Tacis

# Feasibility Study of New Terminal Facilities in the Georgian Ports

# Phase 3 Report

## Cost Benefit Analysis

- Final Version -

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# Cost Benefit Analysis

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# 1 Introduction

In a market economy, economic decisions are mainly taken by private households and companies. The coordination of the resulting individual plans occurs through the market mechanism. Under the conditions of a workable competition this economic system guarantees optimal use of the production factors, i.e. a maximum amount of goods and services are provided to the consumers. In that case, the appropriate investment analysis is the financial investment appraisal.

However, there are also services which the market can only offer in insufficient quantities (market imperfections) or not at all (market failure). This group of "public goods" includes traffic infrastructure investments, which, because of their technical characteristics, do not lead to an optimal package of goods being made available through the market mechanism. In that case, the appropriate tool for the analysis of an investment is the cost-benefit-analysis. that is an economic appraisal taking into account external effects, shadow prices etc.

The overall economic assessment of the planned projects demands the comparison of all relevant project related advantages and disadvantages. The qualification, quantification and evaluation of effects is performed with the comparison of the planned cases and corresponding comparative cases. In view of the diversity of project effects, concerning the direction (positive and negative) as well as the extent, it is desirable to interpret them in a coherent manner (assessed in **US-$**) and not in different scales. Otherwise advantages and disadvantages of infrastructure projects may not be weighted.

As the purpose of the following analysis is to evaluate the justification of investments in the ports of Poti and Batumi, the methodology of the cost-benefit-analysis has to be adapted. Concerning the appraisal of investment in the transport sector, planning systems on the basis of the cost-benefit-analysis have been implemented in different countries. The following cost-benefit-analysis is methodically based on the general approach of the German Federal Transport Planning.[1] Nevertheless, the specific case of a port investment requires some modifications of the standard approach.

The above mentioned assessment of the planned projects in the Georgian ports is based on the realistic case of the previous cash flow analysis[2]. The analysis is carried out for the whole investment project including infrastructure and superstructure investment. The application of the cost-benefit-analysis for the superstructure seems to be appropriate because of the situation of Georgia as a transition economy.

The port, as a link between the land- and waterside traffic carriers and its logistical performance spectrum, has a significant regional and national effect. Two workplaces in the port result in the creation of one additional workplace in the hinterland. The development of the port function and the associated companies strengthens the economic power of the entire region. Especially in Poti, the port is of great significance for a major part of the population as a workplace and source of income. Therefore, the regional economic consideration is a relevant part of methodology.

In order to assess the costs and benefits for the special case of the port investments in Poti and Batumi, different points of view can be taken. The first can be named as the regional point of view on a small scale area i.e. the ports and the cities of Poti and Batumi. The second is the national point of view expanded by the ef-

[1] Macro-Economic Evaluation of Transport Infrastructure Investments, Evaluation Guidelines for the Federal Transport Investment Plan 1992; published by the Federal Minister of Transport, publication series 72, Bonn, 1993
[2] „Feasibility Study of New Terminal Facilities in the Georgian Ports" Phase 3 Report Vol. VI - Financial and Economic Analysis (May 1998) and Annexes to Volume VI

fects to the national economy e.g. of the railways and road network. The third and most complex is the European point of view depicting the European networks of all transport modes. Undoubtedly, the last is the most interesting for the European Union as contractor of this study. This aspect is considered in the calculation of the benefits resulting of changes in the transport volume in seven routes connecting the TEN with the TRACECA-Routes.

# 2 Methodology of Assessment

## 2.1 Comparative Cases

For the evaluation of benefits of the port development in Poti and Batumi a definition of comparative cases is necessary, i.e. which consequences result on the regional, national and international economic point of view when the expansions and renewal projects are not carried out. The comparative cases are therefore described hypothetically as the status quo. This means in concrete, that the existing equipment of the ports is maintained and replaced if necessary, but not extended. The turnover of both ports is „frozen" therefore at 4.2 million tons per year until the year 2002. Due to the replacement investment, one can assume a slight increase up to 4.5 million tons per year in 2007 which will remain constant in the following years up to 2012. The maintenance of this current handling capacity needs only money to perform service and compensation investments of the port assets.

If the ports do not develop as described in the Port Master Plan, the traffic flows, which are mainly transit traffic flows, use other transport routes with less hindrances. Therefore other modes and transport routes will have more transport volumes. The cost/benefit analysis considers the following transport routes as defined in the simulation within this report:

Route No. I
The Corridor No. I is most popular for freight with origin and destination Kazakhstan from/to Russia/Belarus and basis on the TEN corridor II and partly on TEN IX. The sea link via St. Petersburg is a natural route to the North Sea ports. The shipping route via the Caspian Sea Ib is the alternative corridor to the land link via Uralsk Ia. This corridor, a rail link via the Russian Federation, under strong influence of the MPS, is quite reliable. For countries such as Kazakhstan this corridor is still the preferred choice. Road transport is also possible on this land link.

Route No. II
The second Corridor No. II is mainly the TEN corridor III for a rail and road with the origin and destination TRACECA and Central Europe. The transport mode by rail is characterised by transhipment of the goods via Brest/Przmeyal.

Route No. III
This corridor is the link between TRACECA corridors and the TEN corridors IV for rail/road and VII on the Danube through Constanta in Romania.

Route No. IV
Corridor IV is the Southeast European route on shore. It connects the south of France, northern Italy and the Balkan States Yugoslavia, Albania and Bulgaria the TEN route VIII. The Black Sea ports of Varna and Burgas in Bulgaria are the link to the Georgian ports and the TRACECA route.

Route No. V
The sea link through the Black Sea and the Mediterranean Sea is the Corridor V. The main commodity here is the container.

Route No. VI
At last the corridor VI is the shorebound link on road through Turkey. Therefore the cargo doesn't flow through the Georgian ports.

Route No. VII
This route is the sea link through the Black Sea and the Mediterranean Sea. It connects i.e. the Port of Rotterdam and the „Hinterland" traffic.
(Route map see: „Recommendation of the most viable route connections between TRACECA and the TEN" in this report)

## 2.2 Discounting

The discount of benefit and cost values with respect to the base year (1998) is required. The discount rate is set on 6 % per year. This rate can be seen as very high, e.g. the German infrastructure plan calculates with only 3 %. But as that calculation is based on the expected long term economic growth rate in real terms, the discount rate for Georgia diverges from the German calculations. Another approach is to set the opportunity cost of capital as discount rate. The present values of the following analysis are calculated based on a discount rate of 6 %. In chapter 1.3 a sensitivity analysis shows the consequences of a variation in the discount rate. Following the growth rate approach, lower values (3%, 4%, 5%) are assumed. In order to test the opportunity cost approach, values of 10 % and 15 % are set.
The result of this calculation is the cash value of accumulated costs and benefits in the observation period of 15 years. A decision-orientated evaluation of the port development is possible therefrom.

## 2.3 Methods of Evaluation

Costs and benefits may be divided into three categories:

- direct values
- indirect values and
- non-assessable values

The direct values result directly from the projects e.g. expenditure or receipts for estates, expenditures for internal and external development of port areas and so on. The indirect values are the result of the impacts on the port e.g. changes in transport structures. Non assessable values are following impacts which cannot be expressed in monetary values. A typical example is the impact on the image of the Georgian transport market.

Effects of the extension of the Georgian ports on transport structures are calculated with two kinds of cost components of traffic. Internal costs reflect the costs of freight that are covered by the payments of transporting companies:

- costs of infrastructure,
- costs of transport time

External costs reflect the costs of freight that are not covered by the payments of transporting companies:

- air pollution (damage for humans, vegetation and materials),
- noise (sound absorber),
- pollution of soil and waters (cleaning of road and railway waste waters),

- partition effects (crossing limitations of roads and railway),
- consumption of areas (ecological compensation) and
- accidents (not covered by insurance).

In recent studies, well founded approaches for values expressed in money value per ton kilometre for the internal and external costs are developed. Unfortunately the derived figures are relevant for the most parts of Europe. For Eastern Europe countries referring data do not exist. Therefore an estimate may be the only way to proceed. The following data are the result of an estimate based on the figures on European standard and actual transport cost in Eastern European countries.

| **cost factors of traffic** | | in US-$ per tkm |
|---|---|---|
| 1998 | internal costs | external costs |
| road | 0.150 | 0.0314 |
| rail | 0.037 | 0.0079 |
| inl. waterways | 0.030 | 0.0016 |
| seaship | 0.020 | 0.0005 |

The data for the modes road and rail are taken out of a study for Bremen (Germany)[3] and a study concerning the external costs of traffic[4]. For inland waterways the mentioned study presents data for external costs but for seaship neither data for the internal nor the external costs could be found. Therefore a plausible estimate was made resulting in 0.020 US-$ for the internal costs of seaship and 0.0005 US-$ for the external costs.

According to the requirements of a cost benefit analysis, the prices of all relevant items are kept constant over the analysed period of time.

# 3 Cost and Benefit Effects

In the following chapters first the costs of the rehabilitation and the extension of the Ports of Poti and Batumi are calculated. The additional cost of operation and maintenance are also included. In the second step the benefits with respect to three fields are calculated. These fields are the benefits of the reduction in transport costs on an international point of view, environmental benefits on the basis of external costs of traffic and regional benefits.

## 3.1 Assessment of Costs

Three projects of the Georgian Ports are calculated in the following pages:

- Container Terminal Poti
- General Cargo and Bulk Areas Poti
- Batumi Multi-Purpose Terminal

In detail the projects are characterised by the following data. The data are taken from the Vol. VI of this report (Phase 3 Report Vol. VI - Financial and Economic Analysis (May 1998) and Annexes to Volume VI). More detailed descriptions and information are included in this volume.

[3] Cost/benefit analysis of freight traffic centres pilot analysis by the example of the freight traffic centre Bremen - Federal Ministry of Transport 1993

[4] Planco Consulting „The External Costs of Traffic: Rail, Road and Inland Waterways" Essen/Germany 1991

Container Terminal Poti

The project to be calculated is the extension of the container operation in the existing port and the new construction in the north. The comparative case is therefore the maintaining of the existing container operation for the future time with the following characteristic numbers (based on the figures of 1998 with the assumption that the maximum capacity will be reached in 1999):

- 82 employees
- 0.5 mil tons of throughput per year (from 1999 onwards)
- 9.4 mil US-$ of proceeds per year (from 1999 onwards)
- 0.8 mil US-$ of operational costs per year (from 1999 onwards)
- 4.1 mil US-$ of investment between 1998 and 2012 for replacement of the existing facilities and equipment

The investments of the extension of the container terminal in Poti (included breakwater) between 1998 and 2012 are **158** mil US-$ for the case with breakwater and 115 mil US-$ without breakwater. The operational costs (calculated as the sum of personnel costs, costs for office, material etc., energy costs, electric power supply utilities, communication, water/sewage and administration assessment) rise in the case of the extension of Poti container terminal according to the plans from 0.8 mil US-$ per year in 1998 up to 4.3 mil US-$ in the year 2012.

General Cargo and Bulk Areas Poti

The project to be calculated is the extension and renewal of the general cargo and bulk handling facilities. The comparative case is therefore based on the assumption that the existing operations are maintained for the future with the following characteristic numbers (based on the figures of 1998 with the assumption that the maximum capacity is already reached):

- 365 employees
- 1.3 mil tons of throughput per year
- 6.8 mil US-$ of proceeds per year
- 2.4 mil US-$ of operational costs per year
- 3.4 mil US-$ of investment in the years 1998 to 2012 for replacements of existing facilities and equipment

The investments of the rehabilitation and extension of the general cargo and bulk areas of Poti Port according to the plans account for 29 US-$ between 1998 and 2012. The operational costs rise from 2.4 US-$ in 1998 to 11.6 US-$ in 2012.

