & Machineries	Rail (R)
Seg 10	Milan-Antwerp	Automotive & Machineries	Rail (R)
Seg 11	Basel-Rotterdam	Fast Moving Consumer Goods	Inland Waterways (IW)
Seg 12	Vienna-Rotterdam	Heavy Metals	Rail (R)

Figure 1

The sample is composed of shippers fulfilling the following criteria:

- Establishment within 150 km of the segment origin point
- Active in the relevant industrial sector for the segment
- Exporting within the relevant corridor
- Exporting full-loads of non-hazardous and non refrigerated goods

To avoid any confusion it has to be mentioned that the most frequently transport unit effectively used by the shipper on this corridor are truck or trailer or container and boxes and pallet. The transport by full boot or wagon represents only 1% of the transport considered by the sample.

The figure 2 hereafter provides with the distribution of the sample shippers by type of transport unit.

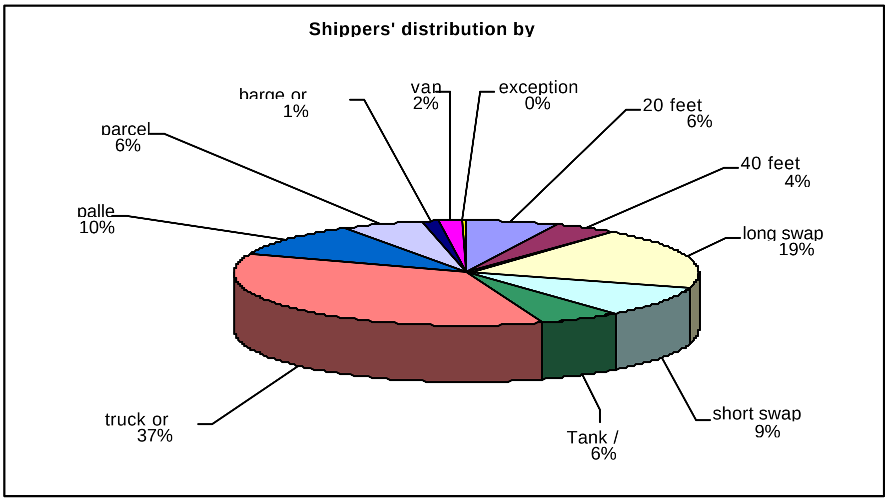

Figure 2

On one hand, different scenarios will be examined in order to evaluate the benefits for shippers of increasing the quality of service in intermodal transport.

On the other hand the case study involves interviews validating the freight operators side examining, for a range of corridors, operator responses to increased demand.

2. IPI MODEL DESCRIPTION

The IPI (Intermodal Perception Index) has been defined based on the construction of a quantitative utility function of shippers of intermodality:

- using the Stated Preferences methodology[1]
- based on a sample of shippers, representative of main types of supply chains
- measuring their propensity to use intermodal transport, given well defined alternatives
- facing modal choice along a couple of representative corridor, where several intermodal alternatives are available

The methodology has been applied to compute an IPI software prototype based on five geographical corridors, four industrial sectors and three intermodal alternative modes to road.

2.1 IPI Method

The IIT study is mainly based on the Stated Preferences survey technique. The design is based on a preliminary survey carried out by interviewing haulers about their present practice in the selected corridors concerning prices and level of service of the supply for the different alternative modes (travel time, frequency, tracking and tracing,..). The questionnaire has been customised by mode and origin-destination.

The main survey has consisted of shippers' interviews. It has been carried out in two steps:

- a screening has been conducted by phone to select the shippers
- the Stated Preferences survey itself was then realised on the base of a mail-back questionnaire with phone assistance.

Models have thereafter been calibrated to enable to predict changes in intermodal market share in relation with modifications of services characteristics and of shippers' localisation.

[1] An brief overview of the Stated Preferences survey method is available in appendix 1.

2.2 IPI Shippers' sample

The selection of segments to be considered in the prototype has been realised according to the actual intermodal transport supply as well as the European Commission requests.

A preliminary survey has been achieved in winter 99. For each segment, a list of 4648 shippers was put together based on information from the European Kompass database and/or information from the relevant Chambres of Commerce. The list of shippers was including some information on the size of the company (turnover or number of workers).

Telephone contacts have been initiated on the basis of a random selection covering the whole ranges of sizes. A screening was conducted over the phone to select those shippers which were satisfying the following criteria: the selected shippers were active in the relevant industrial sector and based within 150 km of the corridor origin; more over they were exporting within the relevant corridor full loads of non-hazardous and non-refrigerated goods.

The contact initiation has been stopped when the number of positive answers has reached a level deemed to be sufficient to obtain the required number of questionnaires (30 questionnaires per segment) or when the list of contact was exhausted.

1761 shippers did not fill the required criteria. 1289 shippers have been chosen to participate to the survey.

2.3 The IPI mail-back survey

From the shippers' sample that was completed in the preliminary survey, 1289 shippers have been selected to take part in the mail-back survey.

This questionnaire was composed of two parts.

The purpose of the first part was to improve the knowledge of the shipper's characteristics (company identification), of the characteristics of the transported flow to be used as reference in the Stated Preferences survey, (description of the exported flow on the corridor, detailed description about a transport flow: origin, destination, transport mode, shipping unit and size, door to door delivery time, door to door price per ton) and qualitative questions about the expectations in intermodal transport services.

The second part of the questionnaire was devoted to the Stated Preferences experiments. To make the proposed options as realistic as possible, the questionnaire had been customised according to origin and destination of the proposed transports and to the selected modes.

The Stated Preferences experiments have been designed as sixteen trade-off between two - intermodal and road - transport alternatives regarding distance, door-to-door delivery time (hours), door to door transport price by equivalent trailer, tracking information delay and number of arrivals per week.

302 of the 1289 mailed questionnaires were sent back and usable.

2.4 IPI Weighting of the sample

The sample has been weighted to represent all the shipment realised in the basic year within the here above mentioned five geographical corridors, four industrial sectors and three intermodal modes.

The weighting has been computed in two steps. On one hand, the sample has been weighted to represent the turnover observed within the universe of companies exporting the related goods in the related corridors the flows transported within the corridors. On the second hand, a corrective coefficient has been computed in order to match the flows transported within the corridor.

2.5 IPI Prototype model

Logit models have been estimated using the Hielow software. Separate models have been estimated for the three intermodal alternative modes including sensibilities related to the geographical corridor, to industrial sector, to the shippers and to the product.

2.6 IPI Prediction modelling method

The objective of the IIT study was to develop and provide the prototype of an easy to use software tool that would enable to assess policies aimed at increasing intermodal transport usage: it should be able to predict the impacts on the perception of intermodal transport of changes in the fares level and/or level of service.

The IPI software should be used by transport authorities as well as by 3PLS, as a help decision-making tool respectively for supply action plan and demand action plan.

This software prototype comes under the form of an EXCEL 7.0 notebook. Values for the action parameters that characterise a strategy to be assessed are defined on an input data screen. Simulation results are available on a results screen. Curves can be drawn in order to represent responses variations to variations of action parameters.

Weighted sample enumeration has been completed under the form of an Excel worksheet. The shippers' characteristics and supply features requested by the prediction models have been listed in the table.

Supply features have been connected with the input data screen so as to enable the table to predict the impacts of possible strategic policies. Intermodal market share of the current situation and the new service supply as well as the perception index have been linked to the results screens. These results are available by industrial sector, by country, by corridor for low and high value products.

2.6.1 IPI Input data screen

The software deals with two types of possible strategic measures. It has to predict shippers' reactions to:

- level of service modifications;
- fare level changes.

Level of service can be changed through modifications to door-to-door transfer time, information delay (hours) and the number of arrival per week.

Shippers' locations modification and/or new terminal implementation can be considered by a modification of the "number of shippers close to a terminal" variable.

The input data screen is provided hereafter.

IPI Input screen

Segment	Mode	Route	Industrial Sector	Intermodal transport current characteristics: Price EURO / trailer	door-to-door transfer time (hour)	information delay (hours)	number of arrival per week	% of shippers close to a terminal
2	Rail	Antwerp-Milano	Automotive	1050	48	18	5	77%
3	Rail	Antwerp-Milano	Heavy Metal	1100	60	18	5	85%
6	Rail	R'dam-Vienna	FMCG	1400	44	18	3	39%
7	Rail	R'dam-Vienna	Heavy Metal	1200	44	18	3	59%
9	Rail	Lyon-Antwerp	Automotive	950	46	18	5	53%
10	Rail	Milano-Antwerp	Automotive	1150	60	18	5	78%
12	Rail	Vienna-R'dam	Heavy Metal	1100	44	18	4	72%
4	Barge	R'dam-Basel	Chemistry	800	108	1	5	48%
5	Barge	R'dam-Basel	FMCG	750	108	1	5	13%
11	Barge	Basel-R'dam	FMCG	850	96	1	5	26%
1	Shortsea	Antwerp-Bilbao	Chemistry	1250	140	24	1	31%
8	Shortsea	Bilbao-Antwerp	FMCG	1250	140	24	1	73%

Segment	Mode	Route	Industrial Sector	Intermodal transport characteristics to be tested: Price EURO / trailer	Door-to-door Transfer time (hour)	information delay (hours)	number of arrival per week	% of shippers close to a terminal
2	Rail	Antwerp-Milano	Automotive	945	43	10	3	77%
3	Rail	Antwerp-Milano	Heavy Metal	990	54	10	3	85%
6	Rail	R'dam-Vienna	FMCG	1260	40	10	3	39%
7	Rail	R'dam-Vienna	Heavy Metal	1080	40	10	3	59%
9	Rail	Lyon-Antwerp	Automotive	855	42	10	3	53%
10	Rail	Milano-Antwerp	Automotive	1035	54	10	3	78%
12	Rail	Vienna-R'dam	Heavy Metal	990	40	10	3	72%
4	Barge	R'dam-Basel	Chemistry	720	100	10	3	48%
5	Barge	R'dam-Basel	FMCG	675	100	10	3	13%
11	Barge	Basel-R'dam	FMCG	765	88	10	3	26%
1	Shortsea	Antwerp-Bilbao	Chemistry	1125	126	10	3	31%
8	Shortsea	Bilbao-Antwerp	FMCG	1125	126	10	3	73%

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Figure 3

2.6.2 IPI Available results

The available results are composed of:

- The intermodal transport market share resulting respectively of the current intermodal supply characteristics and the characteristics of new service to be tested, for both low value and high value products
- The resulting intermodal perception index (IPI), calculated as follows:

$$\textbf{IPI} = \frac{\textbf{Market Share of Intermodal Transport (new service)}}{\textbf{Current market share of Intermodal Transport}}$$

The output data screen is provided hereafter.

