Ex post evaluation of major projects supported by the European Regional Development Fund (ERDF) and Cohesion Fund between 2000 and 2013

Rio-Antirio Bridge

Greece

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This report is part of a study carried out by a Team selected by the Evaluation Unit, DG Regional and Urban Policy, European Commission, through a call for tenders by open procedure No 2016CE16BAT077.

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A network of National Correspondents provides the geographical coverage for the field analysis.

The authors of this report are Nick A. Theophilopoulos, Konstantinos Dinis, Roberto Zani and Enrico Maria Bernardis. The authors are also grateful to Prof. Athanasios P. Bellas for his valuable inputs and to all the project managers, stakeholders and beneficiaries who provided data, information and opinions during the field work.

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Cover picture source: Gefyra, SA (author: Ministry of Public Works).

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LIST OF ABBREVIATIONS

AIA	Athens International Airport
ARR	Athens Ring Road
B/C	Benefit/Cost ratio
CBA	Cost/Benefit Analysis
CC	Concession Contract
CFO	Chief Financial Officer
CJV	Construction Joint Venture
CPI	Consumer Price Index
CSF	Community Support Framework
DG REGIO	Directorate-General for Regional and Urban Policy
EC	European Commission
ECU	European Currency Unit
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EIF	European Investment Fund
EMU	Economic and Monetary Union
ENPV	Economic Net Present Value
ERDF	European Regional Development Fund
ERR	Economic Rate of Return
ESIF	European Structural and Investment Funds
EU	European Union
EUR	Euro
FNPV/C	Financial Net Present Value of the investment
FNPV/K	Financial Net Present Value of national capital
FS	Feasibility Study
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GRD	Greek Drachma
I/C	Interchange
IRR	Internal Rate of Return
MEP	Member of Parliament
MEPPW	Ministry of Environment, Planning and Public Works
NPV	Net Present Value
NUTS2	Nomenclature of Territorial Units for Statistics
O&M	Operating & Maintenance
PATHE	Patras-Athens-Thessaloniki-Evzoni
PPP	Public Private Partnership
ROE	Return on Equity

SAC	Supreme Administrative Court
TEN-T	Trans-European transport networks
ToRs	Terms of References
VAT	Value Added Tax
VOC	Vehicle Operating Cost
VOT	Value of Time

EXECUTIVE SUMMARY

This case study illustrates the story of the Rio-Antirio bridge (further called bridge or major project), a major infrastructure investment co-financed by the EU funded Operational Programme 2000-06 "Road Axes, Ports, Urban Development". More specifically, this is an ex-post evaluation assessing the long-term effects produced by the project and disentangling the mechanisms and determinant factors that have contributed to producing these effects. The analysis draws from an ex-post Cost-Benefit Analysis (CBA)[1] and from an extensive set of qualitative evidence, both secondary (technical reports, official reports, press articles, books and research papers) and primary (interviews with key stakeholders and experts have been carried out in the period from October to April 2018[2]).

OVERALL APPROACH AND METHODOLOGY

The overall approach and methodology followed in the evaluation study is briefly recalled hereafter and more extensively in Annex I.

The Conceptual Framework delivered in the First Intermediate Report has been developed to answer the evaluation questions included in the ToR, and further specified and organised in accordance with the study team's understanding. In particular, there are **three relevant dimensions of the analysis**:

- **The 'WHAT'**: this relates to the typologies of long-term contributions that can be observed. The Team classified all the possible effects generated by transport projects (including road, rail, and urban transport projects) under the four following categories: 'Economic growth'; 'Quality of life and well-being' (i.e. factors that affect the social development, the level of social satisfaction, the perceptions of users and the whole population); 'Effects related to environmental sustainability' and 'Distributional impacts'.
- **The 'WHEN'**: this dimension relates to the point in the project's lifetime at which the effects materialise for the first time (short-term dimension) and stabilise (long-term dimension). The proper timing of an evaluation and the role it can have in relation to the project's implementation is also discussed here.
- **The 'HOW'**: this dimension entails reasoning on the elements, both external and internal to the project, which have determined the observed causal chain of effects to take place and influenced the observed project performance. To do this the Team identified six stylised determinants of projects' outcomes (relation with the context; selection process; project design; forecasting capacity; project governance; managerial capacity). The interplay of such determinants and their influence on the project's effects is crucial to understand the project's final performance.

[1] Data, hypotheses and results are discussed in Annex II.
[2] See Annex III for a detailed list of interviewees.

The methodology developed to answer the evaluation questions consists of ex-post Cost Benefit Analysis complemented by qualitative techniques (interviews, surveys, searches of government and newspaper archives, etc.), **combined in such a way as to produce a project history**. CBA is an appropriate analytical approach for the ex-post evaluation because it can provide quantification and monetisation of some of the long-term effects produced by the project (at least those also considered in the ex-ante CBA). However, the most important contribution of the CBA exercise is to provide a framework of analysis to identify the most crucial aspects of the projects' ex-post performance and final outcome. It is worth noting that the purpose of this evaluation is not to compare ex-ante and ex post CBAs and that the results of these assessments are not easily comparable, because even if they rely on the same principles and draw from the established CBA methodology, there are often important differences between how the ex-ante and ex-post assessments were scoped and what data were taken into account. Qualitative analysis on the other hand is more focussed on understanding the determinants and causal chains of the delivery process as well as to assess effects that may be difficult to translate in monetary terms.