Batumi Multi-Purpose Terminal

The project to be calculated is the establishment of the Multi-Purpose Terminal in Batumi for the handling of general cargo, bulk, RO/RO and container. The comparative case is not to use berths 4 and 5 further. The investments between 1999 and the year 2012 are 30.5 mil US-$.

Values calculated for the cost benefit analysis

For the cost benefit analysis the values of operational costs and investment volumes are calculated as the difference between the values in the planned case (extension of the ports) and the comparative case (only keeping up the current capacity of ports). In addition, the residual values (investments minus depreciation until the year 2012) of the investments in the year 2012 are calculated and taken into calculation as negative costs.

## 3.2 Assessment of Benefits

The money earned for the services offered represent the direct benefits of the investments in the Georgian ports. These are the proceeds out of the port operations. Indirect benefits are expected in three fields: reductions in the transport costs (including savings of reduced waiting rimes) for the companies involved in the freight traffic between Central Asia, TRACECA and the European countries, environmental effects of changes in international traffic patterns and regional benefits.

### 3.2.1 Direct Benefits

Direct benefits are the proceeds earned of the port activities. Within this chapter a detailed analysis and description of the proceeds is not necessary, because this is done in Vol. VI of this report (Phase 3 Report Vol. VI - Financial and Economic Analysis (May 1998) and Annexes to Volume VI). The proceeds are calculated for the three projects:

- Container Terminal Poti
- General Cargo and Bulk Areas Poti
- Batumi Multi-Purpose Terminal

The discounted value of the additional proceeds (difference between planned case and comparative case) between 1998 until 2012 sum up to 253.7 mil US-$.

The direct benefits play an important role in any financial analysis. However, they must not be counted as benefits in an economic analysis because an economic analysis is based on the concept of the consumption of resources. Typically, the port revenues are merely a transfer from the country´s shippers to the port authority and do not represent a net benefit or cost to the country. The safed resources are covered by the different transport cost savings. Therefore, the proceeds are not accounted in the cost/benefit-analysis.

### 3.2.2 Indirect Benefits

#### Transport **Cost savings**

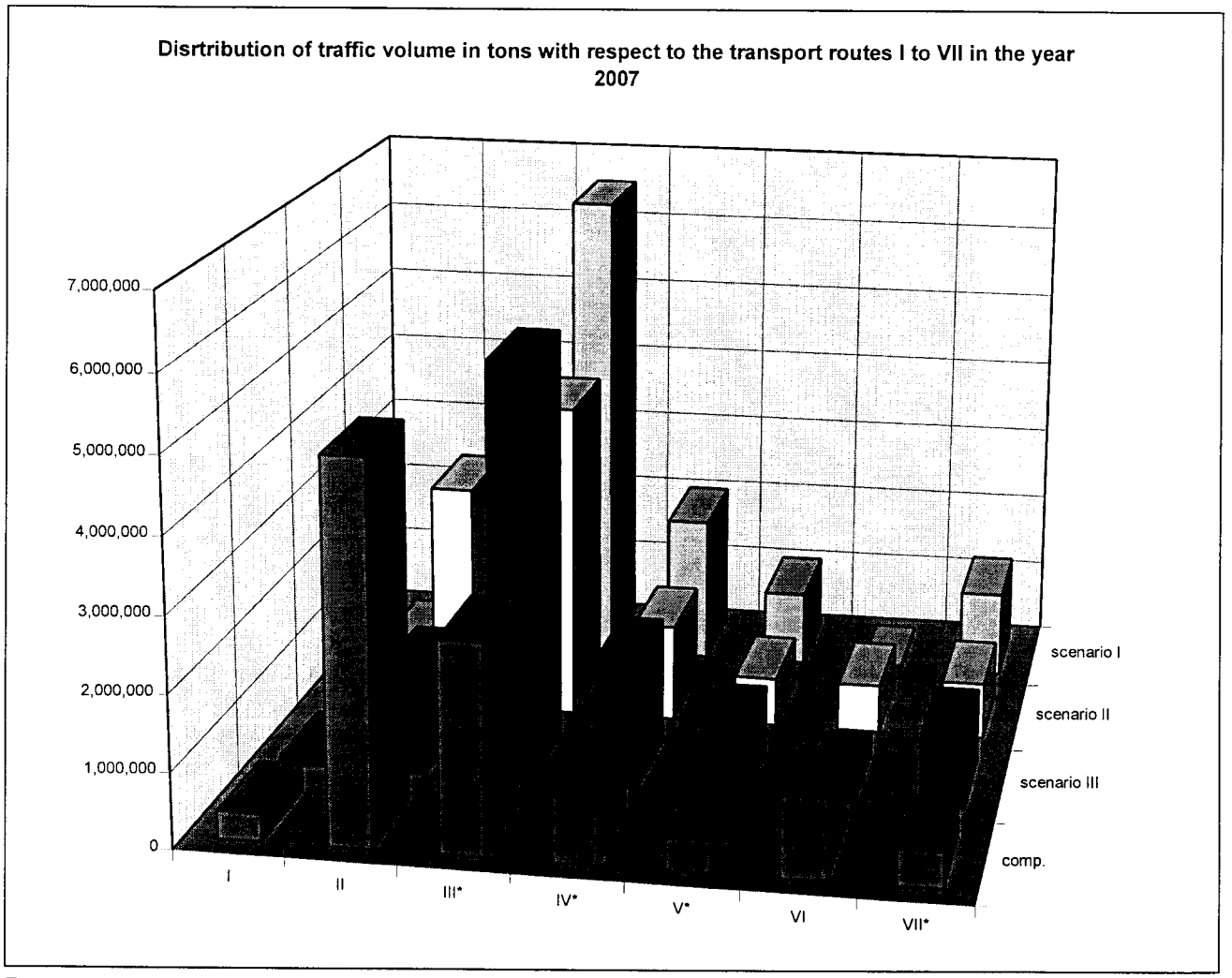
The effect of the rehabilitation and extension of the Georgian ports on the transport costs with respect to international cargo flows are estimated according to the following steps of analysis.

1. Matter of consideration are the above mentioned transport routes I to VII. The total transport volume on these routes and the distribution is estimated. In addition the comparative case and the scenarios (scenario I to III) assumed in the traffic forecast have to be taken into consideration. Further more an estimate of the use of the different transport modes is necessary.
2. The average transport distance between origin and destination of the goods has to be estimated and to be devided among the different modes of transportation.
3. With the transport volume and the average transport distance the transport performance in ton kilometres (tkm) could be calculated.
4. The transport cost of different transport structures is calculated by multiplying the transport performance (tkm) with the cost data (internal and external costs as shown above).
5. With the calculation of the difference between the cost of transport in the comparative case (without investments in the Georgian ports) and the derived scenarios (with investment in the ports and different turnover data) the benefits of the ports in their strengthened position can be compared.

The above presented method of calculation is necessary, because no reliable data concerning the relevant transport routes exist. Following the application of this method is documented with the data compiled within the analysis.

The estimated overall transport volume of the routes I to VII as a result of the simulation, is 7 mil tons in the comparative case and the year 1998. In 2002 the volume is 12.6 mil tons, in 2007 10.8 mill tons and in the year 2012 18.5 mil tons. These data concern international long haulage transport only. Regional and national transport are not considered because the ports development has no influence on these kind of freight traffic.
The distribution of the traffic volume with respect to the transport routes I to VII depend on the cases with/without port development (comparative case/scenarios) and the scenarios I to III of the traffic forecast for the ports. The development and respective the turnover of the Georgian Ports is considered as the independent variable determining therefore the transport volume on the routes bypassing the ports. The distribution of the volumes for the two categories (routes through the ports and routes bypassing the ports) is according to the original, out of the simulation resulting shares.

In the following diagram the distribution of the traffic volume i.e. for scenario I to III and the comparative case in the year 2007 is shown.




Routes marked with * include transhipment in the Georgian ports

The case without development of the Georgian ports (comparative case) shows, that the other routes (I, II, VI) have a higher transport volume than in the case of development of the ports in the scenario III („probable case"). This is the result of the procedure to keep the total volume of all routes (I to VII) within the year of

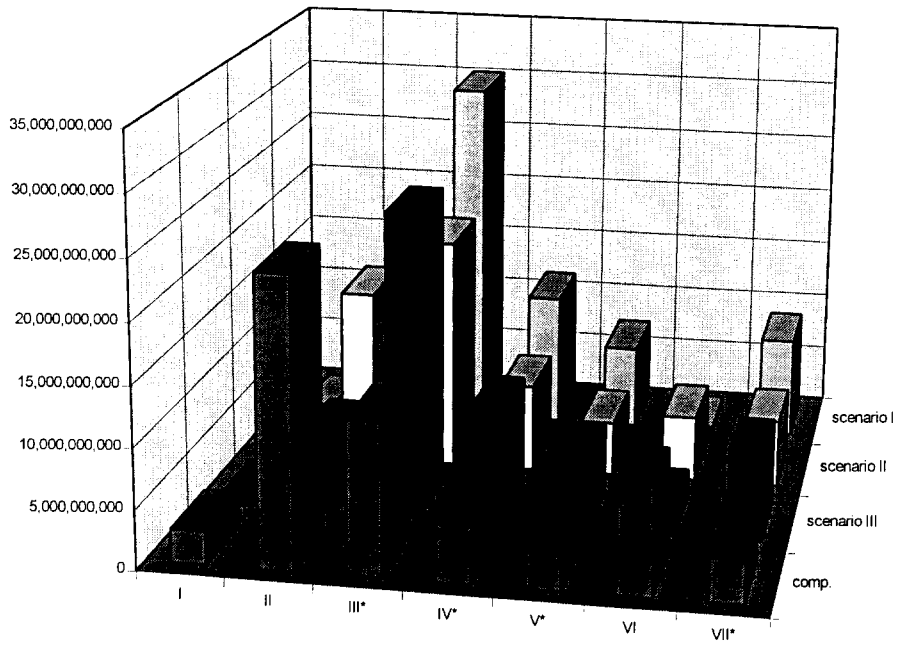
consideration constant and vary the ports turnover according to the expansion in volume in the scenarios I to III in the traffic forecast.