IPI Result screen

Segmentation		Intermodal transport market share						Perception Index		
		Current intermodal Supply characteristics			Intermodal supply characteristics to be tested					
		All Products	Low Value	High value	All Products	Low value	High value	All Products	Low value	High value
Per sector	Automotive	38.3%	52.2%	30.2%	55.2%	70.3%	46.5%	1.44	1.35	1.54
	Heavy Metal	48.1%	65.4%	36.2%	66.9%	81.2%	57.0%	1.39	1.24	1.58
	FMCG	40.9%	62.4%	38.7%	56.0%	74.0%	54.2%	1.37	1.19	1.40
	Chemistry	80.8%	83.6%	79.6%	90.7%	93.9%	89.2%	1.12	1.12	1.12
Per Corridor	Antwerp-Milano & Milano-Antwerp	40.3%	50.8%	34.2%	61.0%	70.8%	55.3%	1.51	1.39	1.62
	Lyon-Antwerp	33.8%	51.2%	28.3%	49.1%	67.4%	43.3%	1.45	1.32	1.53
	R'dam-Vienna & Vienna-R'dam	55.4%	70.4%	41.2%	73.9%	84.7%	63.7%	1.33	1.20	1.55
	R'dam-Basel & Basel-R'dam	53.9%	66.1%	52.8%	60.5%	73.7%	59.4%	1.12	1.11	1.12
	Antwerp-Bilbao & Bilbao-Antwerp	74.3%	84.4%	69.1%	89.5%	94.8%	86.7%	1.20	1.12	1.25
Per Country	Belgium	63.4%	71.2%	58.6%	79.3%	85.5%	75.5%	1.25	1.20	1.29
	The Netherlands	55.2%	71.0%	50.5%	66.0%	83.6%	60.7%	1.19	1.18	1.20
	France	33.8%	51.2%	28.3%	49.1%	67.4%	43.3%	1.45	1.32	1.53
	Italy	55.1%	64.8%	40.7%	72.1%	80.2%	60.1%	1.31	1.24	1.48
	Switzerland	53.5%	43.9%	54.4%	58.4%	49.5%	59.3%	1.09	1.13	1.09
	Austria	35.7%	49.3%	31.4%	58.8%	72.2%	54.5%	1.65	1.46	1.74
	Spain	49.0%	77.5%	48.2%	74.9%	92.2%	74.4%	1.53	1.19	1.54

23/11/99

Figure 4

3. UNITE MORHING EFFET CASE STUDY DATABASE AND ASSUMPTIONS

3.1 Definition of the scenarios

For the need of this case study, the IPI model has been slightly recalibrated to get a uniform design for all segments concerning the frequency variable. The here-above software tool has been modified according to this adaptation. With this software tool, composition and evaluation of scenarios are endlessly well-to-do to manage level of price with respect to the provided level of service and for fine-tuning of pricing policies.

The scenario which have been examined in this case study are based on:

- a variation from 90% to 110% of the current level of price by equivalent trailer
- a variation of the number of arrival a week :

    - Antwerp-Milan (rail-road): 3 to 5 arrivals a week (currently 5 arrivals a week)
    - Rotterdam-Basel (IWW-road): 3 to 5 arrivals a week (currently 5 arrivals a week)
    - Antwerp-Bilbao (SSS-road): 1 to 5 arrivals a week (currently 1 arrival a week)

3.2 Impact from the point of view of the users

Discrete choice model are derived from the consumer theory which is based on the following assumptions:

- for each possibility of choice i, one can associate an utility function which is supposed to translate the level of satisfaction of the choice i for the individual n: U_{in}
- placed in front of a few possibilities, the individual is choosing the most satisfying for himself, hence the one which provides him which the biggest utility.

In transport models, Logit model are the discrete choice model the most commonly used.

The IPI utility function is based on the following “action” variables:

- modifications of price of the intermodal transport and/or road alternatives
- modifications of door to door delivery time of the intermodal transport and/or road alternatives
- modifications of number of arrivals a week
- modification of other characteristics of the supply such as
    - tracking information delay
    - locations of the intermodal terminals
    - …

The utility function is also taking into account “passive” variable which are:

- other characteristics of the supply

    - corridor
    - mode
- characteristics of the demand
    - shippers attributes: industrial sector, annual turnover, yearly number of shipment, volume of shipment, location related to intermodal terminal(s), shipper transport equipment and activity,...
    - goods attributes: type of goods (basic, semi-finished or finished goods), packaging (containerised goods or not), quantity (sending unit and number of shipment per year), and importance of in-time delivery...

The utility function represents the generalised cost of the shippers.

In that case study, the scenarios consider only variations in term of price and frequency (number of arrival a week), and the utility function can be expressed as following:

$$U(f,p) = a * p + b * 1/na$$

where p is the fare, na is the number of arrival a week, and a and b are the respective coefficients of fare and number of arrival a week in the utility function

The generalised cost can be expressed as:

$$GC(p, f) = p + c_f * 1/na$$

Where:
GC is $U(f,p) / a$ is the monetary value of the utility function
$c_f = b / a$ is the corresponding user monetary value of increased the frequency of vehicle arrival per week

The users benefits of increasing the reference frequency of arrival by 1, considering no variation of the current price is given by:

$$UB(f+1) = GC(p_c, f_r + 1) - GC(p_c, f_r) = c_f \left(1/na - 1/(na + 1) \right)$$

The users benefits of increasing the reference frequency of arrival and considering variation of the current price is given by:

$$UB(f, p) = GC(p, f) - GC(p_c, f_r)$$

This benefits expressed in monetary term can be considered as a reduction in % of the current fare:

$$UB(f, p) / pr = \left(GC(p, f) - GC(p_c, f_r) \right) / pr$$

3.2 Impact from the point of view of the operator

Impact from the point of view of the operator can be approached by the impact in term of revenue and in term of cost.

The modification in term of revenue can be provided as direct input of the IPI prototype model.

The variation of the operator costs is difficult to be considered as far as the relevant information is commercially confidential. We have approached the cost function considering the cost function provided by the TERMINET project carried out on behalf of DGTREN for rail and inland waterway intermodal transport.

3.2.1 Operators revenues

The probability of choice of intermodal transport versus road transport is given by the logit model, for each shipper of the sample by:

$$p(IT) = e^{U(IT)} / (e^{U(road)} + e^{U(IT)})$$

where:
p(IT) is the probability of choice of the intermodal transport
U(IT) is the utility of the intermodal transport
U(road) is the utility of the road transport

As the sample has been weighted to represent all the shipment yearly realised, the total intermodal transport demand and the total intermodal transport revenue on a corridor are respectively represented by:

$$\sum_{s} p_s (IT) * w_s$$

and

$$\sum_{s} p_s (IT) * w_s * f_s$$

where:
p_s (IT) is the probability of choice of the intermodal transport of the shippers on the relevant corridor
w_s is the weight the shipper s on the relevant corridor
f_s is the fare paid by the shipper s on the relevant corridor

The model shows that if the frequency of the intermodal transport service is increased at the current level of fare, the demand is increasing as well as the revenue of intermodal transport.

If fares are modified, for a given frequency:

- intermodal transport demand is increasing if the fare are decreasing and decreasing if the fare are increasing
- intermodal transport revenue can be higher or lower than the current ones related to the elasticity of the demand to fare

3.2.2 Operators costs

The TERMINET project approach the cost of rail and inland waterways transport related to:

- the distance to be travelled
- the transport time
- the loading and unloading cost
- the coefficient of charge of the vehicle

To the following assumptions have been made to calibrate the cost function according to the frequency and the yearly demand in tonnes:

- In rail, the length of the train can not be increased because of the infrastructure design
- In Inland Waterways Transport, we have considered two type of boat (capacity of 2000 t and 4500 t)
- The operation of two or more vehicles just after each other or the operation of two or more vehicles at regular frequency has the same cost
- For a given demand, the operator is distributing equally the demand between the vehicle in operation: if the demand is corresponding to half of the capacity of one vehicle and two vehicle are operated, the cost considered is the cost of two vehicle with a loading factor of a quarter of the capacity of the boat
- The demand can not be higher than the capacity of transport

3.3 Limitation of the IPI prototype model

The IPI prototype model is based on the following hypothesis: the dispersion of the shippers' behaviour is the same in the survey as in the reality. Generally, this hypothesis is not verified. A scaling factor reproducing the actual dispersion of the shipper's behaviour is assessed, calibrated, based on revealed preferences data: observation of actual choices in the reality.

The prototype is a first run of potential investigation: in-depth analysis would allowed to get really more precise results; for example, the pilot analysis did not consider a segmentation by type of good transported by the industrial sector of the shipper. The experience shows that a finer typology of goods should be adopted.

4. RESULTS

The figures hereafter provide the results:

- from the user point of view, in term of user benefits
- from the operator point of view, in term of demand and revenue variation and cost variation according the demand

The operator must be interested to find the best compromise maximising the revenue and to minimise the operation cost. For a given fare:

- the revenue is increasing is the demand is increasing and the demand is increasing if the frequency is increasing
- the cost of an additional vehicle is decreasing if the demand is increasing

Because of taking into account the cost function according to the global demand on the corridor, the case study is considering global transport by corridor, taking into account the sectorial distribution of industry and type of goods on the corridor.

The results are provided for three corridors:

- Antwerp-Milan-Antwerp (rail-road)
- Rotterdam-Basel-Rotterdam (IWW-road)
- Antwerp-Bilbao-Antwerp (SSS-road)

Both directions have to be examined: freight transport cost and revenue includes both direction aspects: the demand can be very high in one direction and very in the other one.

4.1 Antwerp-Milan-Antwerp (rail-road)

The figures 5 and 6 and the figures 7 and 8 hereafter provide respectively the user benefits related to frequency and level of fare, in absolute value and in % of the fare, respectively for both Antwerp-Milan and Milan-Antwerp directions. The user benefit is increasing if the level of service (number of arrival a week) is increased or/and if the fare is decreased. If the fare is increasing the user benefits is decreasing.