MAIN PROJECT FEATURES

The origin of the 'Rio-Antirio Bridge - Major Project' (CCI 2003GR161PR009) **dates back more than a hundred years in the past, in the vision of a Greek statesman. The vision of Charilaos Trikoupis, then Greek Prime Minister (1889)**, **was to cross the Gulf of Corinth, connecting Rio on one side with Antirio on the other, thus opening up a whole new set of trade and travel opportunities from mainland Greece into the otherwise remote Peloponnese**. Though it took many years before this dream became a reality, the challenge was set. **When the bridge was completed in 2004, it was the longest bridge of its type anywhere in the world and it** was named "Charilaos Trikoupis" after the man that envisioned this development more than 100 years before.

The bridge is located along the itinerary of the TEN-T Orient East Mediterranean Core Network Corridor (formerly TEN-T Priority Project No. 7) **and interconnects with two major roads:** the Patras–Athens–Thessaloniki motorway and the Western axis of the Kalamata–Patras–Igoumenitsa road.

The project was implemented as a Public Private Partnership (PPP) initiative. The Rio-Antirio bridge concession contract was signed on the 3 January 1996. **The construction works started in 1998 and the bridge was opened for traffic on the 12 August 2004, right before the start of the Greek Olympic Games. The project costed EUR 888.3 million**.

The Rio-Antirio bridge contract was the first Build Operate Transfer (BOT) PPP concession in the road sector in Greece. It was the second transport PPP initiative after the Athens Eleftherios Venizelos International Airport, whose contract was signed on the 31 July 1995 and whose operation started in March 2001. Also, the project was

the third PPP to be put into operation after the Venizelos airport and the Athens metropolitan area ring road (Attiki Odos)[3].

Since its opening the Rio-Antirio bridge allows crossing the Gulf of Corinth in about 5 minutes, compared to an arduous 240 km detour by road or a 45minutes ferry ride. Despite the bridge serves about 80% of the traffic crossing the strait of Rio-Antirio, ferry services remained in operation and are still available today. **Notwithstanding the economic and financial crisis started in 2008 and still ongoing, the PPP concession is overall performing well**, all this making the Rio-Antirio major project an interesting case for ex-post assessment.

PROJECT PERFORMANCE

Based on the different findings produced by the project analysis, the final assessment of the project performance is presented hereafter, along a set of evaluation criteria.

Project relevance and coherence

The project has been envisioned for more than 100 years. The connection of the strait Rio-Antirio with a bridge was meant to solve many problems, in relation to the connection of Peloponnese to the mainland. In addition, the traffic in the strait was not only local, but also national since the strait is part of the national network connecting Peloponnese and the mainland. For example, the originated traffic in Athens with direction Epirus, Corfu, Albania, etc. was passing through the strait using the ferries for many years. **Ferries were not operational when the weather conditions did not allow navigation across the strait. Because of that, it could happen that ferry rides were delayed by hours, sometimes days**.

Despite its relevance from the functional standpoint, the its construction was always postponed due to technical difficulties in its development since it is located in a seismic area and the significant amount of financial resources required to construct a fixed link between Rio and Antirio. **The opportunity to develop the link came after the accession of Greece to the European Union in 1981 and more specifically after the start of the implementation of the Structural Funds policies and related operational programmes, as well as definition of the TEN-T policies and priority projects**.

During the 1990s studies intensified to investigate the technical and financial feasibility to construct the bridge. **In 1993 the Rio-Antirio bridge was appraised in the framework of a national transport study called GREECE 2010,** that also provided an input for the 1994-2000 and the 2000-2006 EU Community Support Frameworks. **In 1994 the bridge was included in the TEN-T priority project No. 7 and it was subsequently included as a major project in the Operational Programme 2000-06 "Road Axes, Ports, Urban Development".** In this regard it is noticed that the construction of the bridge was synergic with the development of many new highways interconnecting the strait with the other parts of Peloponnese and

[3] The PPP contract of Attiki Odos was signed on the 23 May 1996, just a few months after the Rio-Antirio concession.

mainland Greece, creating a scheme that would dramatically change the national transport infrastructure system.

The bridge is nowadays part of the main motorway network of Greece and belongs to the alignment of the Orient-East Mediterranean Core Network Corridor. **The bridge fully responded and still is coherent with the overall general strategic objectives of the national and European policies on transport and mobility**. It is functionally well integrated with the operation of the main national and European strategic road network.

Project effectiveness

The project effectiveness can be assessed with reference to the 8 objectives of the major project as specified in the introductory report of Law 2396/1995 for the ratification of the concession contract of the Rio-Antirio bridge.

Five out of the 8 identified objectives are strictly related to the direct benefits associated to the availability of the bridge as a transport infrastructure, such as generating travel time savings, completing a missing link in the PATHE TEN-T axis (belonging to TEN-T Priority Axis No. 7 – nowadays Orient-East Mediterranean Core Network Corridor) and enhancing international connections to Italy and Western Europe, reducing congestion and pollution in the ports of Rio and Antirio and improving comfort, reliability and quality of the crossing service. Based on the results of the ex-post CBA analysis and the qualitative evidence collected during our interviews, **all these objectives can be considered fully accomplished**.