In the next step the average transport distances on the routes and the composition of transport modes have to be estimated respectively assumed. The transport distances are taken out of the simulation and correspond to the mentioned locations. In the following table the used data are presented:

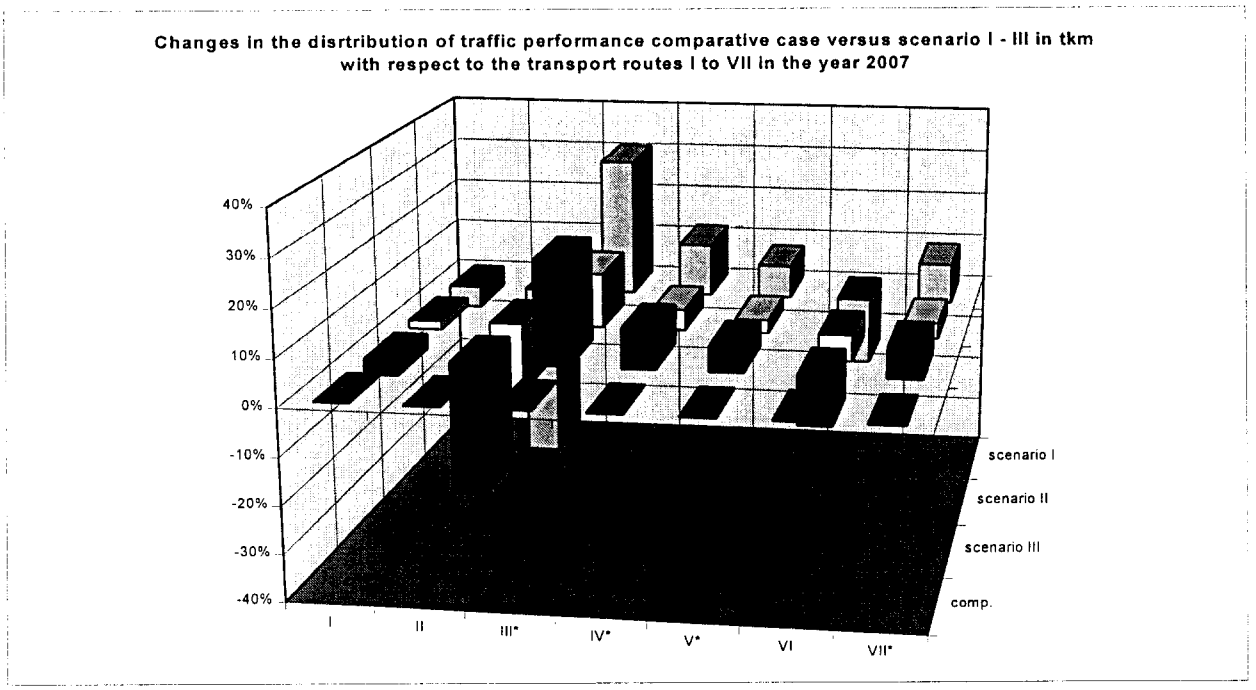
| **Mode of traffic and distances of routes** | | average composition of modes | | | |
|---|---|---|---|---|---|
| Routes | average distance in km | road | rail | inland waterways | seaship |
| I | 7,800 | 0 | 3,795 | 0 | 4,005 |
| II | 4,800 | 20 | 4,780 | 0 | 0 |
| III* | 4,600 | 19 | 3,115 | 0 | 1,466 |
| IV* | 5,700 | 2,255 | 0 | 0 | 3,445 |
| V* | 7,100 | 1,011 | 1,880 | 0 | 4,209 |
| VI | 8,600 | 1,912 | 1,875 | 0 | 4,813 |
| VII* | 7,500 | 1,058 | 0 | 228 | 6,213 |

The multiplication of the transport volumes with the average transport distances gives the transport performance. The results are shown in the following diagram. The transport volumes for the year 2007 in the comparative case and the scenarios I - III are presented as an example. The term „ports" is relevant for the routes **III**, IV, V, and VII (transhipment in Georgian ports), "others" is relevant for the routes I, II and VI.

**Disrtribution of transport performance in tkm with respect to the transport routes I to VII in the year 2007**




The changes in the traffic performance are more visible in the calculation of the changes in the scenarios I to III in comparison to the comparative case (set to 0). In the following diagram the changes are obvious. Routes I, II, and VI show a reduced performance whereas the routes III, IV, V and VII have an increased performance. The strongest shift is between route II and III, the most important routes for the TRACECA connections.

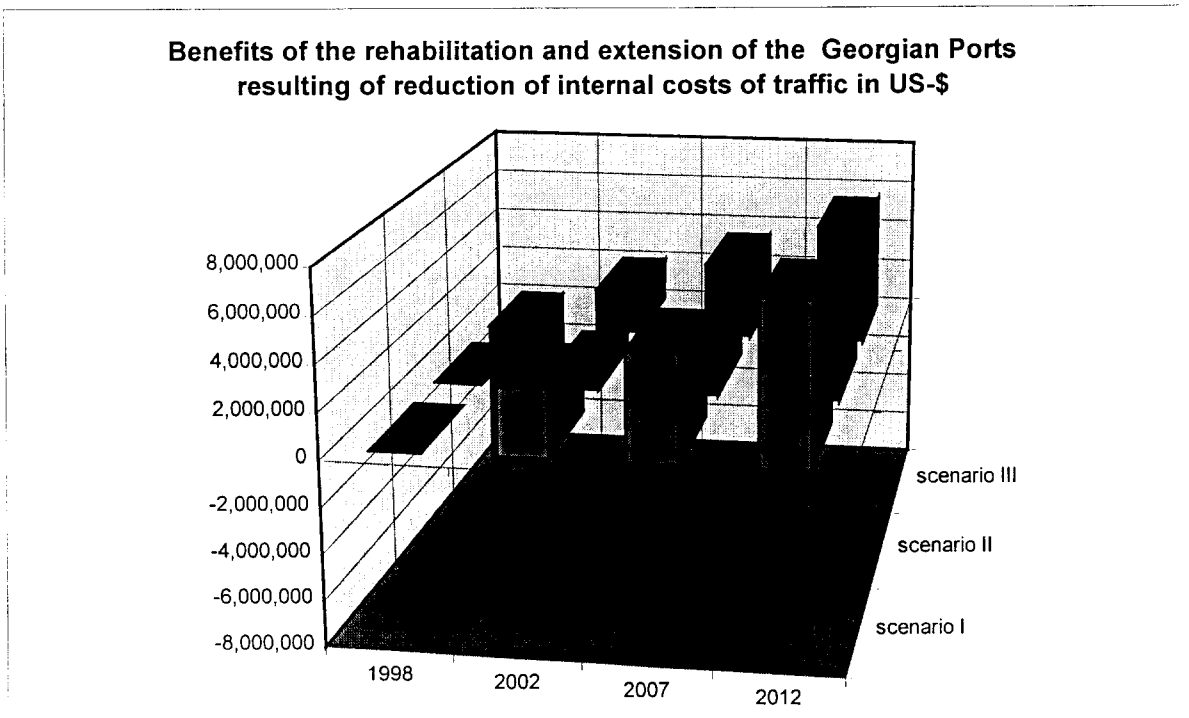



Using the data for the above explained and presented internal costs of traffic and calculating the difference between the comparative case and the development scenarios, the benefits are the result.

Benefits resulting of reduction of internal costs of traffic in US-$

| | 1998 | 2002 | 2007 | 2012 |
|---|---|---|---|---|
| scenario I | 0 | 3,188,369 | 5,068,831 | 7,644,226 |
| scenario II | 0 | 871,355 | 2,007,259 | 3,681,222 |
| scenario III | -3,246,464 | 2,195,020 | 3,757,332 | 5,945,855 |

In the year 1998 the cost reductions are 0 and in scenario III negative. Therefore no cost reduction occurs but an increase in costs. For the following years an increasing cost reduction is the result of the calculation.



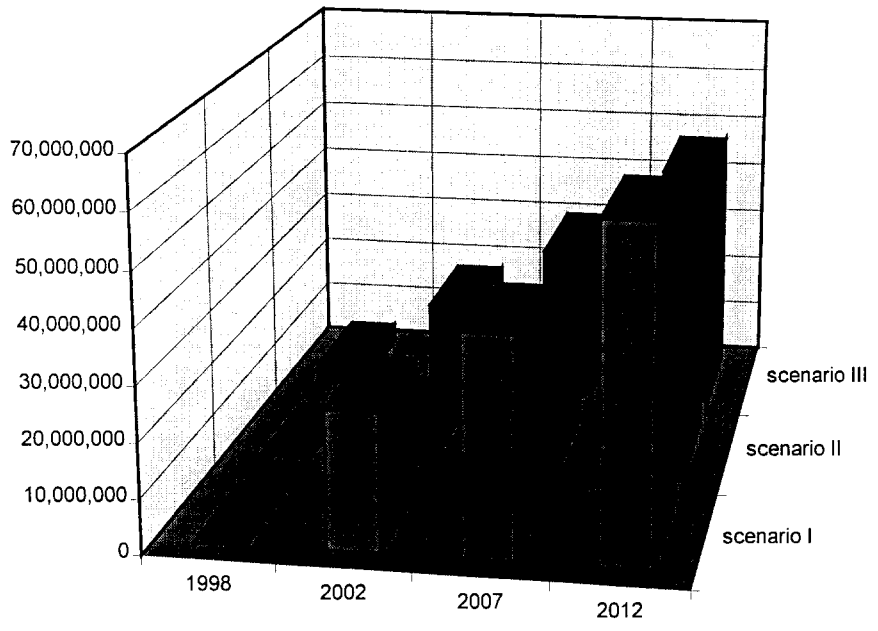
The presented figures take into consideration the reduction of transport performance and the change in the use of the transport modes.
For the calculation of the cost-benefit-ratio the scenario III (probable case) was selected. The calculation of the present value for the period 1998 until 2012 results in benefits of 19,8 mil US-$. However a sensitivity analysis shows that the result depends very strong on the data of the internal costs of traffic.

Environmental Effects
The same procedure as for the internal costs of traffic is executed for the external costs. The different total transport performance and the different external costs of traffic for the modes in the comparative and the port development case result in a noticeable reduction in the environmental effects of traffic. The results of the analysis are shown in the following tables.

Benefits resulting of reduction of external costs of traffic in US-$

| | 1998 | 2002 | 2007 | 2012 |
|---|---|---|---|---|
| scenario I | 0 | 25,252,561 | 40,144,116 | 60,539,396 |
| scenario II | 0 | 6,896,468 | 15,895,160 | 29,153,712 |
| scenario III | 3,647,602 | 17,383,705 | 29,752,712 | 47,088,432 |

**Benefits of the rehabilitation and extension of the Georgian Ports resulting of reduction of external costs of traffic in US-$**




As for the internal costs of traffic the full effect of reduction in external costs takes place in the years up to 2007. In other words the benefits of the rehabilitation and extension of the Georgian Ports are realised in the long term.

Savings of vessel time
Because of the improvement of port facilities, contemporary and future waiting time for the vessels calling at the Georgian ports will disappear in the scenario cases while the resulting costs will remain in the comparative case. Therefore savings of vessel costs have to be accounted for benefits of the port investments. That

reduction is only applicable for the ships calling in the comparative case so that the calculations have to refer to the ports traffic volume of 4.2 mil. tons. The traffic volume of the ports has to be separated in container and general cargo traffic taking into account that the vessels are merely partially loaded. The average turnover of the ports due to 1 ship is estimated at 300 TEU for a container ship and 5000 to. for a general cargo ship. The daily cost of a 1000 TEU container ship is assumed to be at 15000 US-$ respectively 7000 US-$ for a general cargo vessel. As the savings depend on the realisation of the construction, the savings are set to 0 in the years 1998 and 1999. Assuming the average waiting time is 1 day per vessel, the entire saving sums up to a present value of 55.3 mil. US-$.

Regional Effects

The Georgian ports are of main importance for the region. The new workplaces emerging with the development of the ports according to the masterplan present a component of ports benefits. The additional personnel necessary for the extension of ports activities is taken out of the „Financial and Economic Impact Analysis" (Vol. VI). The total additional personnel in the year 2012 is for both ports 390 persons. The average net wages of the personnel (2400 US-$ p.a. per person) multiplied with the additional persons gives the income of the private households as part of the regional benefits. The present value for the period 1998 until 2012 is about 6.5 mil US-$.