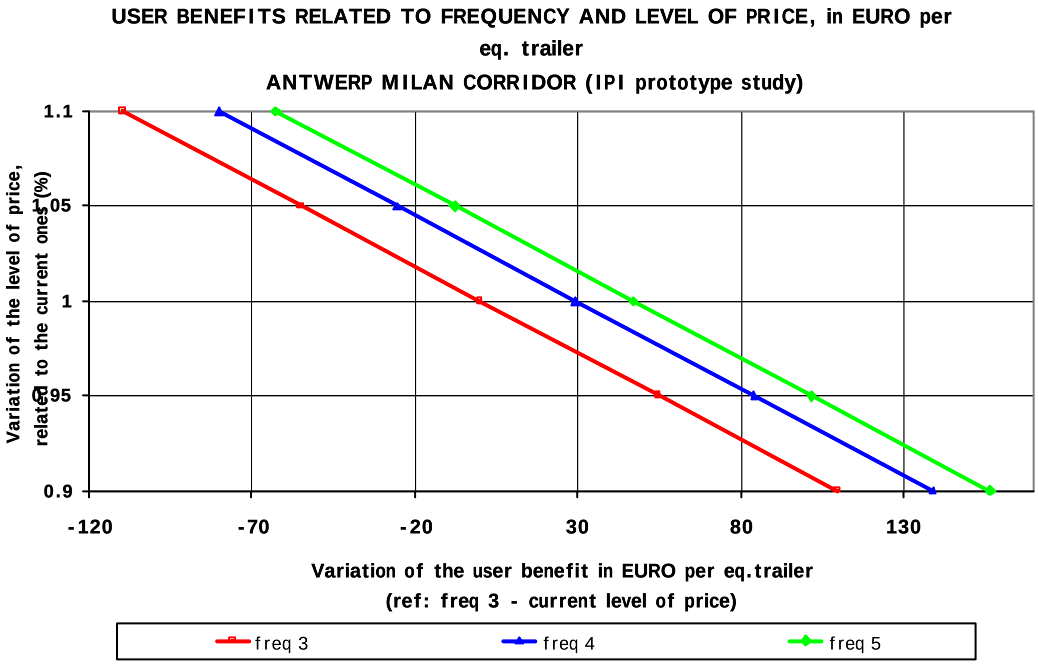

Figure 5

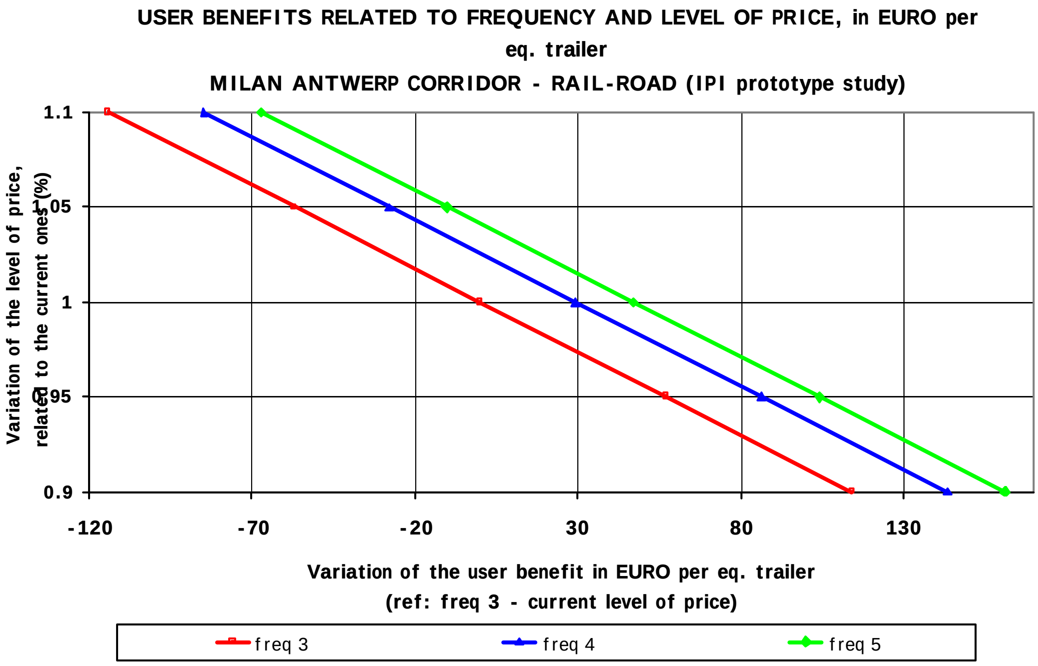

Figure 6

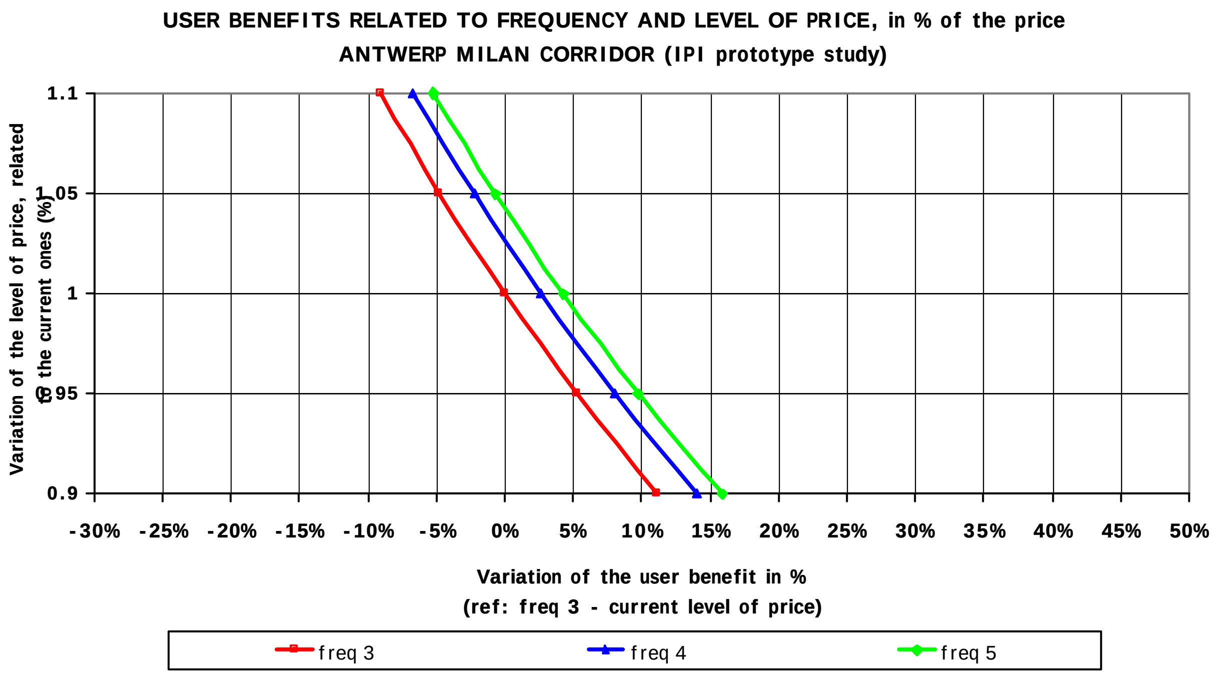

Figure 7

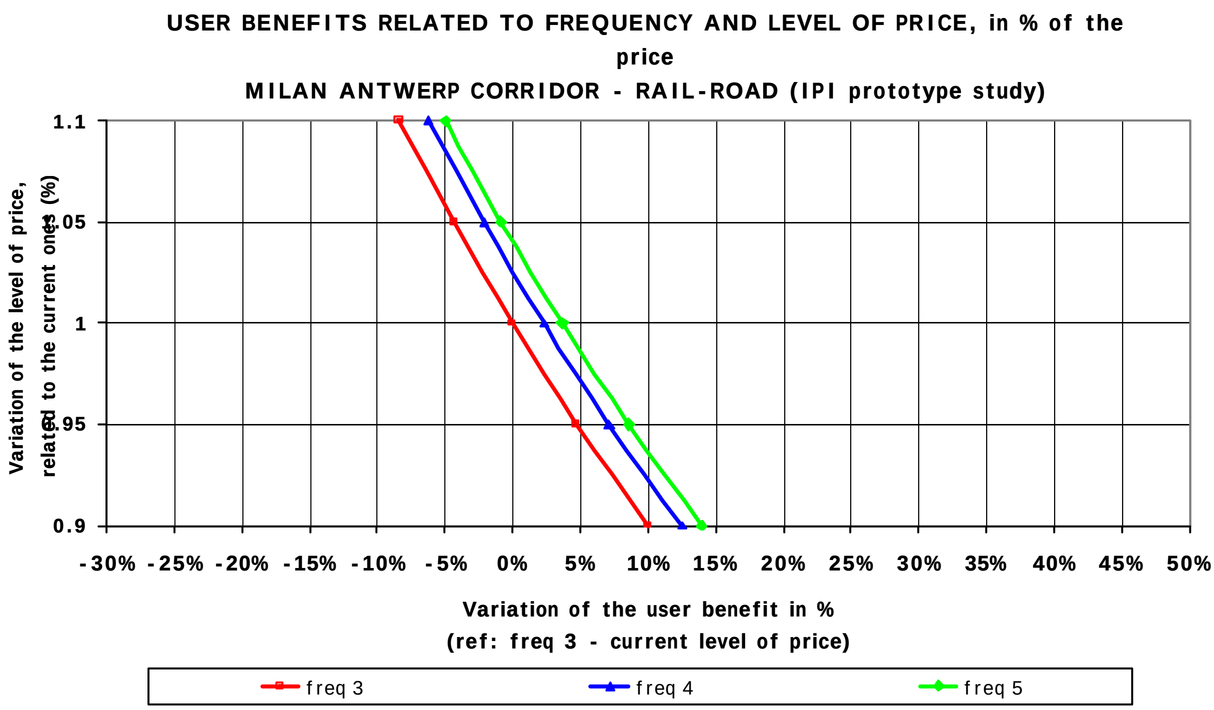

Figure 8

The figures 9 and 10 and the figures 11 and 12 hereafter provide respectively with the variation of the yearly demand and operator revenues related to frequency and level of fare respectively for both Antwerp-Milan and Milan-Antwerp directions.

It appears that the elasticity of the demand to the fare and to the frequency is more important from Milan to Antwerp than from Antwerp to Milan. Hence the potential revenue of increasing frequency and fare is higher from Milan to Antwerp than for Antwerp to Milan. The optimum could be found in term of fare and frequency considering both directions.