The results of the ex-post CBA — with ENPV at the level of EUR 2,185 million and ERR equal to 6.87% — confirm that **the expected effects have materialised to such an extent that the project provides a good social return of the invested resources, making it worthwhile form the point of view of the EU society. Additionally, the risk analysis shows that under the socioeconomic perspective the project has a negligible risk level**, i.e. with negative variations from the reference case of the values of critical variables, there is no probability that the ENPV of the project become negative and a probability of nearly 50% that the expected ENPV and ERR are less than the reference one.

These positive results have been achieved despite delays in the implementation of the Olympia Odos and of Ionia Odos motorways, which have been completed only by mid-2017. The opening for traffic of these two relevant road axes and the further interconnection of these trunk roads with the main local socioeconomic centres in Etoloakarnania (e.g. Agrinio and Mesolongi) are likely to further increase the effectiveness of the project, by maximising its network effect at the national and local levels.

The project was also expected to support local and regional development. **Three of the 8 targets of the project were accordingly identified which related to wider economic benefits**, such as the economic and social development of the territories of Peloponnese, Western Greece (Etoloakarnania) and Epirus, as well as housing development and production sites of the wider area around the bridge. The new crossing was foreseen to enhance the competitiveness of the existing businesses and lead to the establishment of new ones in the isolated areas of the North-Western parts of the country.

While reaching these targets is not solely attributable to the bridge, **the original project concept implied that the project would contribute to achieving those objectives**, all of them relating to wider - in both spatial range and temporal horizon - development goals for the Prefectures of Achaia and Etoloakarnania and the regions of Western Greece, Peloponnese and Epirus. In this regard the analysis performed as part of this ex-post assessment of the Rio-Antirio major project is hampered by the overall limited availability of fact-based evidences concerning most of these wider objectives. However, **the amount of the induced traffic observed on the bridge shows that the project had a relevant impact on the mobility at the regional scale**, and thereby on the geography of the local economy. **Furthermore, interviews have been performed as part of this ex-post assessment which seem confirming that the project is contributing to the achievement of the objectives relating to territorial cohesion and socioeconomic development**. Albeit not allowing for quantification, this suggests that positive wider economic and social impacts were likely generated by the project, although more precise socioeconomic data would be needed to comment on the specific triggered effects.

Project efficiency

The project was implemented on time and at the expected costs. As of the PPP BOT model adopted for its development, implementation and operation, the project proved to be a success and pave the way for other investments in Greece.

The financial sustainability of the project has been assessed based on 2004-2017 data, which is positive. The project investment was co-financed by the EU (CF) and national contribution. The overall level of EU co-funding for this project was 28.5% of the total project costs. Other 22.1% of public funds were provided by the national authorities, while the remaining 49.4% were private funds, secured partly by the private equity of the investor (7.7%) and by an EIB loan (41.7%).

The financial structure of the project proved to be resilient to the effects of the 2008 downturn in the economy, due to a combination of prudent traffic and revenue assumptions at the tendering stage and a relatively low share of private equity. It shall be in fact noticed that, despite the decline in traffic volumes after 2008, the rate of return on the private equity (estimated at 9.30% in our analysis) is still acceptable and in line with the highway construction sector and the assumptions on which the original tender was based. This is also in line with the maximum ROE foreseen in the concession contract (11.50%), which, if reached before 35 full operational years, would trigger the end of the concession period.

EU added value

The construction of the Rio-Antirio bridge was a unique project from the technical, scientific, organizational and even financial and institutional stand points. The implementation of a such large and complex project through a PPP was practically unknown at the time to the Greek public administration, since major road projects were implemented as purely public projects. **The whole process required an unprecedented development of institutional learning for the public decision-making system** since the project was amongst the first major concession contracts implemented in the transport sector in the country.

One of the main enabling factors of the project appears to be a very close vertical collaboration between the Ministry of National Economy and the European Commission in order to develop the required institutional and organisational competences to develop and implement the project. These two bodies were particularly concerned with the availability and performance of the supporting structures and therefore, throughout the implementation period, put forward their modifications to the institutional arrangements and paid particular attention to the overall results of the implementation system. **Another important factor was the contribution of the Cohesion Fund to the major project** that provided the appropriate funds, **without which the development of the bridge as part of a PPP initiative would not have been financially viable**. Moreover, **EIB's involvement, with special expertise in financing major projects, besides ensuring valuable resources, resulted in the creation of such a financial design model that minimised any risks in case of non-completion of the project**.

The successful delivery of the project within the expected deadlines and budget, which at the time was a challenge for Greek projects, highlighted it as a 'good practice' model. **In fact, the administrative heritage of the Rio-Antirio bridge has been successfully exploited in the implementation of other Road Axes projects under the third Community Support Framework CSF (2000-2006).** One of the significant outcomes of this implementation system, was the change in attitudes towards the new organisation of management structures in the context of public utilities and services.

MECHANISMS AND DETERMINANTS

The project overall positive performance is the result of a combination of factors: a good start after lengthy negotiations, good planning and design, a well-grounded selection process, a profitable involvement and commitment from all the relevant stakeholders.

In terms of project determinants, **context is without doubt one the most important pre-requisite of the project's performance**. The Rio-Antirio bridge was in fact in line with the context needs and the objectives of the transport program in Greece and within the European context, as it is part of TEN-T and it has adequate demand for the service. On the face of it, **good managerial capacity and effective project governance were able to promptly provide an adequate response and make financial and technical capacity available for the initiation, implementation and operation of the project**.