Every workplace in the ports of Poti and Batumi creates further workplaces in the regional and national districts. Examples are companies that directly deal with the transport of goods, forwarders, the road haulage or the railways, but also industry and manufacturers as well as further services like restaurants and hotels.

It is not possible within the scope of this study to exactly research the current and future levels of the multiplier effect. Researches at other ports (i.e. Bremen, Hamburg) show results that correspond to the specialisation of the ports multiplier effects from additionally 0.3 to 0.8 workplaces in addition. The Georgian ports are places for the handling of transit cargo which indicates a small effect. Therefore the middle value from 0.5 further workplaces in the regional and national economies in reference to a workplace in the port itself is calculated. The income per year per person is presumed to be 1800 US-$ that is lower than the generated income of the specialised workplaces in the ports themselves.

The discounted present value of the multiplier effect is about 2.4 mil US-$.

The calculations mentioned above referred to the additional income from the operation of the ports. But as well, additional income is generated during the construction of the facilities which leads to benefits in the with-case.[5] In order to quantify the employment effect, an estimation of the workforce required for the execution of the project is necessary. As far as the investment in the Georgian ports are concerned, it is presumed that an investment of 100 mill. US-$ requires 3600 man-years. This amount is higher than those presumed i.e. for the German infrastructure planning where the amount of 1250 man-years is taken into account. That relatively high amount seems to be appropriate because of the labour intensity that is certainly much higher in Georgia than in Western Europe. The employment effect thus obtained must be verified for its capability of being regionalised. 70 % of the employment effects occurring in the involved branches of industry are considered as regionally attributable. Furthermore, in the investment costs, employment effects from the construction of the projects are considered to account for maximum 90 % of the benefit-relevant share in the labour income. This limitation is based on the fact that despite the high structural unemployment in the region it cannot be assumed that the workforce employed on the project would have been unemployed in the case without project implementation. Assuming an average wage of 2000 US-$ per worker per year the present value of the additional income of personnel due to the construction is about 8 mil. US-$ in the case with breakwater respectively 6 mil. US-$ without breakwater.

[5] The procedure follows the principles of the German Transport Infrastructure Planning.

### 3.2.3 Non-assessable Benefits

For the following benefits of the ports development it is not possible to derive values in US-$. They are non-assessable but have to be mentioned and described to be complete in the list of benefits.

Industrial Site Effects and Structural Effects of Demand for Areas
The costs of the developed areas, as well as the costs of measures for compensation have to be considered. The measures to enhance environmental benefits are recommended (environmental assessment Phase 2 report Vol. V.) and are already integrated in the Master Plan. Besides, since the prices for land and the population density are low, these effects can be neglected.

Town Planing Effects
The relief of the cities of the emissions and hazards caused by heavy trucks is an important goal of town planing. Concerning the urban traffic it is possible to concentrate the freight traffic of the ports to fixed routes. These effects are of intangible value and cannot be calculated.

Effects for Nature and Landscape
The ecological value of the necessary areas has to be assessed. Only for the possible extension of a container terminal in the north of Poti, new land has to be developed. Up to now, this area has been of high ecological value. But the ecological costs cannot only consider the container terminal but also future planning. According to the environmental assessment (Phase 2 Report Vol. V), no positive or negative effects can be calculated.

Port Economies
The companies in the ports have the main advantage of a port development. Without the extensions, the companies would not exist or agglomerations and specialisations and therefore economies-of-scale could not be achieved. The port authorities and the operators in the ports are the executives for the port development. All direct costs and procedures accumulate to their budgets.

The first thing to do for the calculation of the cost and benefit ratio, is the demarcation of costs and benefits which are closely related to the port development. In the scope of the model of relevant regional and national economical costs and benefits the following values have to be derived:

- operation of the projected port development
- development of space
- all construction costs

Industry and Trade
The range of services of the local industry and trade is highly influenced by impulses from the ports. Poti and Batumi have developed to important centres in the Georgia. This agglomeration will go on in the future. The extent of the effects of the port on the local industry and trade can be estimated not with acceptable reliability.

Private Households
The possible development of economies will considerably improve the workplace situation in Poti and Batumi. Factors are

- new workplaces and securing of workplaces (already calculated)
- optimisation of procedures
- humanisation of workplaces
- enlargement of work fields
- new carrier chances
- education and professional training

Considering the high unemployment rate, this contribution to the regional economy is of high importance.

# 4 Cost/Benefit Ratio

As a result of the above analysed fields of costs and benefits of the ports development a complete compilation of all quantified effects is necessary. The following table shows the compiled data in case of the investment with breakwater at Poti.

| Effects | present value [US-$] |
|---|---|
| Costs | |
| Costs of additional investment and operation | 199,153,569 |
| | |
| Benefits | |
| reduction in internal costs of traffic | 19,791,099 |
| reduction in external costs of traffic | 226,083,167 |
| additional income of personnel (due to operation) | 6,454,114 |
| income multiplier effect (due to additional income) | 2,420,293 |
| additional income of personnel (due to construction) | 8,103,642 |
| savings of vessel time | 55,365,291 |
| Total benefits | 318,217,605 |
| Cost/Benefit-Ratio (with breakwater) | 1 : 1.60 |

As a result of the cost/benefit analysis an amount of cost of about 199 mil US-$ induces benefits of an amount of 318 mil US-$. The cost/benefit ratio of 1 : 1.6 could be qualified as acceptable. An alternative calculation was executed for the variant without breakwater for the port of Poti. The results concerning the cost/benefit ratio show no dramatic difference as presented below.

| Effects | present value [US-$] |
|---|---|
| Costs | |
| Costs of additional investment and operation | 166,186,422 |
| | |
| Benefits | |
| reduction in internal costs of traffic | 19,791,099 |
| reduction in external costs of traffic | 226,083,167 |
| additional income of personnel (due to operation) | 6,454,114 |
| income multiplier effect (due to additional income) | 2,420,293 |
| additional income of personnel (due to construction) | 6,384,860 |
| savings of vessel time | 50,877,811 |
| Total benefits | 316,498,824 |
| Cost/Benefit-Ratio (without breakwater) | 1 : 1.90 |

As mentioned above (see 1.1.2), the results depend on the discount rate chosen for the calculation of the present values. The above indicated amounts refer to a discount rate of 6 %. The following sensitivity analysis shows the deviations occuring due to different discount rates for the case including breakwater:

| discount rate | total costs | total benefits | cost/benefit-ratio |
|---|---|---|---|
| 3 % | 214,711,558 | 405,051,893 | 1:1.87 |
| 4 % | 209,389,697 | 372,963,828 | 1:1.78 |
| 5 % | 204,198,362 | 344,145,174 | 1:1.69 |
| 6 % | 199,153,569 | 318,217,605 | 1:1.60 |
| 10 % | 180,597,634 | 237,317,025 | 1:1.31 |
| 15 % | 161,093,290 | 171,452,942 | 1:1.06 |

The main beneficiaries are the environment and the forwarding companies, integrators and other companies of the transport sector engaged in the freight transport between Eastern Europe, Asia, TRACECA and the Western European countries. But also the Georgian ports, the ports personnel and the region are beneficiaries of the investments.

As a conclusion the rehabilitation and extension of the Ports of Poti and Batumi result in acceptable benefits. On the basis of the cost/benefit analysis the realisation of the masterplans could be recommended.

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# Annex

Table 1: cost/benefit-analysis Poti & Batumi

Table 2: transport volume and transport performance (scenario 3)

Table 3: distance per mode and internal costs per mode

Table 4: calculation of internal costs: scenario 3 vs. comparative case

Table 5: distance per mode and external costs per mode

Table 6: calculation of external costs: scenario 3 vs. comparative case

Table 1

## Cost-Benefit-Analysis Poti & Batumi

discount rate: 0.06

| effects \ year no. | present value [USD] | 1998<br>0 | 1999<br>1 | 2000<br>2 |
|---|---|---|---|---|
| COMPONENTS OF COSTS | | | | |
| Batumi: multi purpose terminal (additional investment and operation) | 48,706,184 | 11479107 | 14062453 | 2679728 |
| Poti: general cargo and bulk (additional investment and operation) | 56,956,670 | 16611000 | 732474 | 1435316 |
| Poti: container terminal (add. investment and operation); with breakwater | 138,133,390 | -500000 | 24437478 | 28758701 |
| *Poti: container terminal (add. investment and operation); without breakwater* | 105,166,243 | -500000 | 12104145 | 16425368 |
| Sum of costs of additional investment and operation (with breakwater) | 243,796,243 | 27,590,107 | 39,232,405 | 32,873,745 |
| *Sum of costs of additional investment and operation (without breakwater)* | *210,829,097* | 27,590,107 | 26,899,072 | 20,540,412 |
| ./. Residual values (Poti + Batumi) of Inv. in the year 2012 (with breakwater) | 44,642,675 | | | |
| *./. Residual values (Poti + Batumi) of Inv. in the year 2012 (without breakwater)* | *35,022,629* | | | |
| TOTAL COSTS (Poti container terminal with breakwater) | 199,153,569 | | | |
| *TOTAL COSTS (Poti container terminal without breakwater)* | *166,186,422* | | | |
| COMPONENTS OF BENEFITS | | | | |
| proceeds | | | | |
| reduction in internal costs of traffic | 19,791,099 | (3,246,464) | (1,886,093) | (525,722) |
| reduction in external costs of traffic | 226,083,167 | 3,647,602 | 7,081,628 | 10,515,653 |
| additional income of personnel due to operation of ports | 6,454,114 | 285,600 | 336,000 | 436,800 |
| income multiplier effect due to additional income of operation | 2,420,293 | 107,100 | 126,000 | 163,800 |
| additional income due to construction (with breakwater) | 8,103,642 | 1,710,798 | 1,639,809 | 1,016,336 |
| *additional income due to construction (without breakwater)* | *6,384,860* | *1,710,798* | *996,468* | *372,995* |
| savings of vessel time | 55,365,291 | 0 | 0 | 6,808,000 |
| TOTAL BENEFITS (Poti container terminal with breakwater) | 318,217,605 | | | |
| *TOTAL BENEFITS (Poti container terminal without breakwater)* | *316,498,824* | | | |
| COST/BENEFIT-RATIO (Poti container terminal with breakwater) | 1.5979 | | | |
| | 1 : 1.60 | | | |
| *COST/BENEFIT-RATIO (Poti container terminal without breakwater)* | *1.9045* | | | |
| | 1 : 1.90 | | | |