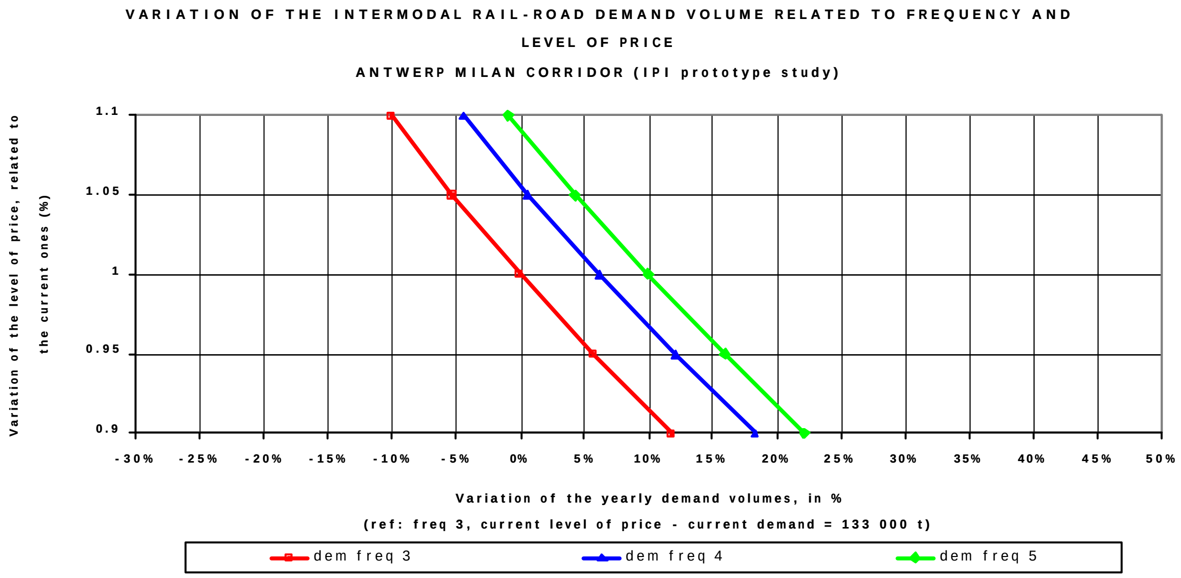

Figure 9

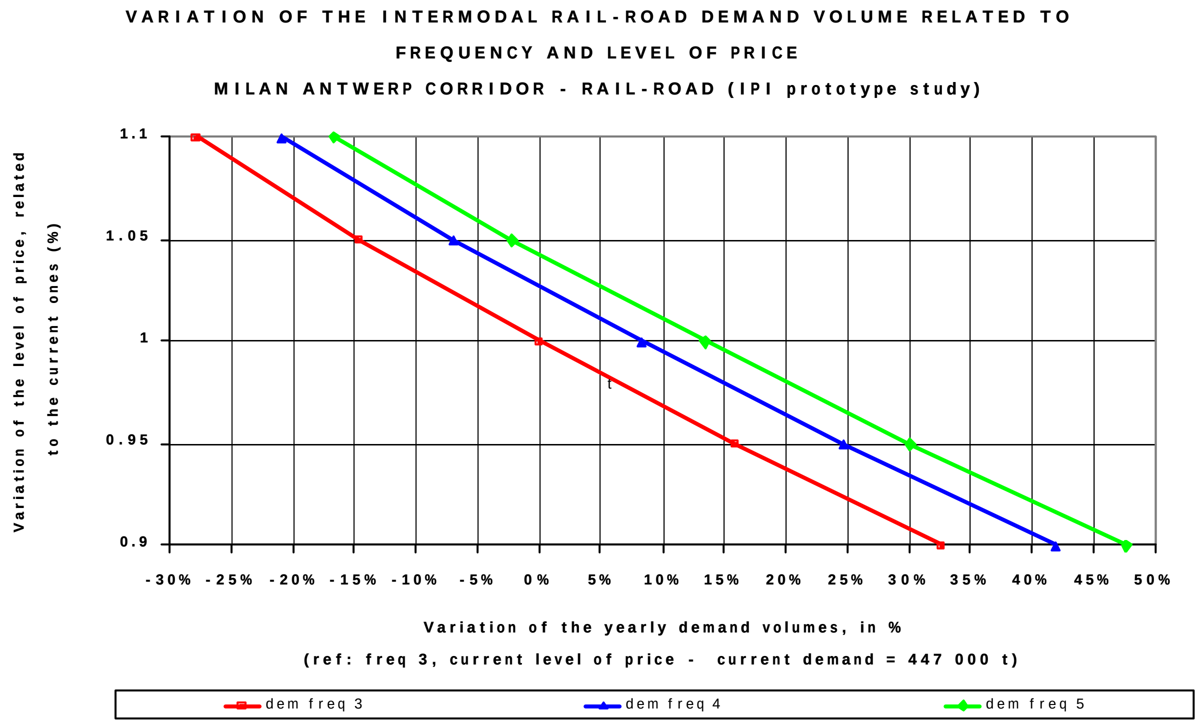

Figure 10

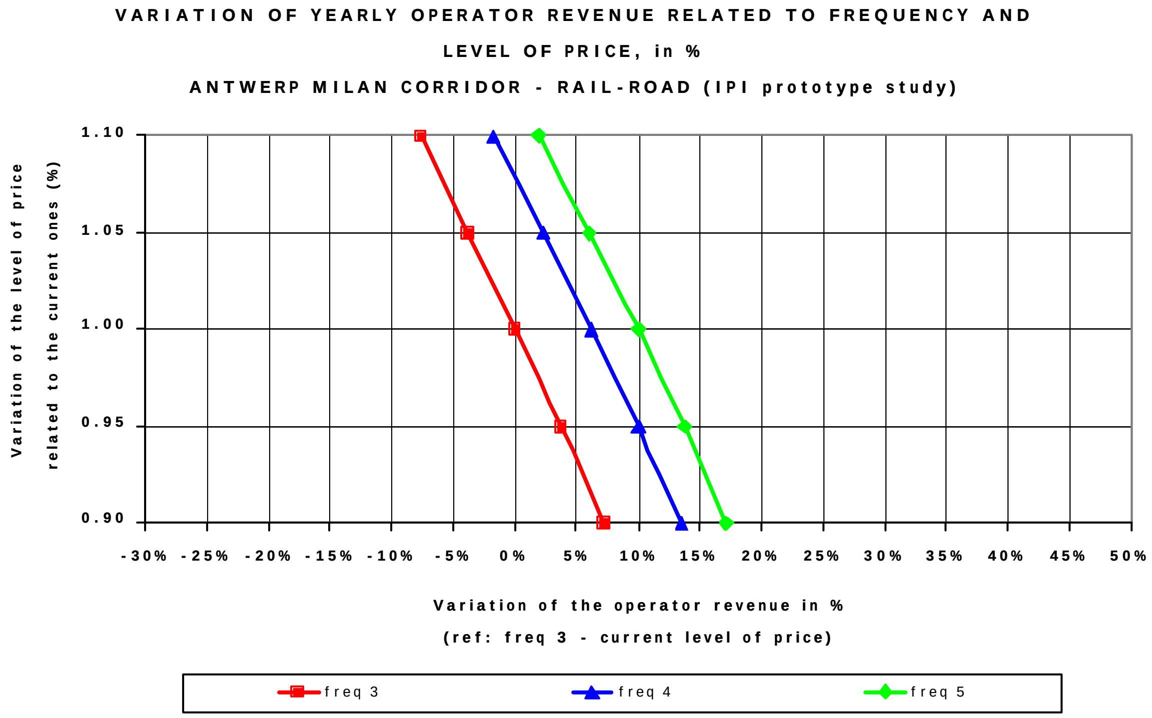

Figure 11

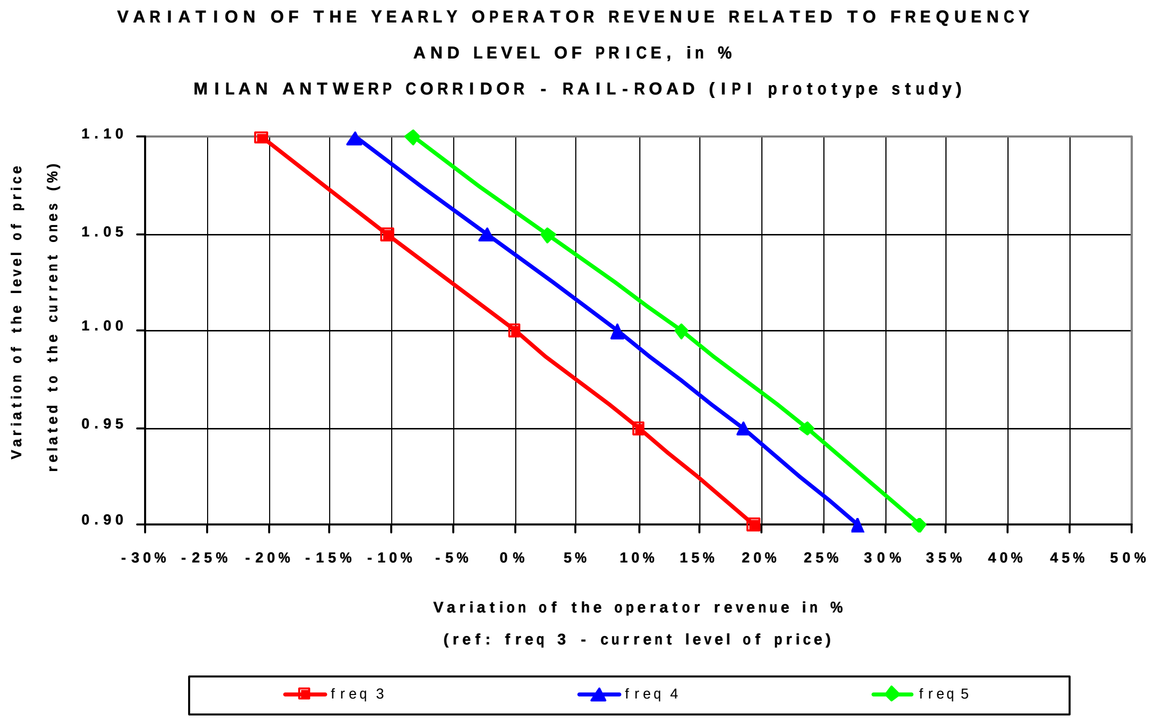

Figure 12

The figure 13 hereafter provide with the cost function of the rail transport related to frequency and demand. It shows that for the current demand on both directions (respectively 133 000 t and 447 000 t) the current frequency of five trains a week is fully justified.

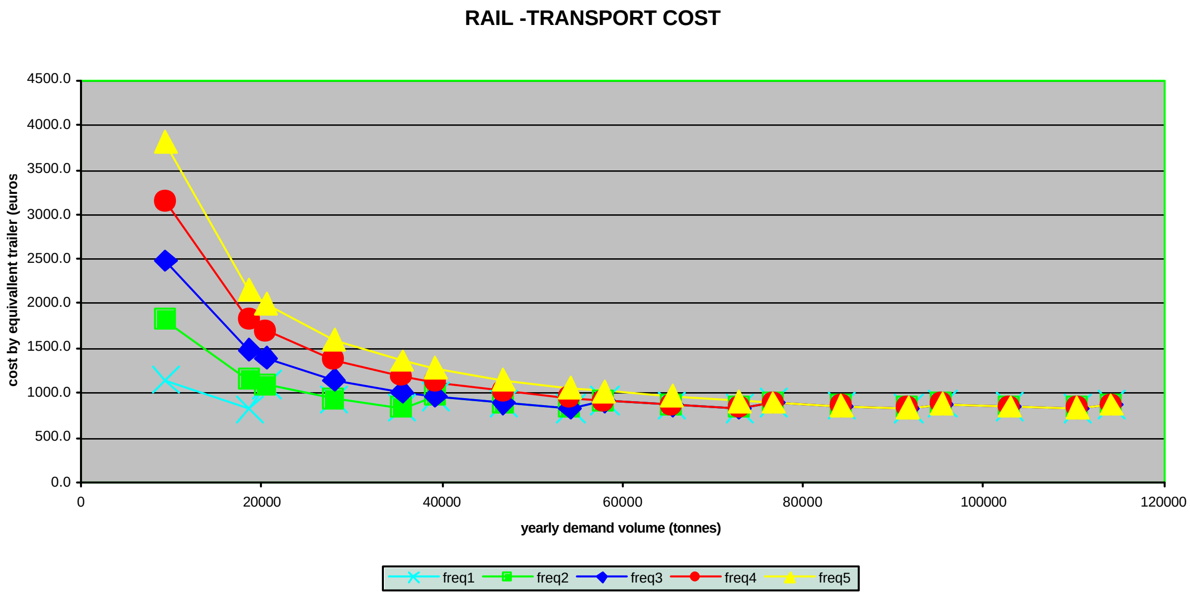

Figure 13

4.2 Rotterdam-Basel-Rotterdam (IWW-road)

The figures 14 and 15 and the figures 16 and 17 hereafter provide respectively the user benefits related to frequency and level of fare, in absolute value and in % of the fare, respectively for both Rotterdam-Basel and Basel-Rotterdam directions. The user benefit is increasing if the level of service (number of arrival a week) is increased or/and if the fare is decreased. If the fare is increasing the user benefits is decreasing. It appears that the potential user benefits are higher on the Basel Rotterdam direction.