The whole project definition and selection process managed by the Ministry of Public Works Special Secretariat EYDE/SERA (now called EYDE/LSEP) **have also been crucial for the appropriate definition and performance of the PPP BOT scheme adopted to implement and operate the project**.

The project preparation and design proved to be very effective, also in the adaptation of the construction solutions at the stages of detailed design at the project implementation stage. **The total costs for the construction of the project were in line with the expected estimates**. **The project time-schedule was also**

respected, and the concessionary company was able to react to a request by the Greek Authorities to speed up the completion of the works in time for the start of the Olympic Games on the 13 August 2004. The bridge opened for traffic the day before the inauguration of the games.

Further to an overall correct estimation of the total project cost and implementation time-schedule, **the project also proved to be based on prudent traffic and revenue forecasts**. **This resulted in the maintaining of the project financial sustainability** even in the current challenging economic environment, considering that the economic crisis started in 2008 has overall caused a decline in traffic by 40%.

CONCLUSIONS

The ex-post assessment of the major project relating to the implementation of the Rio-Antirio bridge supports the conclusion that **the project was overall technically sound from both the infrastructural and functional standpoints**, contributing to the main targets and objectives of the EU transport and cohesion policies. **The project was effectively implemented, the service is operated as expected and the users are overall satisfied with the project.**

The results of the ex-post CBA are positive also confirming that the project is adding value to the EU society, notwithstanding the challenging negative economic context as of 2008. **The analysis seems confirming the financial sustainability of the project and the viability of the PPP BOT scheme** adopted for the development, implementation and operation of the fixed link. Together with the twin PPP BOT Attiki Odos investment, the Rio-Antirio major project is considered a pioneering example of innovative financing that built the legal context and institutional and regulatory framework for the successful extension of the use of PPP contractual solutions to other projects in the transport sector and other sectors. Considering that without the EIB support and contribution from the European Union, the project could not have been implemented, the investment is furthermore a significant case of relevant EU added value.

Since late 19th century, **the implementation of the Rio-Antirio bridge** was a national dream and a project going far beyond local boundaries. Its implementation in 2004 **was a big step towards the completion of the Trans-European Transport Network (TEN-T**), which also contributed **to overcome the isolation of Western Greece, while providing growth prospects in the region**. In this regard it is worth commenting that the benefits generated so far by the bridge are predominantly of local/regional nature. Indeed right after the opening of the bridge an increase in the traffic across the Rio-Antirio strait has been registered. This induced demand is associated to a change in the mobility patterns at the regional scale: more and most of the trips across the bridge are of regional nature or in any case have their origin or destination in the prefectures interconnected by the bridge. **The recent completion of the Olympia Odos and Ionia Odos motorways by mid-2017, will increase long-distance traffic across the bridge and thus also the effects generated by the bridge also at the wider national and international scale. At the same time the completion of these trunk roads and possibly the development of a better interconnection of the main socioeconomic centres in Etoloakarnania with the Ionia Odos (e.g. Agrinio and Mesolongi), are expected to further**

increase the positive results so far achieved by the bridge at the regional scale. Finally, in consideration of the predominance of the use of the bridge at the regional and local scales, the possible further reduction of the tariffs, especially for frequent users or for round trips could be considered which might further amplify the magnitude of the effects generated by the bridge at the regional/local scale especially in terms of regional and economic development.

1. PROJECT DESCRIPTION

The idea of building a fixed crossing between Rio- and Antirio was envisioned more than a hundred years ago by an elder statesman, Charilaos Trikoupis, then Greek Prime Minister (1889). His vision was to cross the Gulf of Corinth, connecting Rio on one side with Antirio on the other, and by that opening up a whole new set of trade and travel opportunities from mainland Greece into the otherwise remote Peloponnese. When the Rio-Antirio bridge was completed in 2004, just in time for the Greek Olympics, it was the longest bridge of its type anywhere in the world. This is the reason why the bridge was named "Charilaos Trikoupis", after the man that envisioned this development more than 100 years ago.

The bridge is located along the itinerary of the TEN-T Orient East Mediterranean Core Network Corridor (formerly TEN-T Priority Project No. 7) and interconnects with two major roads: the intersection of the Patras–Athens–Thessaloniki motorway (which forms part of the European motorway) and the Western axis of the Kalamata–Patras–Igoumenitsa road.

The project was implemented as a PPP initiative. The Rio-Antirio bridge concession contract was signed on the 03 January 1996. The bridge was planned in the mid-1990s and was built by a French-Greek consortium led by the French group Vinci SA. **The construction works started in 1998 and were completed early August 2004. Costed EUR 888.3 million, the bridge opened for traffic on the 12 August 2004, right before the start of the Olympic Games on the 13 August 2004**. **Since 2004 the Rio-Antirio bridge allows crossing the Gulf of Corinth in about 5 minutes, compared to 45 minutes by ferry**. Ferry services remained in operation and are still available today, despite the bridge serving about 80% of the traffic crossing the strait of Rio-Antirio. **Notwithstanding the economic and financial crisis started in 2008 and still ongoing, the PPP concession is overall performing well**, all this making the Rio-Antirio major project an interesting case for ex-post assessment.