| 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|
| 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 2372187 | 1295280 | 2426441 | 1929181 | 2476593 | 2392746 | 2774411 | 4919373 | 3580815 |
| 2345698 | 4067586 | 5672895 | 4835736 | 3455990 | 3746944 | 4897928 | 5875645 | 6291862 |
| 49298396 | 24616178 | 742275 | 820221 | 1079006 | 781617 | 5776558 | 13087447 | 5242734 |
| 36965063 | 24616178 | 742275 | 820221 | 1079006 | 781617 | 5776558 | 13087447 | 5242734 |
| 54,016,281 | 29,979,044 | 8,841,611 | 7,585,138 | 7,011,589 | 6,921,307 | 13,448,897 | 23,882,465 | 15,115,411 |
| 41,682,948 | 29,979,044 | 8,841,611 | 7,585,138 | 7,011,589 | 6,921,307 | 13,448,897 | 23,882,465 | 15,115,411 |
| 834,649 | 2,195,020 | 2,507,482 | 2,819,945 | 3,132,407 | 3,444,870 | 3,757,332 | 4,195,037 | 4,632,742 |
| 13,949,679 | 17,383,705 | 19,857,506 | 22,331,308 | 24,805,109 | 27,278,911 | 29,752,712 | 33,219,856 | 36,687,000 |
| 506,400 | 547,200 | 650,400 | 686,400 | 715,200 | 715,200 | 794,400 | 868,800 | 880,800 |
| 189,900 | 205,200 | 243,900 | 257,400 | 268,200 | 268,200 | 297,900 | 325,800 | 330,300 |
| 2,140,402 | 1,212,155 | 195,910 | 138,802 | 16,330 | 0 | 179,353 | 583,556 | 153,045 |
| *1,498,105* | *1,212,155* | *195,910* | *138,802* | *16,330* | *0* | *179,353* | *583,556* | *153,045* |
| 6,608,000 | 6,608,000 | 6,608,000 | 6,608,000 | 6,608,000 | 6,608,000 | 6,608,000 | 6,608,000 | 6,608,000 |

| 2010 | 2011 | 2012 |
|---|---|---|
| 12 | 13 | 14 |
| | | |
| 3813990 | 4267108 | 4668732 |
| 7375362 | 7832673 | 9170964 |
| 10781379 | 2682108 | 15031695 |
| 10781379 | 2682108 | 15031695 |
| 21,970,731 | 14,781,889 | 28,871,391 |
| 21,970,731 | 14,781,889 | 28,871,391 |
| | | 100,932,800 |
| | | 79,182,800 |
| | | |
| | | |
| | | |
| 5,070,446 | 5,508,151 | 5,945,855 |
| 40,154,144 | 43,621,288 | 47,088,432 |
| 880,800 | 936,000 | 936,000 |
| 330,300 | 351,000 | 351,000 |
| 373,449 | 0 | 521,640 |
| *373,449* | *0* | *521,640* |
| 6,608,000 | 6,608,000 | 6,608,000 |

Table 2

**transport volume**

| scenario 3 | 1998 | 2002 | 2007 | 2012 |
|---|---|---|---|---|
| **total transport volume** | 7,000,000 | 12,670,000 | 10,885,000 | 18,490,000 |
| via Georgian ports | 4,200,000 | 6,884,800 | 9,095,100 | 11,772,500 |
| route III | 2,478,463 | 4,210,273 | 5,561,941 | 7,199,256 |
| route IV | 706,095 | 1,284,346 | 1,696,673 | 2,196,137 |
| route V | 217,595 | 646,596 | 854,179 | 1,105,631 |
| route VII | 797,848 | 743,585 | 982,306 | 1,271,476 |
| sum | 4,200,001 | 6,884,800 | 9,095,099 | 11,772,500 |
| bypassing Georgian ports | 2,800,000 | 5,785,200 | 1,789,900 | 6,717,500 |
| route I | 162,742 | 329,136 | 101,832 | 382,177 |
| route II | 2,169,896 | 4,506,633 | 1,394,320 | 5,232,888 |
| route VI | 467,362 | 949,431 | 293,747 | 1,102,434 |
| sum | 2,800,000 | 5,785,200 | 1,789,899 | 6,717,499 |
| route I | 162,742 | 329,136 | 101,832 | 382,177 |
| route II | 2,169,896 | 4,506,633 | 1,394,320 | 5,232,888 |
| route III | 2,478,463 | 4,210,273 | 5,561,941 | 7,199,256 |
| route IV | 706,095 | 1,284,346 | 1,696,673 | 2,196,137 |
| route V | 217,595 | 646,596 | 854,179 | 1,105,631 |
| route VI | 467,362 | 949,431 | 293,747 | 1,102,434 |
| route VII | 797,848 | 743,585 | 982,306 | 1,271,476 |
| sum | 7,000,001 | 12,670,000 | 10,884,998 | 18,489,999 |
| **shares of different routes** | | | | |
| route I | 2.3% | 2.6% | 0.9% | 2.1% |
| route II | 31.0% | 35.6% | 12.8% | 28.3% |
| route III | 35.4% | 33.2% | 51.1% | 38.9% |
| route IV | 10.1% | 10.1% | 15.6% | 11.9% |
| route V | 3.1% | 5.1% | 7.8% | 6.0% |
| route VI | 6.7% | 7.5% | 2.7% | 6.0% |
| route VII | 11.4% | 5.9% | 9.0% | 6.9% |
| sum | 100.0% | 100.0% | 100.0% | 100.0% |

**transport performance**

| scenario 3 | km | 1998 | 2002 | 2007 | 2012 |
|---|---|---|---|---|---|
| **total transport performance** | | | | | |
| via Georgian ports | | | | | |
| route III | 4,600 | 11,400,929,800 | 19,367,255,800 | 25,584,928,600 | 33,116,577,600 |
| route IV | 5,700 | 4,024,741,500 | 7,320,772,200 | 9,671,036,100 | 12,517,980,900 |
| route V | 7,100 | 1,544,924,500 | 4,590,831,600 | 6,064,670,900 | 7,849,980,100 |
| route VII | 7,500 | 5,983,860,000 | 5,576,887,500 | 7,367,295,000 | 9,536,070,000 |
| sum | | 22,954,455,800 | 36,855,747,100 | 48,687,930,600 | 63,020,608,600 |
| bypassing Georgian ports | | | | | |
| route I | 7,800 | 1,269,387,600 | 2,567,260,800 | 794,289,600 | 2,980,980,600 |
| route II | 4,800 | 10,415,500,800 | 21,631,838,400 | 6,692,736,000 | 25,117,862,400 |
| route VI | 8,600 | 4,019,313,200 | 8,165,106,600 | 2,526,224,200 | 9,480,932,400 |
| sum | | 15,704,201,600 | 32,364,205,800 | 10,013,249,800 | 37,579,775,400 |
| route I | 7,800 | 1,269,387,600 | 2,567,260,800 | 794,289,600 | 2,980,980,600 |
| route II | 4,800 | 10,415,500,800 | 21,631,838,400 | 6,692,736,000 | 25,117,862,400 |
| route III | 4,600 | 11,400,929,800 | 19,367,255,800 | 25,584,928,600 | 33,116,577,600 |
| route IV | 5,700 | 4,024,741,500 | 7,320,772,200 | 9,671,036,100 | 12,517,980,900 |
| route V | 7,100 | 1,544,924,500 | 4,590,831,600 | 6,064,670,900 | 7,849,980,100 |
| route VI | 8,600 | 4,019,313,200 | 8,165,106,600 | 2,526,224,200 | 9,480,932,400 |
| route VII | 7,500 | 5,983,860,000 | 5,576,887,500 | 7,367,295,000 | 9,536,070,000 |
| total transport performance | | 38,658,657,400 | 69,219,952,900 | 58,701,180,400 | 100,600,384,000 |
| **shares of different routes** | | | | | |
| route I | | 3.3% | 3.7% | 1.4% | 3.0% |
| route II | | 26.9% | 31.3% | 11.4% | 25.0% |
| route III | | 29.5% | 28.0% | 43.6% | 32.9% |
| route IV | | 10.4% | 10.6% | 16.5% | 12.4% |
| route V | | 4.0% | 6.6% | 10.3% | 7.8% |
| route VI | | 10.4% | 11.8% | 4.3% | 9.4% |
| route VII | | 15.5% | 8.1% | 12.6% | 9.5% |
| sum | | 100.0% | 100.0% | 100.0% | 100.0% |

| comparative case | 1998 | 2002 | 2007 | 2012 |
|---|---|---|---|---|
| **total transport volume** | 7,000,000 | 12,670,000 | 10,885,000 | 18,490,000 |
| via Georgian ports | 4,200,000 | 4,200,000 | 4,500,000 | 4,500,000 |
| route III | 2,568,433 | 2,568,433 | 2,751,892 | 2,751,892 |
| route IV | 783,502 | 783,502 | 839,466 | 839,466 |
| route V | 394,449 | 394,449 | 422,624 | 422,624 |
| route VII | 453,616 | 453,616 | 486,018 | 486,018 |
| sum | 4,200,000 | 4,200,000 | 4,500,000 | 4,500,000 |
| bypassing Georgian ports | 2,800,000 | 8,470,000 | 6,385,000 | 13,990,000 |
| route I | 159,300 | 481,882 | 363,260 | 795,930 |
| route II | 2,181,182 | 6,598,074 | 4,973,873 | 10,898,118 |
| route VI | 459,519 | 1,390,044 | 1,047,867 | 2,295,952 |
| sum | 2,800,001 | 8,470,000 | 6,385,000 | 13,990,000 |
| route I | 159,300 | 481,882 | 363,260 | 795,930 |
| route II | 2,181,182 | 6,598,074 | 4,973,873 | 10,898,118 |
| route III | 2,568,433 | 2,568,433 | 2,751,892 | 2,751,892 |
| route IV | 783,502 | 783,502 | 839,466 | 839,466 |
| route V | 394,449 | 394,449 | 422,624 | 422,624 |
| route VI | 459,519 | 1,390,044 | 1,047,867 | 2,295,952 |
| route VII | 453,616 | 453,616 | 486,018 | 486,018 |
| total transport volume | 7,000,001 | 12,670,000 | 10,885,000 | 18,490,000 |
| **shares of different routes** | | | | |
| route I | 2.3% | 3.8% | 3.3% | 4.3% |
| route II | 31.2% | 52.1% | 45.7% | 58.9% |
| route III | 36.7% | 20.3% | 25.3% | 14.9% |
| route IV | 11.2% | 6.2% | 7.7% | 4.5% |
| route V | 5.6% | 3.1% | 3.9% | 2.3% |
| route VI | 6.6% | 11.0% | 9.6% | 12.4% |
| route VII | 6.5% | 3.6% | 4.5% | 2.6% |
| sum | 100.0% | 100.0% | 100.0% | 100.0% |

| comparative case | km | 1998 | 2002 | 2007 | 2012 |
|---|---|---|---|---|---|
| **total transport performance** | | | | | |
| via Georgian ports | | | | | |
| route III | 4,600 | 11,814,791,800 | 11,814,791,800 | 12,658,703,200 | 12,658,703,200 |
| route IV | 5,700 | 4,465,961,400 | 4,465,961,400 | 4,784,956,200 | 4,784,956,200 |
| route V | 7,100 | 2,800,587,900 | 2,800,587,900 | 3,000,630,400 | 3,000,630,400 |
| route VII | 7,500 | 3,402,120,000 | 3,402,120,000 | 3,645,135,000 | 3,645,135,000 |
| sum | | 22,483,461,100 | 22,483,461,100 | 24,089,424,800 | 24,089,424,800 |
| bypassing Georgian ports | | | | | |
| route I | 7,800 | 1,242,540,000 | 3,758,679,600 | 2,833,428,000 | 6,208,254,000 |
| route II | 4,800 | 10,469,673,600 | 31,670,755,200 | 23,874,590,400 | 52,310,966,400 |
| route VI | 8,600 | 3,951,863,400 | 11,954,378,400 | 9,011,656,200 | 19,745,187,200 |
| sum | | 15,664,077,000 | 47,383,813,200 | 35,719,674,600 | 78,264,407,600 |
| route I | 7,800 | 1,242,540,000 | 3,758,679,600 | 2,833,428,000 | 6,208,254,000 |
| route II | 4,800 | 10,469,673,600 | 31,670,755,200 | 23,874,590,400 | 52,310,966,400 |
| route III | 4,600 | 11,814,791,800 | 11,814,791,800 | 12,658,703,200 | 12,658,703,200 |
| route IV | 5,700 | 4,465,961,400 | 4,465,961,400 | 4,784,956,200 | 4,784,956,200 |
| route V | 7,100 | 2,800,587,900 | 2,800,587,900 | 3,000,630,400 | 3,000,630,400 |
| route VI | 8,600 | 3,951,863,400 | 11,954,378,400 | 9,011,656,200 | 19,745,187,200 |
| route VII | 7,500 | 3,402,120,000 | 3,402,120,000 | 3,645,135,000 | 3,645,135,000 |
| total transport performance | | 38,147,538,100 | 69,867,274,300 | 59,809,099,400 | 102,353,832,400 |
| **shares of different routes** | | | | | |
| route I | | 3.3% | 5.4% | 4.7% | 6.1% |
| route II | | 27.4% | 45.3% | 39.9% | 51.1% |
| route III | | 31.0% | 16.9% | 21.2% | 12.4% |
| route IV | | 11.7% | 6.4% | 8.0% | 4.7% |
| route V | | 7.3% | 4.0% | 5.0% | 2.9% |
| route VI | | 10.4% | 17.1% | 15.1% | 19.3% |
| route VII | | 8.9% | 4.9% | 6.1% | 3.6% |
| sum | | 100.0% | 100.0% | 100.0% | 100.0% |