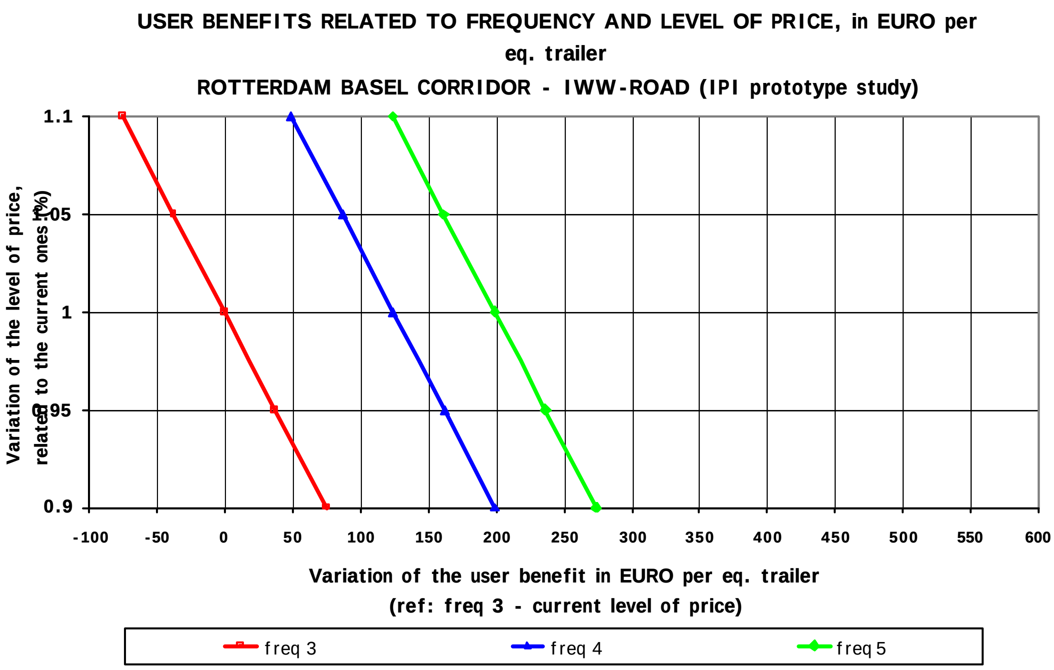

Figure 14

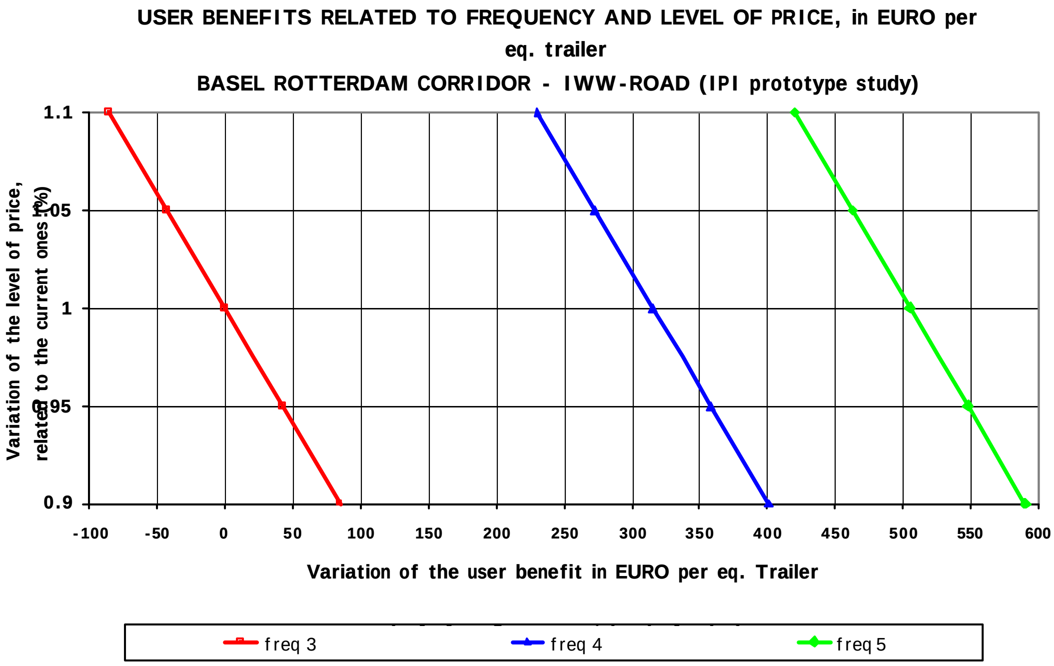

Figure 15

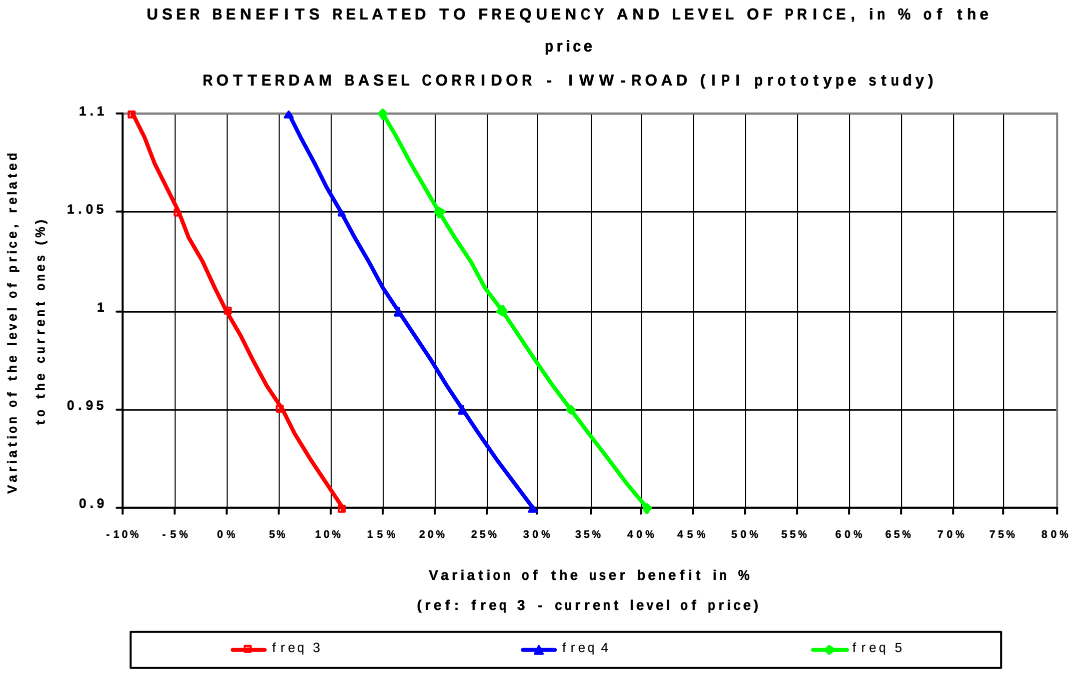

Figure 16

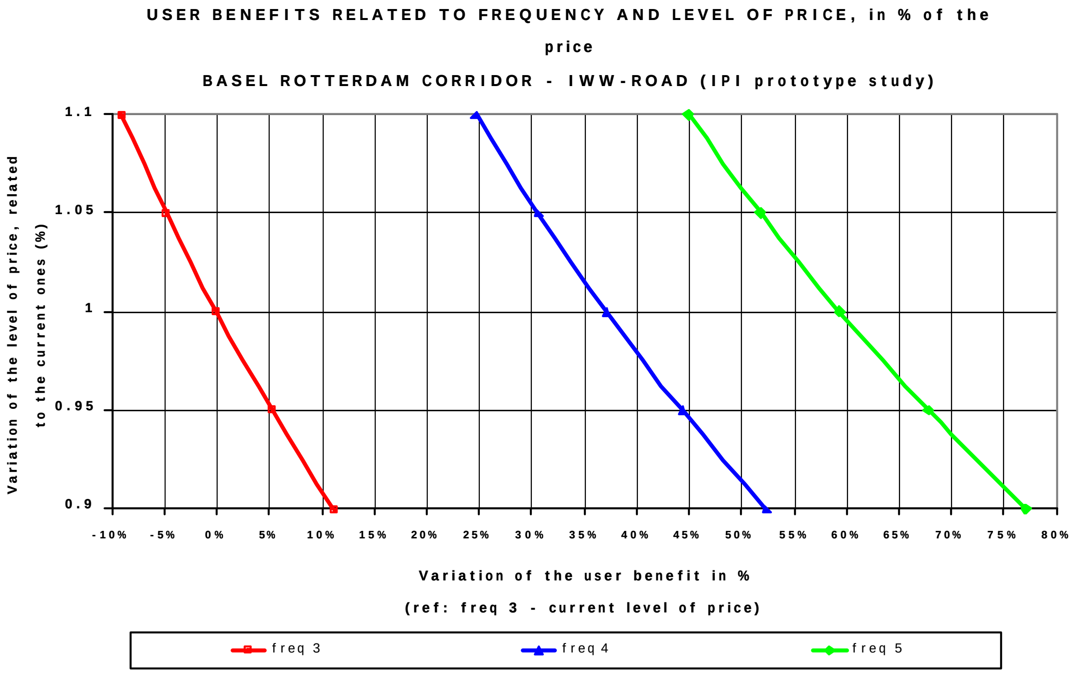

Figure 17

The figures 18 and 19 and the figures 20 and 21 hereafter provide respectively with the variation of the yearly demand and operator revenues related to frequency and level of fare respectively for both Rotterdam-Basel and Basel-Rotterdam directions.
It appears that the elasticity of the demand to the fare and to the frequency is more important from Rotterdam to Basel than from Basel to Rotterdam. Hence the potential revenue of increasing frequency and fare is higher from Rotterdam to Basel than from Basel to Rotterdam. The optimum could be found in term of fare and frequency considering both directions.