The Rio-Antirio bridge contract was the first BOT PPP concession in the road transport sector in Greece. It was the second transport PPP initiative after the Athens Eleftherios Venizelos International Airport, whose contract was signed on the 31 July 1995 and whose operation started in March 2001. The major project was the third PPP to be put into operation after the Venizelos airport and the Athens metropolitan area ring road, Attiki Odos, whose BOT contract was signed just a few months after the Rio-Antirio concession on the 23 May 1996. The construction of Attiki Odos was completed in 2004; its different sections were put into operation between 2001 and August 2004.

This section contains a brief description of the project. The socioeconomic context, the target population and key structural features of the infrastructure and service delivered are outlined in order to give a general description of the project context and objectives.

1.1. *CONTEXT*

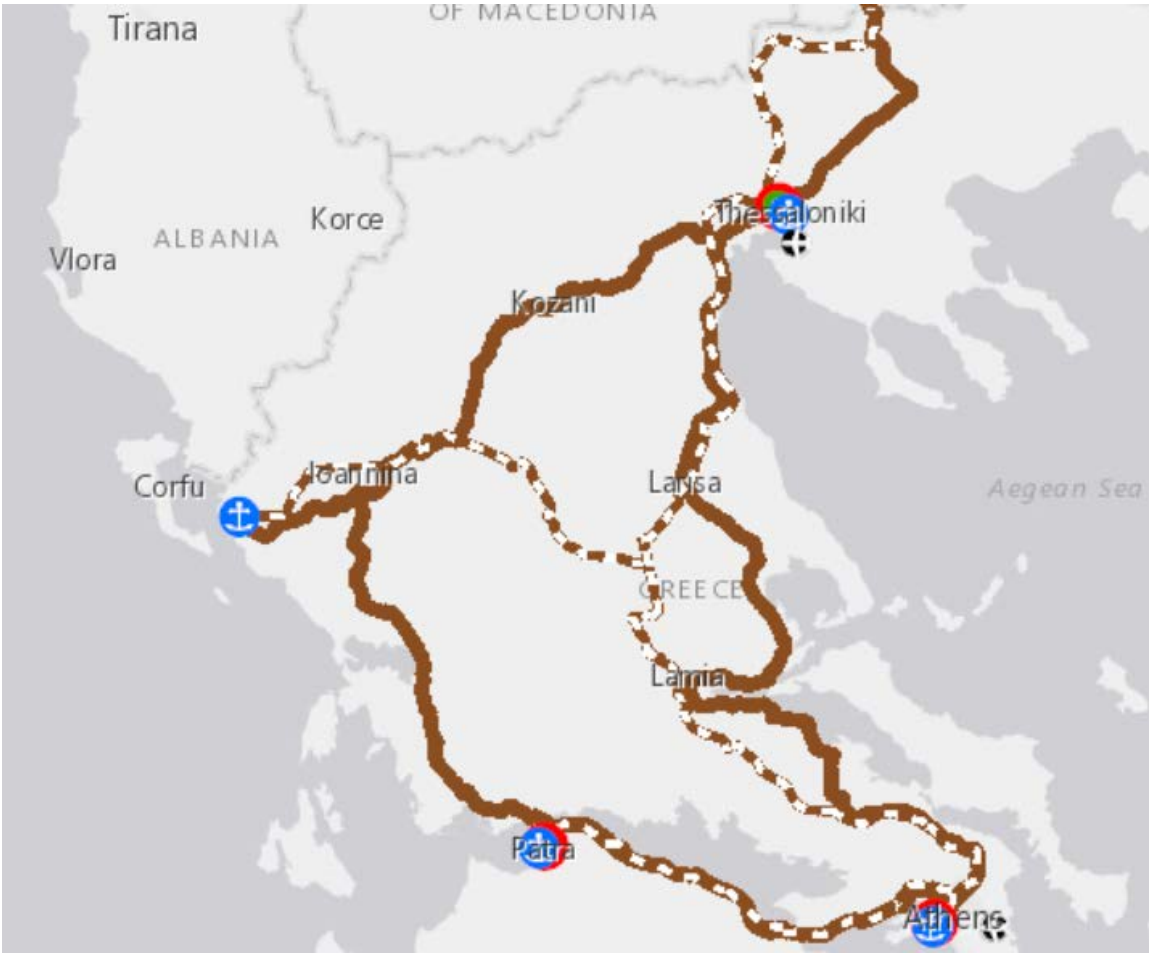
The Rio-Antirio bridge is located in the Region of Western Greece and crosses the Gulf of Corinth connecting Peloponnese with mainland Greece. **The bridge is part of the Western road axis from the Albanian border to Kalamata and connects the PATHE** (Patras-Athens-Thessaloniki) **motorway to the Egnatia motorway**. By providing safe and comfortable access to the ports of Patras and Igoumenitsa it supports gateways to Italy and the rest of Western Europe. **Other key connecting road arteries are Olympia and Ionia Odos**, which have been recently upgraded to motorway standards (works have been completed by mid-2017).

Figure 1. Location of the bridge in the wider context of the Greek motorway network

Source: Gefyra SA

The bridge is indeed part of the main motorway network of Greece. It furthermore belongs to the Orient-East Mediterranean Core Network Corridor.