Table 3

## Distance per mode [km]

| Mode | Road | Rail | inl.water | seaship | sum |
|---|---|---|---|---|---|
| route | | | | | |
| I | 0 | 3795 | 0 | 4005 | 7800 |
| II | 20 | 4780 | 0 | 0 | 4800 |
| III | 19 | 3115 | 0 | 1466 | 4600 |
| IV | 2255 | 0 | 0 | 3445 | 5700 |
| V | 1011 | 1880 | 0 | 4209 | 7100 |
| VI | 1912 | 1875 | 0 | 4813 | 8600 |
| VII | 1058 | 0 | 228 | 6213 | 7499 |

## Internal costs per ton per mode [USD/tkm*km = USD/t]

| Mode<br>cost per mode | Road<br>*0.15* | Rail<br>*0.037* | inl. water<br>*0.03* | seaship<br>*0.02* | sum |
|---|---|---|---|---|---|
| route | | | | | |
| I | 0.00 | 140.42 | 0.00 | 80.10 | 220.52 |
| II | 3.00 | 176.86 | 0.00 | 0.00 | 179.86 |
| III | 2.85 | 115.26 | 0.00 | 29.32 | 147.43 |
| IV | 338.25 | 0.00 | 0.00 | 68.90 | 407.15 |
| V | 151.65 | 69.56 | 0.00 | 84.18 | 305.39 |
| VI | 286.80 | 69.38 | 0.00 | 96.26 | 452.44 |
| VII | 158.70 | 0.00 | 6.84 | 124.26 | 289.80 |

Table 4

**Calculation of internal costs [in USD]: scenario 3 vs. comparative case**

| scenario 3 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| via Georgian ports | | | | | | | | | | | | | | | |
| route III | 365,387,408 | 429,215,430 | 493,043,452 | 556,871,475 | 620,699,497 | 660,553,428 | 700,407,359 | 740,261,290 | 780,115,221 | 819,969,152 | 868,245,385 | 916,521,617 | 964,797,850 | 1,013,074,083 | 1,061,350,316 |
| route IV | 287,486,579 | 346,345,303 | 405,204,027 | 464,062,750 | 522,921,474 | 556,497,262 | 590,073,049 | 623,648,837 | 657,224,624 | 690,800,412 | 731,471,765 | 772,143,119 | 812,814,473 | 853,485,826 | 894,157,180 |
| route V | 66,451,337 | 99,204,491 | 131,957,645 | 164,710,799 | 197,463,952 | 210,142,707 | 222,821,461 | 235,500,216 | 248,178,970 | 260,857,725 | 276,215,910 | 291,574,095 | 306,932,281 | 322,290,466 | 337,648,651 |
| route VII | 231,216,350 | 227,284,996 | 223,353,642 | 219,422,287 | 215,490,933 | 229,327,202 | 243,163,471 | 256,999,740 | 270,836,010 | 284,672,279 | 301,432,572 | 318,192,865 | 334,953,158 | 351,713,452 | 368,473,745 |
| sum | 950,541,674 | 1,102,050,220 | 1,253,558,765 | 1,405,067,311 | 1,556,575,856 | 1,656,520,599 | 1,756,465,341 | 1,856,410,083 | 1,956,354,825 | 2,056,299,567 | 2,177,365,632 | 2,298,431,697 | 2,419,497,762 | 2,540,563,826 | 2,661,629,891 |
| bypassing Georgian ports | | | | | | | | | | | | | | | |
| route I | 35,887,052 | 45,060,145 | 54,233,239 | 63,406,332 | 72,579,425 | 62,554,637 | 52,529,848 | 42,505,060 | 32,480,272 | 22,455,483 | 34,819,539 | 47,183,595 | 59,547,650 | 71,911,706 | 84,275,761 |
| route II | 390,277,495 | 495,348,874 | 600,420,253 | 705,491,632 | 810,563,011 | 698,606,888 | 586,650,765 | 474,694,642 | 362,738,518 | 250,782,395 | 388,863,363 | 526,944,331 | 665,025,299 | 803,106,268 | 941,187,236 |
| route VI | 211,450,926 | 265,977,148 | 320,503,370 | 375,029,592 | 429,555,814 | 370,224,936 | 310,894,058 | 251,563,180 | 192,232,302 | 132,901,424 | 206,077,085 | 279,252,745 | 352,428,406 | 425,604,066 | 498,779,727 |
| sum | 637,615,473 | 806,386,168 | 975,156,862 | 1,143,927,556 | 1,312,698,251 | 1,131,386,461 | 950,074,672 | 768,762,882 | 587,451,092 | 406,139,303 | 629,759,987 | 853,380,671 | 1,077,001,355 | 1,300,622,039 | 1,524,242,724 |
| route I | 35,887,052 | 45,060,145 | 54,233,239 | 63,406,332 | 72,579,425 | 62,554,637 | 52,529,848 | 42,505,060 | 32,480,272 | 22,455,483 | 34,819,539 | 47,183,595 | 59,547,650 | 71,911,706 | 84,275,761 |
| route II | 390,277,495 | 495,348,874 | 600,420,253 | 705,491,632 | 810,563,011 | 698,606,888 | 586,650,765 | 474,694,642 | 362,738,518 | 250,782,395 | 388,863,363 | 526,944,331 | 665,025,299 | 803,106,268 | 941,187,236 |
| route III | 365,387,408 | 429,215,430 | 493,043,452 | 556,871,475 | 620,699,497 | 660,553,428 | 700,407,359 | 740,261,290 | 780,115,221 | 819,969,152 | 868,245,385 | 916,521,617 | 964,797,850 | 1,013,074,083 | 1,061,350,316 |
| route IV | 287,486,579 | 346,345,303 | 405,204,027 | 464,062,750 | 522,921,474 | 556,497,262 | 590,073,049 | 623,648,837 | 657,224,624 | 690,800,412 | 731,471,765 | 772,143,119 | 812,814,473 | 853,485,826 | 894,157,180 |
| route V | 66,451,337 | 99,204,491 | 131,957,645 | 164,710,799 | 197,463,952 | 210,142,707 | 222,821,461 | 235,500,216 | 248,178,970 | 260,857,725 | 276,215,910 | 291,574,095 | 306,932,281 | 322,290,466 | 337,648,651 |
| route VI | 211,450,926 | 265,977,148 | 320,503,370 | 375,029,592 | 429,555,814 | 370,224,936 | 310,894,058 | 251,563,180 | 192,232,302 | 132,901,424 | 206,077,085 | 279,252,745 | 352,428,406 | 425,604,066 | 498,779,727 |
| route VII | 231,216,350 | 227,284,996 | 223,353,642 | 219,422,287 | 215,490,933 | 229,327,202 | 243,163,471 | 256,999,740 | 270,836,010 | 284,672,279 | 301,432,572 | 318,192,865 | 334,953,158 | 351,713,452 | 368,473,745 |
| total internal costs | 1,588,157,148 | 1,908,436,388 | 2,228,715,627 | 2,548,994,867 | 2,869,274,107 | 2,787,907,060 | 2,706,540,012 | 2,625,172,965 | 2,543,805,918 | 2,462,438,870 | 2,807,125,619 | 3,151,812,368 | 3,496,499,117 | 3,841,185,866 | 4,185,872,615 |
| internal costs per route [in %] | | | | | | | | | | | | | | | |
| route I | 2.3% | 2.4% | 2.4% | 2.5% | 2.5% | 2.2% | 1.9% | 1.6% | 1.3% | 0.9% | 1.2% | 1.5% | 1.7% | 1.9% | 2.0% |
| route II | 24.6% | 26.0% | 26.9% | 27.7% | 28.2% | 25.1% | 21.7% | 18.1% | 14.3% | 10.2% | 13.9% | 16.7% | 19.0% | 20.9% | 22.5% |
| route III | 23.0% | 22.5% | 22.1% | 21.8% | 21.6% | 23.7% | 25.9% | 28.2% | 30.7% | 33.3% | 30.9% | 29.1% | 27.6% | 26.4% | 25.4% |
| route IV | 18.1% | 18.1% | 18.2% | 18.2% | 18.2% | 20.0% | 21.8% | 23.8% | 25.8% | 28.1% | 26.1% | 24.5% | 23.2% | 22.2% | 21.4% |
| route V | 4.2% | 5.2% | 5.9% | 6.5% | 6.9% | 7.5% | 8.2% | 9.0% | 9.8% | 10.6% | 9.8% | 9.3% | 8.8% | 8.4% | 8.1% |
| route VI | 13.3% | 13.9% | 14.4% | 14.7% | 15.0% | 13.3% | 11.5% | 9.6% | 7.6% | 5.4% | 7.3% | 8.9% | 10.1% | 11.1% | 11.9% |
| route VII | 14.6% | 11.9% | 10.0% | 8.6% | 7.5% | 8.2% | 9.0% | 9.8% | 10.6% | 11.6% | 10.7% | 10.1% | 9.6% | 9.2% | 8.8% |
| sum | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