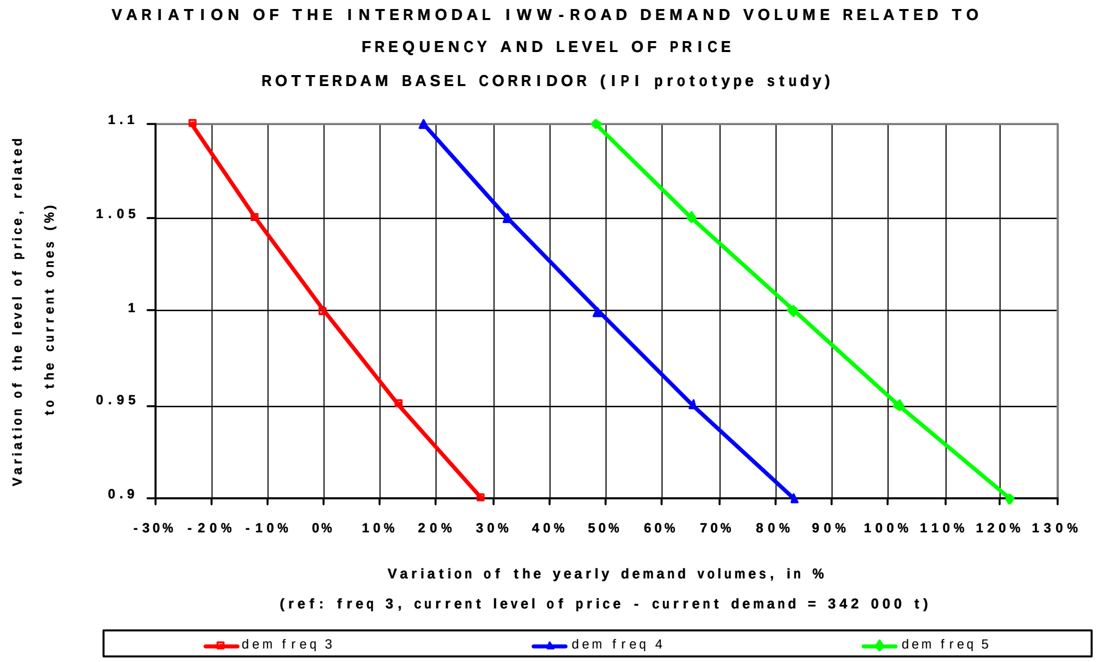

Figure 18

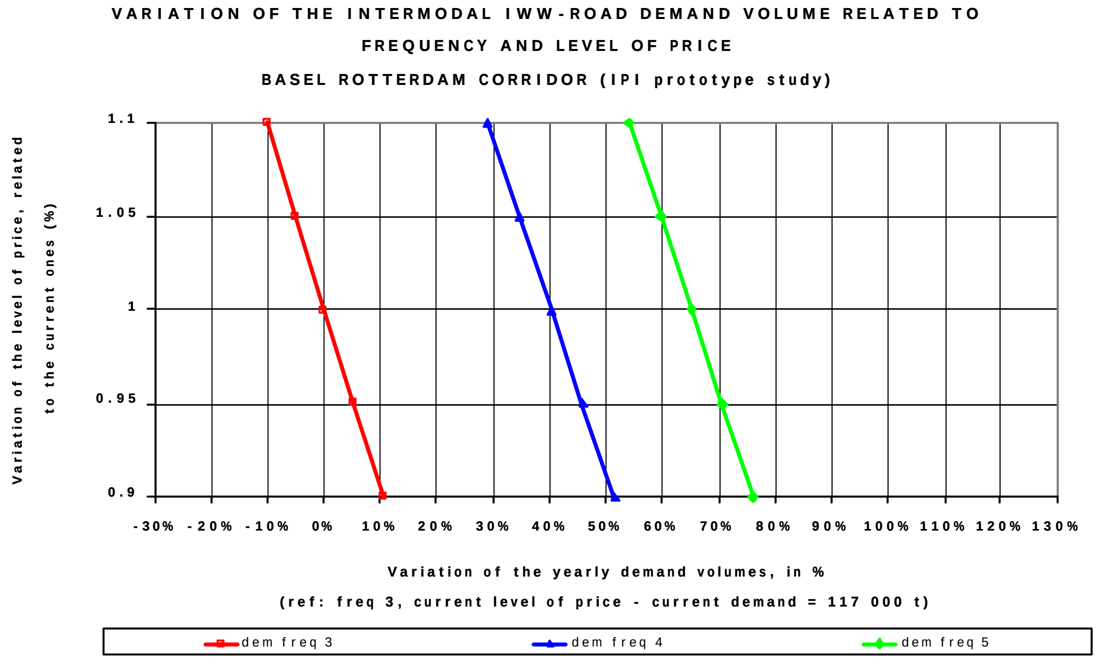

Figure 19

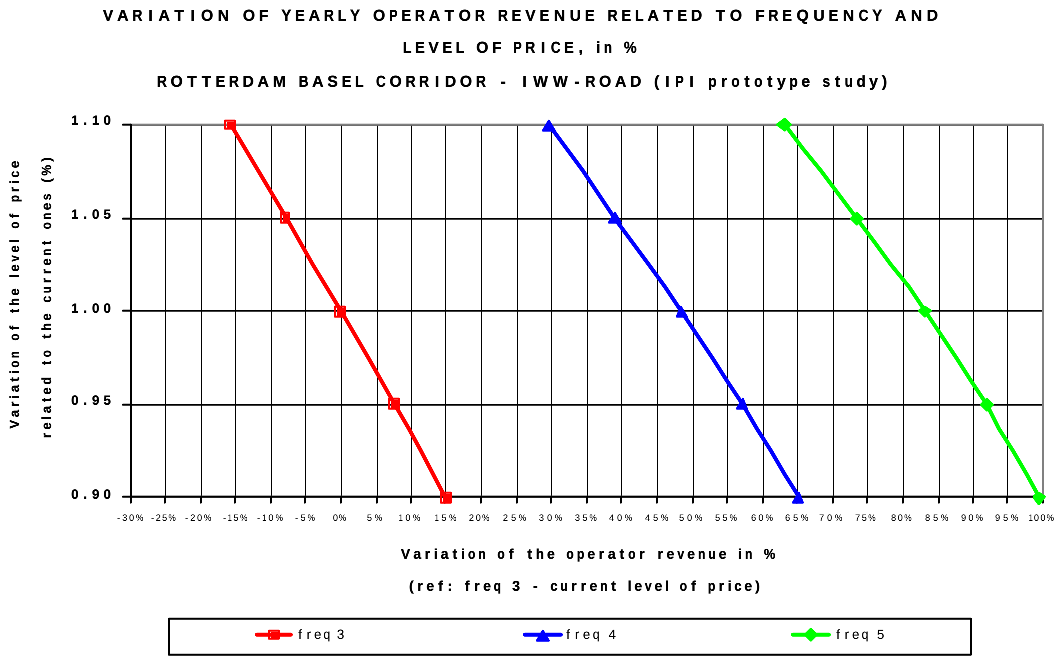

Figure 20

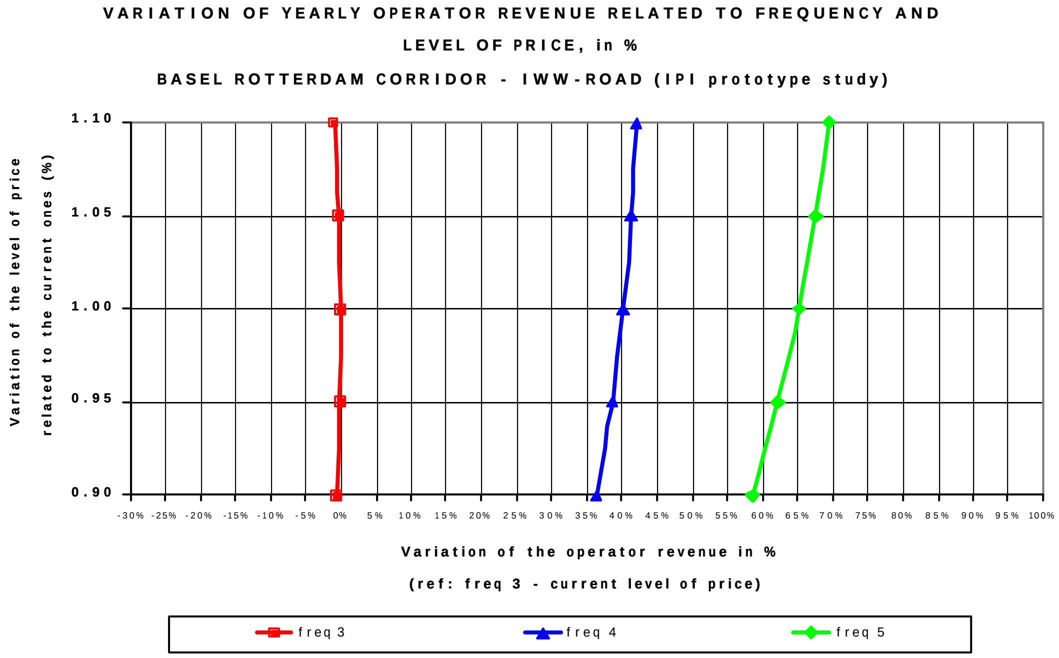

Figure 21

The figure 22 hereafter provide with the cost function of the inland waterways transport related to frequency and demand. The level of the current demand on both direction is respectively 342 000 t and 117 000 t.

The current frequency of barge of 2000t a week can be explained considering the impact of decreasing the frequency:

the lost of revenue for the operator: on Rotterdam Basel and Basel Rotterdam directions, for the current level of fare, respectively 83% and 65 % of revenue decrease if the frequency was decreased to 4 and respectively 83% and 65 % if the frequency was decreased to 3.

The increasing cost due to the decrease of demand: on Rotterdam Basel and Basel Rotterdam directions, for the current level of fare, respectively 35 % and 25 % of demand decrease if the frequency was decreased to 4 and respectively 82 % and 40 % if the frequency was decreased to 3; it appears that such a decrease in term of demand induce higher or equal cost for lower frequencies.

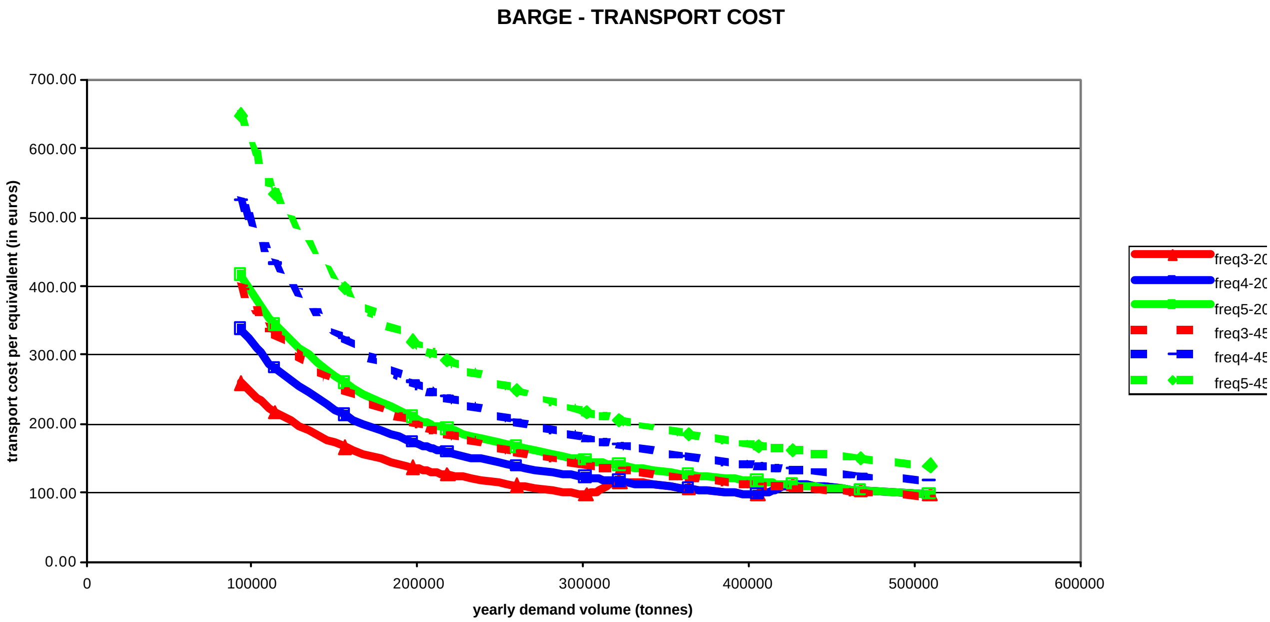

Figure 22

4.3 Antwerp-Bilbao-Antwerp (SSS-road)

The figures[2] 23 and 24 and the figures 25 and 26 hereafter provide the user benefits related to frequency and level of fare, in absolute value and in % of the fare for both Antwerp-Bilbao and Bilbao-Antwerp directions. The user benefit is increasing if the level of service (number of arrival a week) is increased or/and if the fare is decreased. If the fare is increasing the user benefits is decreasing.