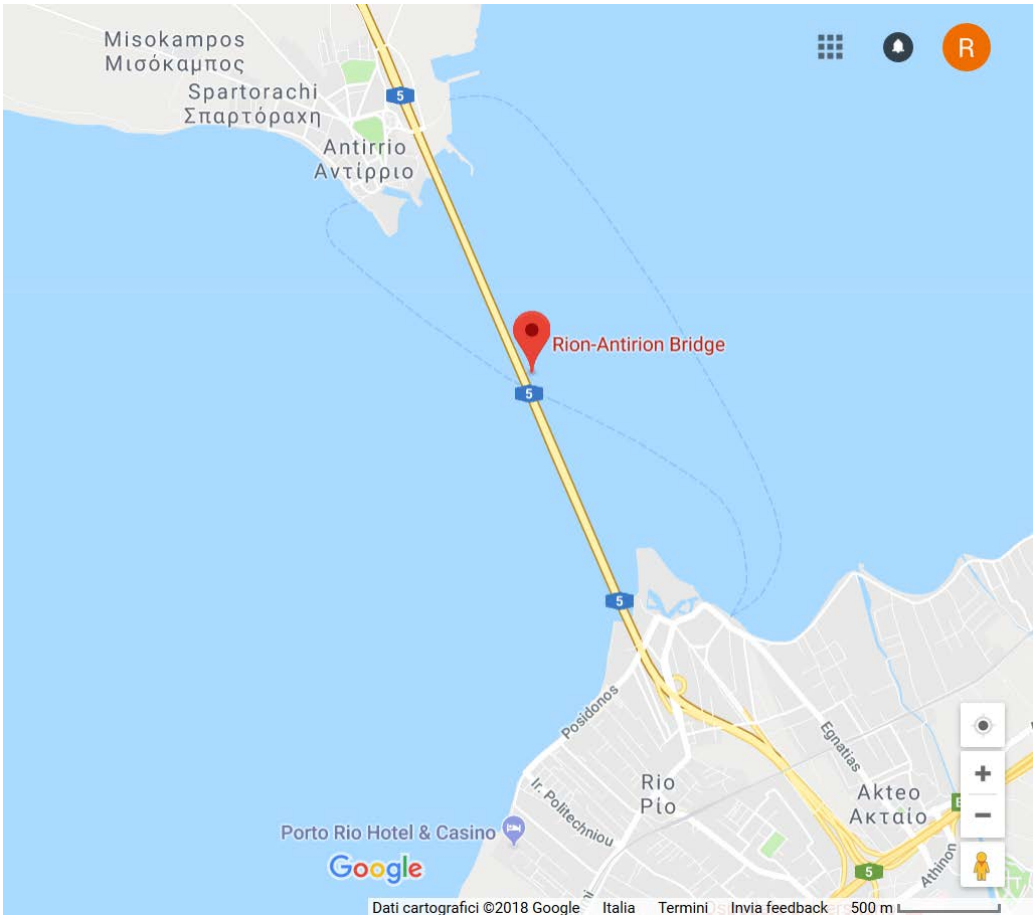
Figure 2. Alignment of the Orient-East Mediterranean Corridor in Greece



Source: TENtec; Notes: continues brown lines represent the road links of the corridor; brown dotted lines represent the railway links of the corridor

The bridge is not the only crossing in operation along the itinerary of the Orient-East Mediterranean Corridor; ferries are also in operation between Rio and Antirio. Services are operated everyday between 5:45 a.m. and 11:45 p.m., with an overall frequency of about 1 ferry every 30 minutes in both directions, for a total of 36 routes planned per day and direction. The frequency depends however on the weather conditions and mainly on the wind direction. The cost of the ferry services as of today ranges between EUR 6.50 for light vehicles to EUR 24.50 for heavy vehicles.

Figure 3. Crossings between Rio and Antirio



Source: Google map

The bridge is in operation 24h a day, 365 days per year. The following table summarises the basic toll schemes applied to cross the bridge. It is worth specifying that further to the basic tariff, a number of frequent users' solutions has been introduced since 2004 and 2005 (epass subscription programmes), which can reduce significantly the cost of the crossing with combinations that can even result in lower prices than the cost of the ferry (i.e. EUR 4.54 each for 16-20 or 21 and more crossings). A round trip card for passenger cars and a round trip card for trucks (Epistrefo 36) are available, allowing cars to cross the bridge for a cost of EUR 6.80 (each crossing), if the return trip is done in three hours-time; and trucks to pay EUR 34.75 for each crossing if the return trip is made within a period of 36 hours. For passenger cars the use of the card may be also convenient for return trips made in a period of 3-4 and 4-5 hours the cost of each crossing resulting in EUR 8.70 and 10.85 respectively. The benefits of the two cards reduce significantly for return trips over 5 hours and 36 hours respectively for cars and trucks (EUR 13.30 for cars per crossing and EUR 41.50 for trucks per crossing). A simulator is also available on the website of Gefyra to the users, to calculate the cost of their needed services.[4]

[4] https://www.gefyra.gr/en/prices/Sundromhtika-Programmata/

Table 1. Rio-Antirio bridge toll rates

Category	Vehicle category	Sub-category	Toll-rate
1	Motorcycles (vehicles with engine and less than 4 wheels)		€ 1.90
2	Private cars (all 4-wheel cars of a height up to 2 m) with or without a trailer or a caravan, up to 2 m		€ 13.30
2	Camping cars		€ 13.30
3	Private cars with a trailer or a caravan, of a height in excess of 2 m		€ 20.00
3	Trucks of a height in excess of 2 m	2 axles	€ 20.00
4	Trucks	3 axles	€ 32.50
5	Trucks	4 axles	€ 41.50
6	Trucks	+ 5 axles	€ 41.50
7	Bus or coach	Up to 20 seats	€ 30.00
8	Bus or coach	20 to 40 seats	€ 42.00
9	Bus or coach	+ 40 seats	€ 65.00