| comparative case | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| via Georgian ports | | | | | | | | | | | | | | | |
| route III | 378,651,235 | 378,651,235 | 378,651,235 | 378,651,235 | 378,651,235 | 384,060,524 | 389,469,812 | 394,879,101 | 400,288,389 | 405,697,678 | 405,697,678 | 405,697,678 | 405,697,678 | 405,697,678 | 405,697,678 |
| route IV | 319,002,839 | 319,002,839 | 319,002,839 | 319,002,839 | 319,002,839 | 323,559,988 | 328,117,136 | 332,674,285 | 337,231,433 | 341,788,582 | 341,788,582 | 341,788,582 | 341,788,582 | 341,788,582 | 341,788,582 |
| route V | 120,460,780 | 120,460,780 | 120,460,780 | 120,460,780 | 120,460,780 | 122,181,653 | 123,902,525 | 125,623,398 | 127,344,271 | 129,065,143 | 129,065,143 | 129,065,143 | 129,065,143 | 129,065,143 | 129,065,143 |
| route VII | 131,457,917 | 131,457,917 | 131,457,917 | 131,457,917 | 131,457,917 | 133,335,937 | 135,213,957 | 137,091,977 | 138,969,996 | 140,848,016 | 140,848,016 | 140,848,016 | 140,848,016 | 140,848,016 | 140,848,016 |
| sum | 949,572,771 | 949,572,771 | 949,572,771 | 949,572,771 | 949,572,771 | 963,138,101 | 976,703,431 | 990,268,760 | 1,003,834,090 | 1,017,399,420 | 1,017,399,420 | 1,017,399,420 | 1,017,399,420 | 1,017,399,420 | 1,017,399,420 |
| bypassing Georgian ports | | | | | | | | | | | | | | | |
| route I | 35,128,040 | 52,911,582 | 70,695,124 | 88,478,667 | 106,262,209 | 101,030,623 | 95,799,037 | 90,567,451 | 85,335,865 | 80,104,279 | 99,186,324 | 118,268,369 | 137,350,414 | 156,432,459 | 175,514,504 |
| route II | 392,307,395 | 590,912,943 | 789,518,492 | 988,124,041 | 1,186,729,590 | 1,128,303,831 | 1,069,878,073 | 1,011,452,315 | 953,026,556 | 894,600,798 | 1,107,707,739 | 1,320,814,680 | 1,533,921,621 | 1,747,028,562 | 1,960,135,503 |
| route VI | 207,902,479 | 313,152,998 | 418,403,518 | 523,654,038 | 628,904,557 | 597,941,987 | 566,979,417 | 536,016,847 | 505,054,276 | 474,091,706 | 587,027,174 | 699,962,641 | 812,898,108 | 925,833,576 | 1,038,769,043 |
| sum | 635,337,913 | 956,977,524 | 1,278,617,134 | 1,600,256,745 | 1,921,896,356 | 1,827,276,441 | 1,732,656,527 | 1,638,036,612 | 1,543,416,697 | 1,448,796,783 | 1,793,921,236 | 2,139,045,690 | 2,484,170,143 | 2,829,294,597 | 3,174,419,051 |
| route I | 35,128,040 | 52,911,582 | 70,695,124 | 88,478,667 | 106,262,209 | 101,030,623 | 95,799,037 | 90,567,451 | 85,335,865 | 80,104,279 | 99,186,324 | 118,268,369 | 137,350,414 | 156,432,459 | 175,514,504 |
| route II | 392,307,395 | 590,912,943 | 789,518,492 | 988,124,041 | 1,186,729,590 | 1,128,303,831 | 1,069,878,073 | 1,011,452,315 | 953,026,556 | 894,600,798 | 1,107,707,739 | 1,320,814,680 | 1,533,921,621 | 1,747,028,562 | 1,960,135,503 |
| route III | 378,651,235 | 378,651,235 | 378,651,235 | 378,651,235 | 378,651,235 | 384,060,524 | 389,469,812 | 394,879,101 | 400,288,389 | 405,697,678 | 405,697,678 | 405,697,678 | 405,697,678 | 405,697,678 | 405,697,678 |
| route IV | 319,002,839 | 319,002,839 | 319,002,839 | 319,002,839 | 319,002,839 | 323,559,988 | 328,117,136 | 332,674,285 | 337,231,433 | 341,788,582 | 341,788,582 | 341,788,582 | 341,788,582 | 341,788,582 | 341,788,582 |
| route V | 120,460,780 | 120,460,780 | 120,460,780 | 120,460,780 | 120,460,780 | 122,181,653 | 123,902,525 | 125,623,398 | 127,344,271 | 129,065,143 | 129,065,143 | 129,065,143 | 129,065,143 | 129,065,143 | 129,065,143 |
| route VI | 207,902,479 | 313,152,998 | 418,403,518 | 523,654,038 | 628,904,557 | 597,941,987 | 566,979,417 | 536,016,847 | 505,054,276 | 474,091,706 | 587,027,174 | 699,962,641 | 812,898,108 | 925,833,576 | 1,038,769,043 |
| route VII | 131,457,917 | 131,457,917 | 131,457,917 | 131,457,917 | 131,457,917 | 133,335,937 | 135,213,957 | 137,091,977 | 138,969,996 | 140,848,016 | 140,848,016 | 140,848,016 | 140,848,016 | 140,848,016 | 140,848,016 |
| total internal cost | 1,584,910,684 | 1,906,550,295 | 2,228,189,906 | 2,549,829,516 | 2,871,469,127 | 2,790,414,542 | 2,709,359,957 | 2,628,305,372 | 2,547,250,788 | 2,466,196,203 | 2,811,320,656 | 3,156,445,110 | 3,501,569,563 | 3,846,694,017 | 4,191,818,470 |
| internal costs per route [in %] | | | | | | | | | | | | | | | |
| route I | 2.2% | 2.8% | 3.2% | 3.5% | 3.7% | 3.6% | 3.5% | 3.4% | 3.4% | 3.2% | 3.5% | 3.7% | 3.9% | 4.1% | 4.2% |
| route II | 24.8% | 31.0% | 35.4% | 38.8% | 41.3% | 40.4% | 39.5% | 38.5% | 37.4% | 36.3% | 39.4% | 41.8% | 43.8% | 45.4% | 46.8% |
| route III | 23.9% | 19.9% | 17.0% | 14.9% | 13.2% | 13.8% | 14.4% | 15.0% | 15.7% | 16.5% | 14.4% | 12.9% | 11.6% | 10.5% | 9.7% |
| route IV | 20.1% | 16.7% | 14.3% | 12.5% | 11.1% | 11.6% | 12.1% | 12.7% | 13.2% | 13.9% | 12.2% | 10.8% | 9.8% | 8.9% | 8.2% |
| route V | 7.6% | 6.3% | 5.4% | 4.7% | 4.2% | 4.4% | 4.6% | 4.8% | 5.0% | 5.2% | 4.6% | 4.1% | 3.7% | 3.4% | 3.1% |
| route VI | 13.1% | 16.4% | 18.8% | 20.5% | 21.9% | 21.4% | 20.9% | 20.4% | 19.8% | 19.2% | 20.9% | 22.2% | 23.2% | 24.1% | 24.8% |
| route VII | 8.3% | 6.9% | 5.9% | 5.2% | 4.6% | 4.8% | 5.0% | 5.2% | 5.5% | 5.7% | 5.0% | 4.5% | 4.0% | 3.7% | 3.4% |
| sum | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| economized internal costs | (3,246,464) | (1,886,093) | (525,722) | 834,649 | 2,195,020 | 2,507,482 | 2,819,945 | 3,132,407 | 3,444,870 | 3,757,332 | 4,195,037 | 4,632,742 | 5,070,446 | 5,508,151 | 5,945,855 |

Table 5

## Distance per mode [km]

| Mode | Road | Rail | inl.water | seaship | sum |
|---|---|---|---|---|---|
| route | | | | | |
| I | 0 | 3795 | 0 | 4005 | 7800 |
| II | 20 | 4780 | 0 | 0 | 4800 |
| III | 19 | 3115 | 0 | 1466 | 4600 |
| IV | 2255 | 0 | 0 | 3445 | 5700 |
| V | 1011 | 1880 | 0 | 4209 | 7100 |
| VI | 1912 | 1875 | 0 | 4813 | 8600 |
| VII | 1058 | 0 | 228 | 6213 | 7499 |

## External costs per ton per mode [USD/tkm*km = USD/t]

| Mode<br>cost per mode | Road<br>*0.0314* | Rail<br>*0.0079* | inl. water<br>*0.0016* | seaship<br>*0.0005* | sum |
|---|---|---|---|---|---|
| route | | | | | |
| I | 0.00 | 29.98 | 0.00 | 2.00 | 31.98 |
| II | 0.63 | 37.76 | 0.00 | 0.00 | 38.39 |
| III | 0.60 | 24.61 | 0.00 | 0.73 | 25.94 |
| IV | 70.81 | 0.00 | 0.00 | 1.72 | 72.53 |
| V | 31.75 | 14.85 | 0.00 | 2.10 | 48.70 |
| VI | 60.04 | 14.81 | 0.00 | 2.41 | 77.26 |
| VII | 33.22 | 0.00 | 0.36 | 3.11 | 36.69 |