[2] As far as the utility function is the same for both directions, the user benefits curves which is the results of the difference of utility related to different scenarios of supply is the same for both directions

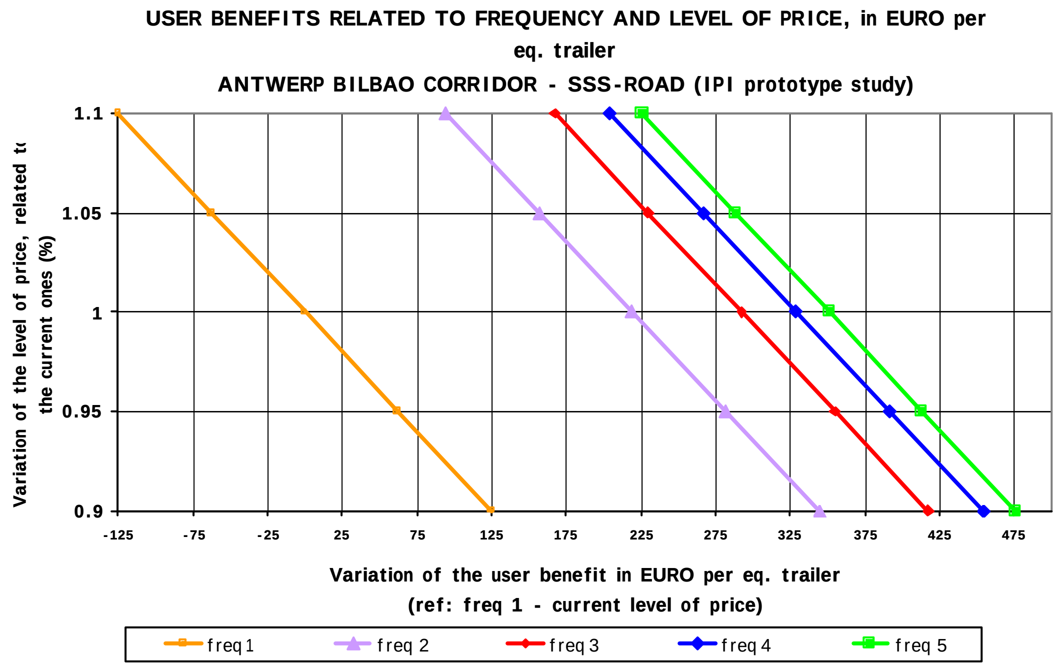

Figure 23

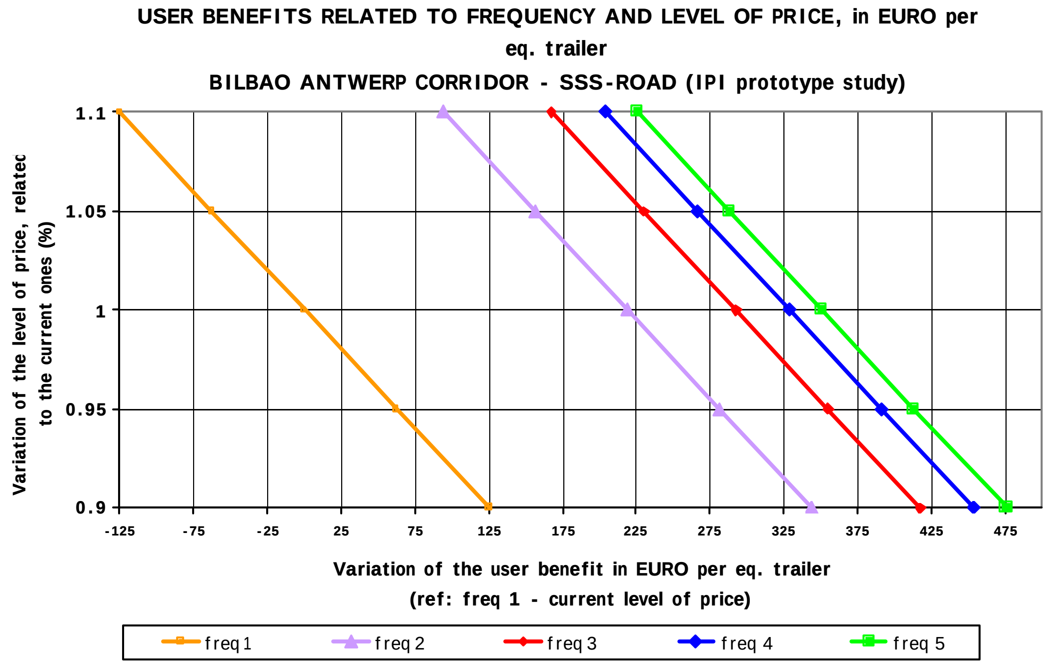

Figure 24

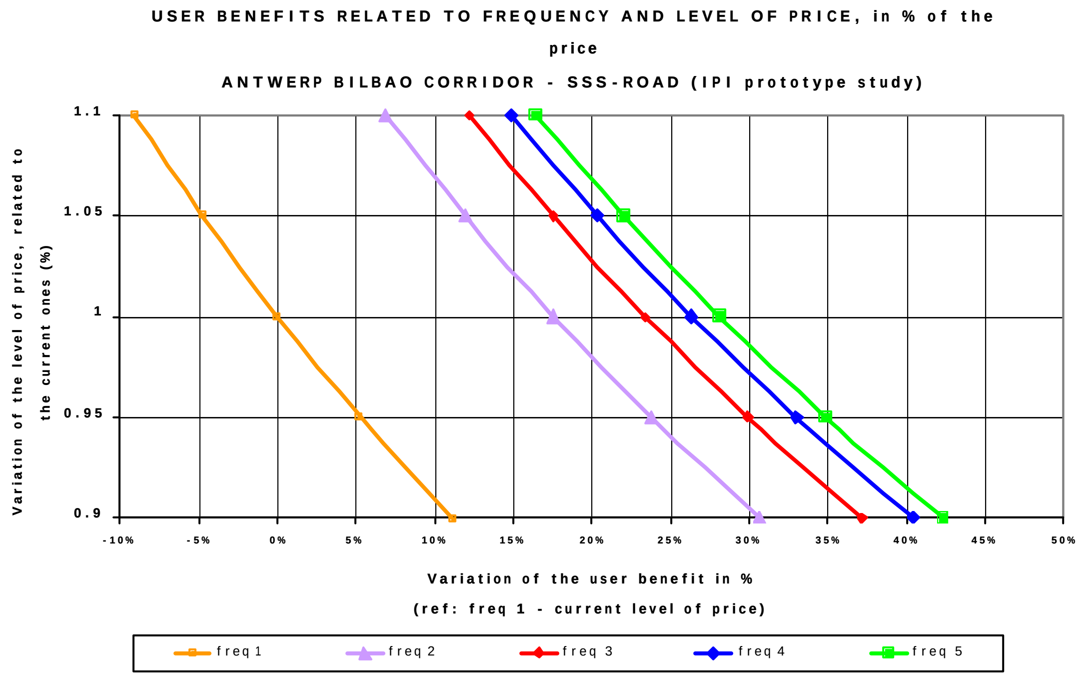

Figure 25

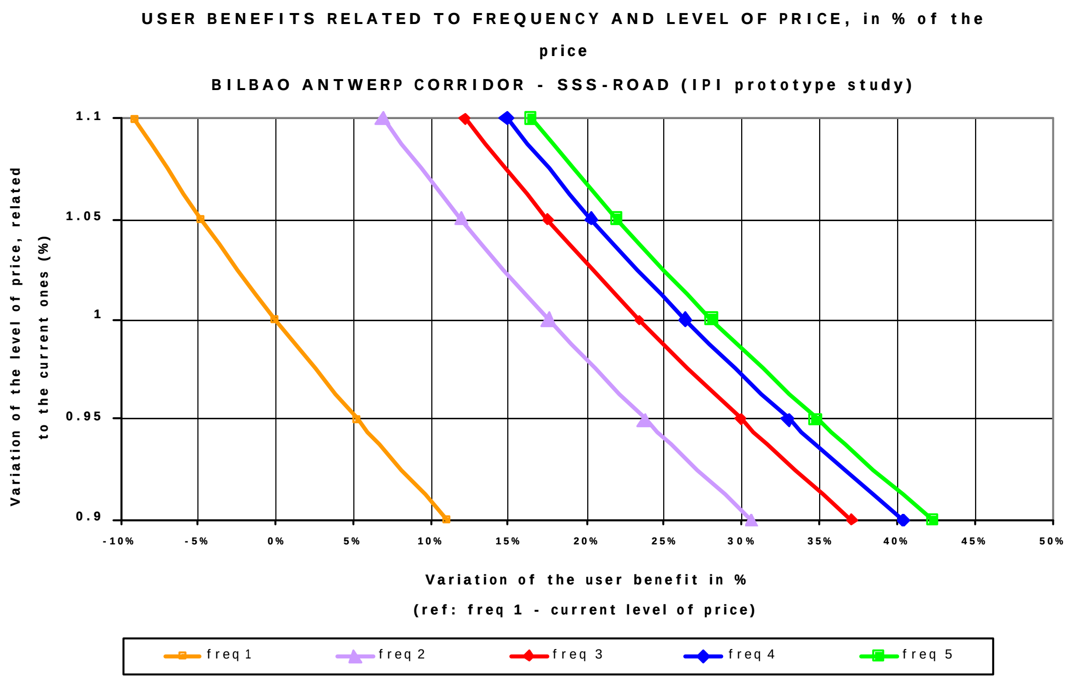

Figure 26

The figures 27 and 28 and the figures 29 and 30 hereafter provide respectively with the variation of the yearly demand and operator revenues related to frequency and level of fare respectively for both Antwerp-Bilbao and Bilbao-Antwerp directions.

It appears that the elasticity of the demand to the fare and to the frequency is more important from Bilbao to Antwerp than from Antwerp to Bilbao. Hence the potential revenue of increasing frequency and fare is higher from Bilbao to Antwerp than for Antwerp to Bilbao. The optimum could be found in term of fare and frequency considering both directions.