Source: Gefyra SA

As already mentioned, the bridge links the towns of **Rio** at the outskirts of the city of Patras (Prefecture of Achaia, South coast) and **Antirio** (Prefecture of Etoloakarnania, North coast). **The three main prefectures of the region of Western Greece that constitute the zone of influence of the Rio-Antirio bridge are:**

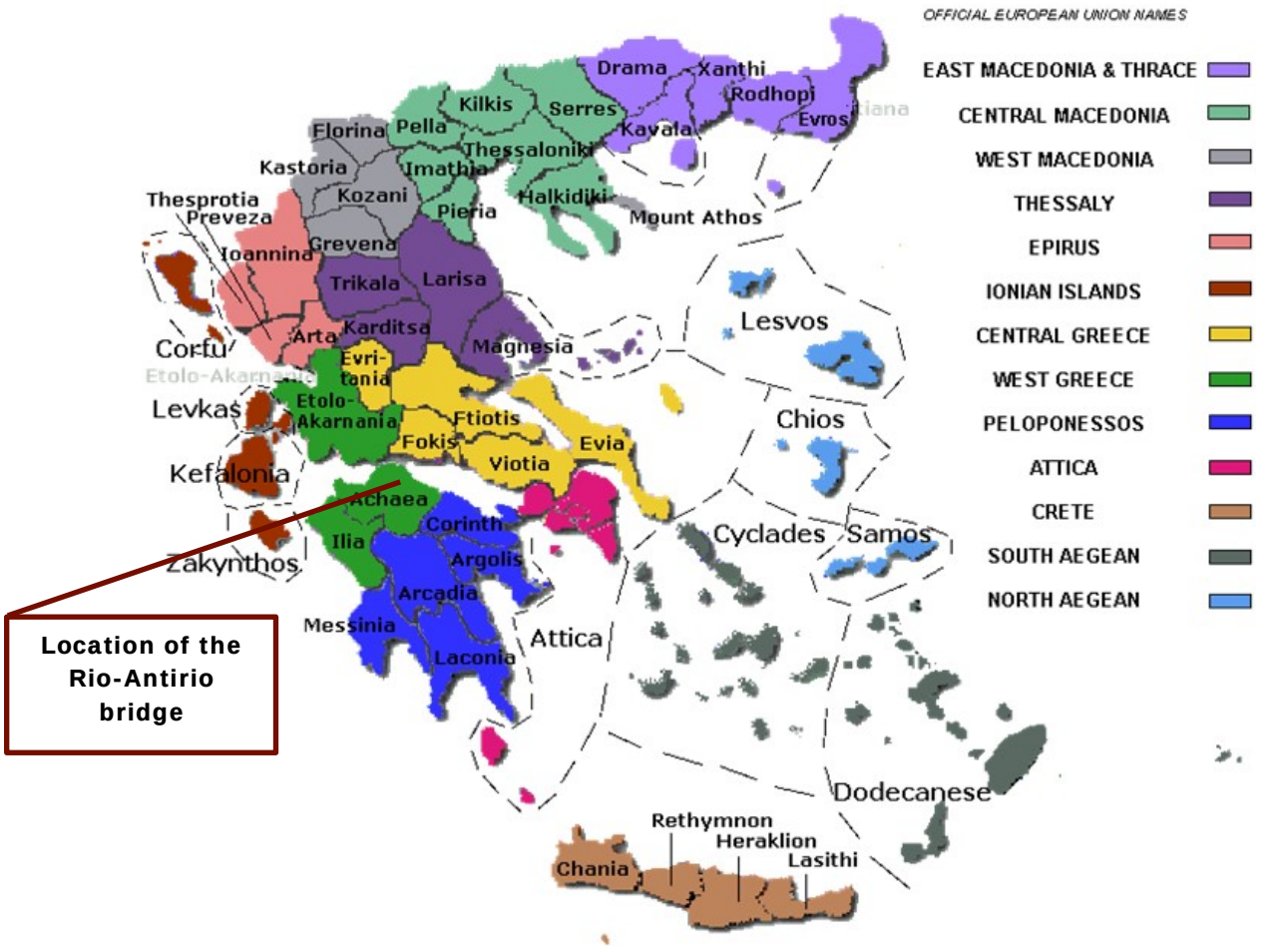
- **Etoloakarnania**;
- **Achaia**;
- **Ilia**.

This is the North-Western part of Peloponnese and Western part of mainland Greece. The total area of this zone is 11,350 km^2 and is 8.6% of the total area of the country. The Prefecture of Etoloakarnania, which is the largest prefecture in the country, has an area of 5,448 km^2, the Prefecture Achaia occupies a total area of 3,274 km^2 and the Prefecture of Ilia covers a total area of 2,621 km^2.

For the most part the lands of Western Greece are mountainous (45.3%) semi-mountainous (25.6%) and only 29.1% are plain. It has extensive coastlines and in all three areas, it borders with the Ionian Sea and the gulfs of Amvrakikos, Patras and Corinth.