Table 6

Calculation of external costs (in USD): scenario 3 vs. comparative case

| scenario 3 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| via Georgian ports | | | | | | | | | | | | | | | |
| route III | 64,286,621 | 75,516,586 | 86,746,552 | 97,976,517 | 109,206,482 | 116,218,422 | 123,230,362 | 130,242,302 | 137,254,242 | 144,266,182 | 152,759,950 | 161,253,718 | 169,747,486 | 178,241,254 | 186,735,022 |
| routeIV | 51,212,717 | 61,697,781 | 72,182,845 | 82,667,909 | 93,152,973 | 99,134,147 | 105,115,322 | 111,096,496 | 117,077,670 | 123,058,844 | 130,304,019 | 137,549,194 | 144,794,369 | 152,039,544 | 159,284,719 |
| route V | 10,597,290 | 15,820,581 | 21,043,872 | 26,267,163 | 31,490,454 | 33,512,391 | 35,534,328 | 37,556,266 | 39,578,203 | 41,600,140 | 44,049,378 | 46,498,616 | 48,947,854 | 51,397,092 | 53,846,330 |
| route VII | 29,275,038 | 28,777,276 | 28,279,515 | 27,781,754 | 27,283,993 | 29,035,847 | 30,787,701 | 32,539,555 | 34,291,409 | 36,043,263 | 38,165,337 | 40,287,411 | 42,409,485 | 44,531,559 | 46,653,633 |
| sum | 155,371,666 | 181,812,225 | 208,252,784 | 234,693,343 | 261,133,902 | 277,900,807 | 294,667,713 | 311,434,618 | 328,201,524 | 344,968,429 | 365,278,684 | 385,588,939 | 405,899,194 | 426,209,449 | 446,519,704 |
| bypassing Georgian ports | | | | | | | | | | | | | | | |
| route I | 5,204,977 | 6,535,422 | 7,865,867 | 9,196,312 | 10,526,757 | 9,072,784 | 7,618,811 | 6,164,838 | 4,710,866 | 3,256,893 | 5,050,148 | 6,843,403 | 8,636,657 | 10,429,912 | 12,223,167 |
| route II | 83,302,307 | 105,729,141 | 128,155,974 | 150,582,808 | 173,009,641 | 149,113,302 | 125,216,962 | 101,320,623 | 77,424,284 | 53,527,945 | 83,000,470 | 112,472,995 | 141,945,520 | 171,418,045 | 200,890,570 |
| route VI | 36,106,425 | 45,417,082 | 54,727,738 | 64,038,395 | 73,349,051 | 63,217,973 | 53,086,895 | 42,955,816 | 32,824,738 | 22,693,659 | 35,188,812 | 47,683,964 | 60,179,116 | 72,674,268 | 85,169,421 |
| sum | 124,613,710 | 157,681,645 | 190,749,580 | 223,817,514 | 256,885,449 | 221,404,059 | 185,922,668 | 150,441,278 | 114,959,888 | 79,478,497 | 123,239,429 | 167,000,361 | 210,761,294 | 254,522,226 | 298,283,158 |
| route I | 5,204,977 | 6,535,422 | 7,865,867 | 9,196,312 | 10,526,757 | 9,072,784 | 7,618,811 | 6,164,838 | 4,710,866 | 3,256,893 | 5,050,148 | 6,843,403 | 8,636,657 | 10,429,912 | 12,223,167 |
| route II | 83,302,307 | 105,729,141 | 128,155,974 | 150,582,808 | 173,009,641 | 149,113,302 | 125,216,962 | 101,320,623 | 77,424,284 | 53,527,945 | 83,000,470 | 112,472,995 | 141,945,520 | 171,418,045 | 200,890,570 |
| route III | 64,286,621 | 75,516,586 | 86,746,552 | 97,976,517 | 109,206,482 | 116,218,422 | 123,230,362 | 130,242,302 | 137,254,242 | 144,266,182 | 152,759,950 | 161,253,718 | 169,747,486 | 178,241,254 | 186,735,022 |
| route IV | 51,212,717 | 61,697,781 | 72,182,845 | 82,667,909 | 93,152,973 | 99,134,147 | 105,115,322 | 111,096,496 | 117,077,670 | 123,058,844 | 130,304,019 | 137,549,194 | 144,794,369 | 152,039,544 | 159,284,719 |
| route V | 10,597,290 | 15,820,581 | 21,043,872 | 26,267,163 | 31,490,454 | 33,512,391 | 35,534,328 | 37,556,266 | 39,578,203 | 41,600,140 | 44,049,378 | 46,498,616 | 48,947,854 | 51,397,092 | 53,846,330 |
| route VI | 36,106,425 | 45,417,082 | 54,727,738 | 64,038,395 | 73,349,051 | 63,217,973 | 53,086,895 | 42,955,816 | 32,824,738 | 22,693,659 | 35,188,812 | 47,683,964 | 60,179,116 | 72,674,268 | 85,169,421 |
| route VII | 29,275,038 | 28,777,276 | 28,279,515 | 27,781,754 | 27,283,993 | 29,035,847 | 30,787,701 | 32,539,555 | 34,291,409 | 36,043,263 | 38,165,337 | 40,287,411 | 42,409,485 | 44,531,559 | 46,653,633 |
| sum | 279,985,376 | 339,493,870 | 399,002,363 | 458,510,857 | 518,019,351 | 499,304,866 | 480,590,381 | 461,875,896 | 443,161,411 | 424,446,926 | 488,518,114 | 552,589,301 | 616,660,488 | 680,731,675 | 744,802,862 |
| external costs per route [in %] | | | | | | | | | | | | | | | |
| route I | 1.9% | 1.9% | 2.0% | 2.0% | 2.0% | 1.8% | 1.6% | 1.3% | 1.1% | 0.8% | 1.0% | 1.2% | 1.4% | 1.5% | 1.6% |
| route II | 29.8% | 31.1% | 32.1% | 32.8% | 33.4% | 29.9% | 26.1% | 21.9% | 17.5% | 12.6% | 17.0% | 20.4% | 23.0% | 25.2% | 27.0% |
| route III | 23.0% | 22.2% | 21.7% | 21.4% | 21.1% | 23.3% | 25.6% | 28.2% | 31.0% | 34.0% | 31.3% | 29.2% | 27.5% | 26.2% | 25.1% |
| route IV | 18.3% | 18.2% | 18.1% | 18.0% | 18.0% | 19.9% | 21.9% | 24.1% | 26.4% | 29.0% | 26.7% | 24.9% | 23.5% | 22.3% | 21.4% |
| route V | 3.8% | 4.7% | 5.3% | 5.7% | 6.1% | 6.7% | 7.4% | 8.1% | 8.9% | 9.8% | 9.0% | 8.4% | 7.9% | 7.6% | 7.2% |
| route VI | 12.9% | 13.4% | 13.7% | 14.0% | 14.2% | 12.7% | 11.0% | 9.3% | 7.4% | 5.3% | 7.2% | 8.6% | 9.8% | 10.7% | 11.4% |
| route VII | 10.5% | 8.5% | 7.1% | 6.1% | 5.3% | 5.8% | 6.4% | 7.0% | 7.7% | 8.5% | 7.8% | 7.3% | 6.9% | 6.5% | 6.3% |
| sum | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

| comparative case | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| via Georgian ports | | | | | | | | | | | | | | | |
| route III | 66,620,272 | 66,620,272 | 66,620,272 | 66,620,272 | 66,620,272 | 67,571,988 | 68,523,703 | 69,475,419 | 70,427,134 | 71,378,850 | 71,378,850 | 71,378,850 | 71,378,850 | 71,378,850 | 71,378,850 |
| routeIV | 56,827,008 | 56,827,008 | 56,827,008 | 56,827,008 | 56,827,008 | 57,638,816 | 58,450,625 | 59,262,433 | 60,074,241 | 60,886,049 | 60,886,049 | 60,886,049 | 60,886,049 | 60,886,049 | 60,886,049 |
| route V | 19,210,416 | 19,210,416 | 19,210,416 | 19,210,416 | 19,210,416 | 19,484,851 | 19,759,286 | 20,033,721 | 20,308,157 | 20,582,592 | 20,582,592 | 20,582,592 | 20,582,592 | 20,582,592 | 20,582,592 |
| route VII | 16,644,305 | 16,644,305 | 16,644,305 | 16,644,305 | 16,644,305 | 16,882,087 | 17,119,869 | 17,357,651 | 17,595,433 | 17,833,215 | 17,833,215 | 17,833,215 | 17,833,215 | 17,833,215 | 17,833,215 |
| sum | 159,302,001 | 159,302,001 | 159,302,001 | 159,302,001 | 159,302,001 | 161,577,742 | 163,853,483 | 166,129,224 | 168,404,965 | 170,680,706 | 170,680,706 | 170,680,706 | 170,680,706 | 170,680,706 | 170,680,706 |
| bypassing Georgian ports | | | | | | | | | | | | | | | |
| route I | 5,094,892 | 7,674,177 | 10,253,462 | 12,832,747 | 15,412,032 | 14,653,255 | 13,894,477 | 13,135,700 | 12,376,922 | 11,618,145 | 14,385,762 | 17,153,378 | 19,920,995 | 22,688,612 | 25,456,229 |
| route II | 83,735,577 | 126,126,698 | 168,517,819 | 210,908,940 | 253,300,061 | 240,829,446 | 228,358,830 | 215,888,215 | 203,417,600 | 190,946,984 | 236,433,338 | 281,919,691 | 327,406,044 | 372,892,397 | 418,378,750 |
| route VI | 35,500,508 | 53,472,621 | 71,444,735 | 89,416,848 | 107,388,961 | 102,101,930 | 96,814,898 | 91,527,867 | 86,240,835 | 80,953,803 | 100,238,164 | 119,522,525 | 138,806,886 | 158,091,247 | 177,375,609 |
| sum | 124,330,977 | 187,273,496 | 250,216,015 | 313,158,535 | 376,101,054 | 357,584,630 | 339,068,205 | 320,551,781 | 302,035,357 | 283,518,932 | 351,057,263 | 418,595,595 | 486,133,926 | 553,672,257 | 621,210,588 |
| route I | 5,094,892 | 7,674,177 | 10,253,462 | 12,832,747 | 15,412,032 | 14,653,255 | 13,894,477 | 13,135,700 | 12,376,922 | 11,618,145 | 14,385,762 | 17,153,378 | 19,920,995 | 22,688,612 | 25,456,229 |
| route II | 83,735,577 | 126,126,698 | 168,517,819 | 210,908,940 | 253,300,061 | 240,829,446 | 228,358,830 | 215,888,215 | 203,417,600 | 190,946,984 | 236,433,338 | 281,919,691 | 327,406,044 | 372,892,397 | 418,378,750 |
| route III | 66,620,272 | 66,620,272 | 66,620,272 | 66,620,272 | 66,620,272 | 67,571,988 | 68,523,703 | 69,475,419 | 70,427,134 | 71,378,850 | 71,378,850 | 71,378,850 | 71,378,850 | 71,378,850 | 71,378,850 |
| route IV | 56,827,008 | 56,827,008 | 56,827,008 | 56,827,008 | 56,827,008 | 57,638,816 | 58,450,625 | 59,262,433 | 60,074,241 | 60,886,049 | 60,886,049 | 60,886,049 | 60,886,049 | 60,886,049 | 60,886,049 |
| route V | 19,210,416 | 19,210,416 | 19,210,416 | 19,210,416 | 19,210,416 | 19,484,851 | 19,759,286 | 20,033,721 | 20,308,157 | 20,582,592 | 20,582,592 | 20,582,592 | 20,582,592 | 20,582,592 | 20,582,592 |
| route VI | 35,500,508 | 53,472,621 | 71,444,735 | 89,416,848 | 107,388,961 | 102,101,930 | 96,814,898 | 91,527,867 | 86,240,835 | 80,953,803 | 100,238,164 | 119,522,525 | 138,806,886 | 158,091,247 | 177,375,609 |
| route VII | 16,644,305 | 16,644,305 | 16,644,305 | 16,644,305 | 16,644,305 | 16,882,087 | 17,119,869 | 17,357,651 | 17,595,433 | 17,833,215 | 17,833,215 | 17,833,215 | 17,833,215 | 17,833,215 | 17,833,215 |
| total external cost | 283,632,978 | 346,575,497 | 409,518,017 | 472,460,536 | 535,403,055 | 519,162,372 | 502,921,689 | 486,681,005 | 470,440,322 | 454,199,639 | 521,737,970 | 589,276,301 | 656,814,632 | 724,352,963 | 791,891,294 |
| external costs per route [in %] | | | | | | | | | | | | | | | |
| route I | 1.8% | 2.2% | 2.5% | 2.7% | 2.9% | 2.8% | 2.8% | 2.7% | 2.6% | 2.6% | 2.8% | 2.9% | 3.0% | 3.1% | 3.2% |
| route II | 29.5% | 36.4% | 41.2% | 44.6% | 47.3% | 46.4% | 45.4% | 44.4% | 43.2% | 42.0% | 45.3% | 47.8% | 49.8% | 51.5% | 52.8% |
| route III | 23.5% | 19.2% | 16.3% | 14.1% | 12.4% | 13.0% | 13.6% | 14.3% | 15.0% | 15.7% | 13.7% | 12.1% | 10.9% | 9.9% | 9.0% |
| route IV | 20.0% | 16.4% | 13.9% | 12.0% | 10.6% | 11.1% | 11.6% | 12.2% | 12.8% | 13.4% | 11.7% | 10.3% | 9.3% | 8.4% | 7.7% |
| route V | 6.8% | 5.5% | 4.7% | 4.1% | 3.6% | 3.8% | 3.9% | 4.1% | 4.3% | 4.5% | 3.9% | 3.5% | 3.1% | 2.8% | 2.6% |
| route VI | 12.5% | 15.4% | 17.4% | 18.9% | 20.1% | 19.7% | 19.3% | 18.8% | 18.3% | 17.8% | 19.2% | 20.3% | 21.1% | 21.8% | 22.4% |
| route VII | 5.9% | 4.8% | 4.1% | 3.5% | 3.1% | 3.3% | 3.4% | 3.6% | 3.7% | 3.9% | 3.4% | 3.0% | 2.7% | 2.5% | 2.3% |
| sum | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| safed external costs | 3,647,602 | 7,081,628 | 10,515,653 | 13,949,679 | 17,383,705 | 19,857,506 | 22,331,308 | 24,805,109 | 27,278,911 | 29,752,712 | 33,219,856 | 36,687,000 | 40,154,144 | 43,621,288 | 47,088,432 |