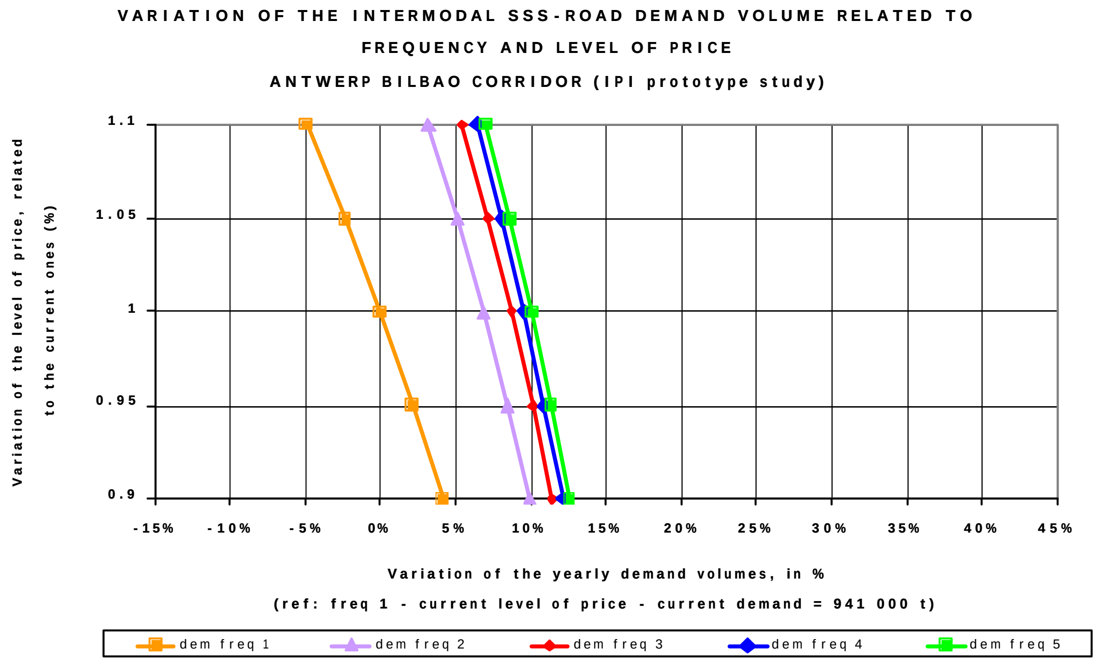

Figure 27

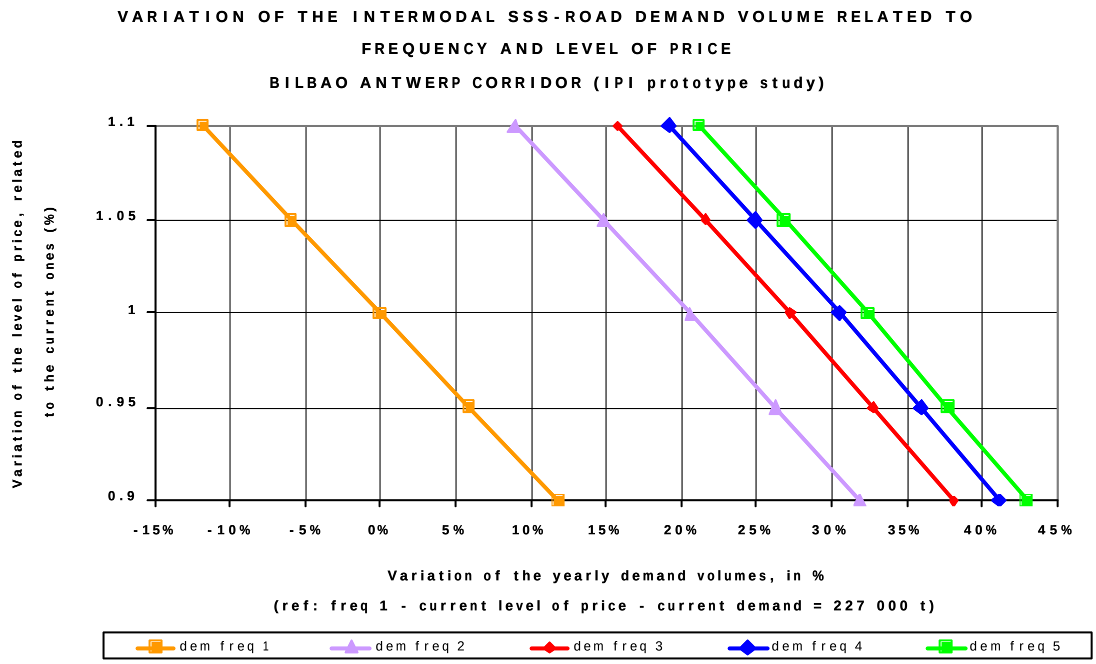

Figure 29

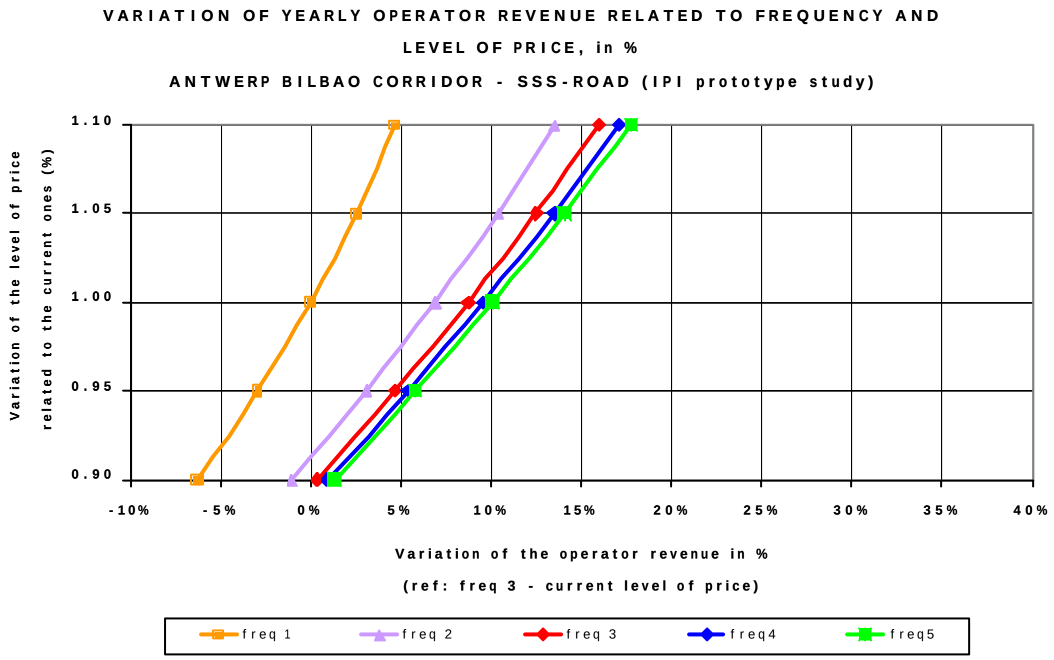

Figure 29

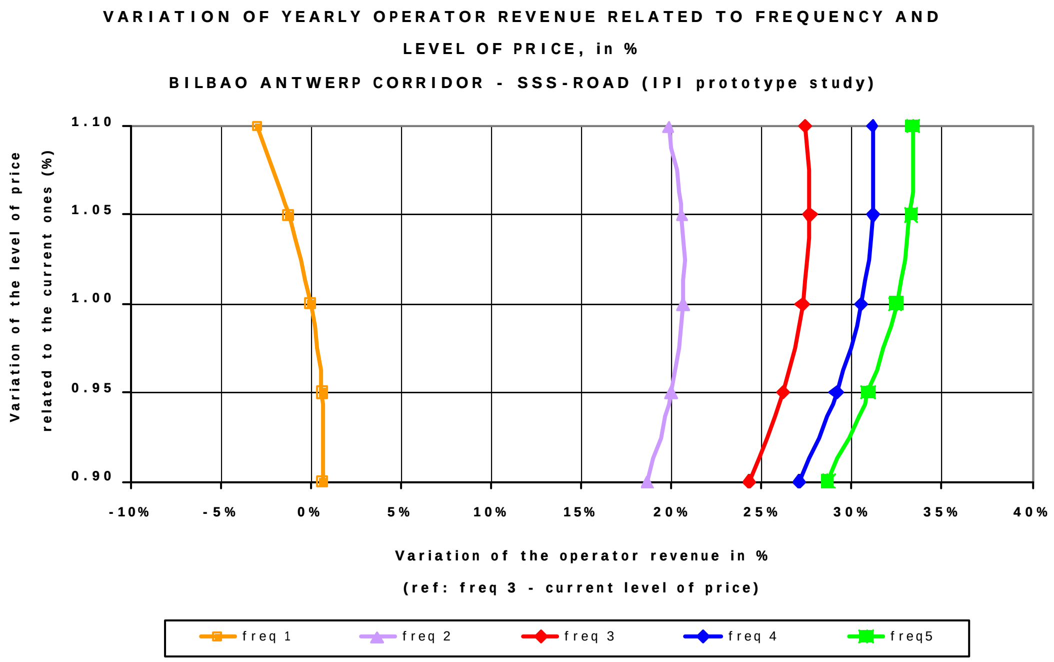

Figure 30

These figures shows the limited potential of increasing the current frequency of 1 to 2 (5% and 21% revenue increases respectively on the Antwerp-Bilbao and Bilbao-Antwerp directions) and much more limited potential of further frequency increase.

Unfortunately, no information has been found to compute the cost function of the short sea shipping transport related to frequency and demand.

5. GENERALISATION

5.1 Transferability of the methodology

The Morhing effect is based on the generalised cost. The generalised cost can be easily computed on the base of a utility function that can be obtained from a stated preferences survey.

Section 3.2. provides the mathematical concept of the user benefits calculation.

5.2 Transferability of the case study results

The values obtained in the case study are based on the IPI prototype model. They can be used as a first approximation. The following aspect must however be considered in term of generalisation of results.

- The geographical scope of the IIT study is limited.

- The prototype is a first run of potential investigation: in-depth analysis would allowed to get really more precise results; for example, the pilot analysis did not consider a segmentation by type of good transported by the industrial sector of the shipper. The experience shows that a finer typology of goods should be adopted.

- The prototype model is based on the following hypothesis: the dispersion of the shippers' behaviour is the same in the survey as in the reality. Generally, this hypothesis is not verified. A scaling factor reproducing the actual dispersion of the shipper's behaviour is assessed, calibrated, based on revealed preferences data: observation of actual choices in the reality.

The generalisation of the IPI prototype model in Europe could be used as a base to calculate the European user benefits value due to the Morhing effect for freight. An "a priori" segmentation could be achieved to represent all combined modes, all geographical transport corridors and all type of goods and industrial sectors. Hence, the results of the resulting "Stated Preferences" survey would enable to calculate more precise user benefits value and hence to get a better evaluation of the Morhing Effect.

A mid term approach could consist to consider that the utility function obtained in the IPI study are transferable, combined mode by combined mode, supposing that the utility function is independent of the geographical corridor and that the type of goods and industrial sector is not so much differentiated within a combined mode.

A sample enumeration could be built, for any other geographical corridor, based on the characteristics of the shippers exporting goods in the corridor, which are relevant in the model. This type of approach would provide a mid term evaluation taking into account a distribution of the shippers and their characteristics adapted tot the experimented corridor.

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