The geomorphology of the region presents considerable variety, since this includes mountains with especially high altitude (2,335 m Aroania, Erymanthos 2,222 m, Panachaiko 1,926 m), large natural lakes (Lake Trichonida 95.8 km2, which is the largest in the country, Amvrakia 14.4 km^2, Lysimacheia 13 km^2, Caiaphas etc.) and rivers (Acheloos 220 km, which is the second longest river in Greece, Peneus, Alpheus, Evenus, Selinuntas, Vouraikos, Peiros and Glafkos).

Figure 4. Regions and Prefectures of Greece



Source: https://www.sfakia-crete.com/sfakia-crete/prefecturesregions.html

The following table details the population in total value and percentage for the years 1991, 2001 and 2011 for each prefecture and Western Greece.

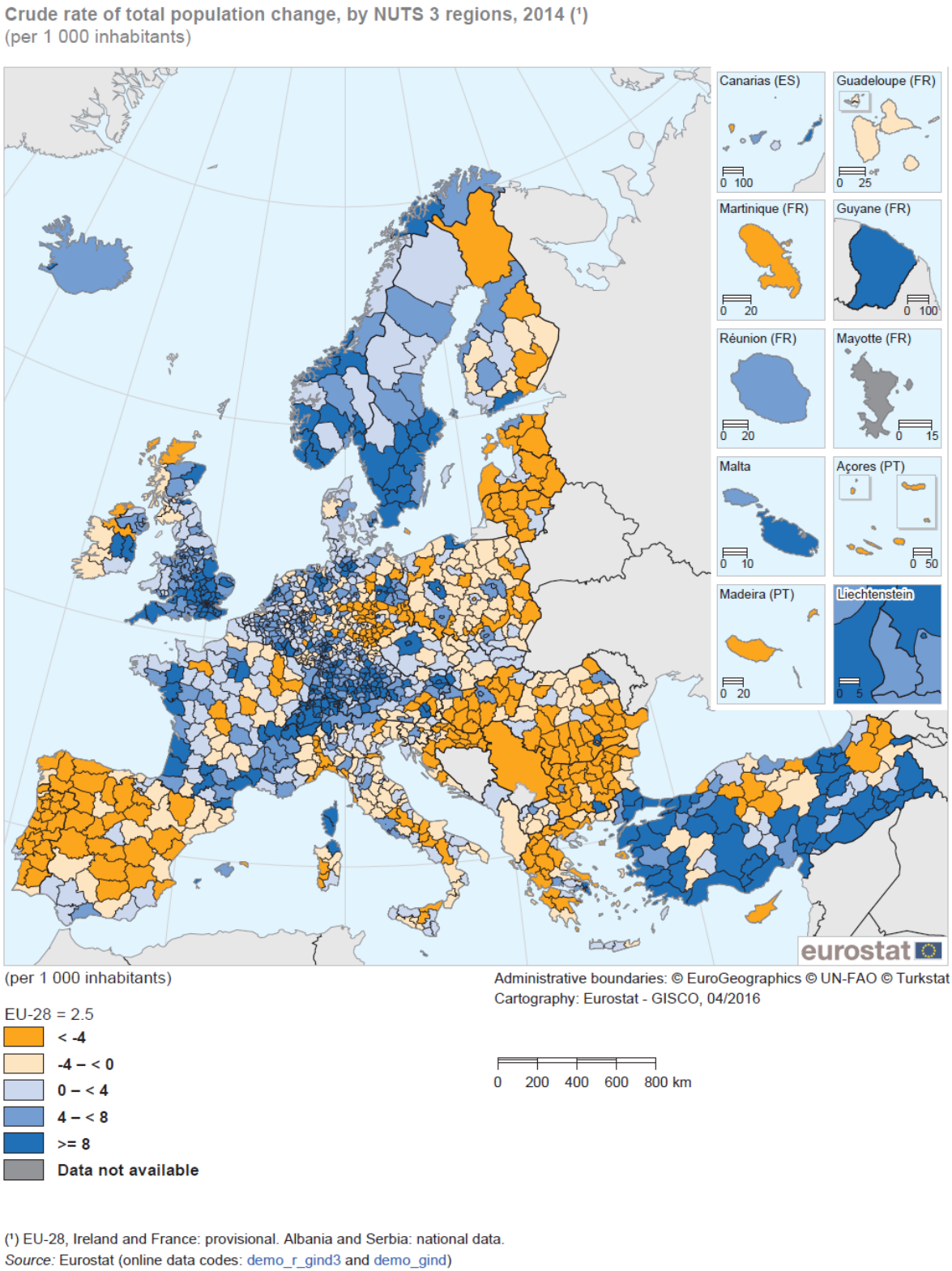
Table 2. Region of Western Greece Population (1991-2011)

PREFECTURE	POPULATION-1991	% - 1991	POPULATION-2001	%- 2001	POPULATION-2011	% - 2011
AIT/NIAS	228,180	32	224,429	30	210.802	31
ACHAIA	300,078	42	322,789	44	309.694	46
ILIA	179,429	26	193,288	26	159.300	23
TOTAL (Region of Western Greece)	**707,687**	**100**	**740,506**	**100**	**679,796**	**100**

Source: ELSTAT

Based on Census statistics, the evolution of the population of the region had an increase between 1991 and 2001, when the bridge was planned and started to be constructed, and a decrease between 2001 and 2011, when the bridge was completed and entered into operation, and when the economic crises of 2008 started.

Figure 5. Population change in the regions of the European Union

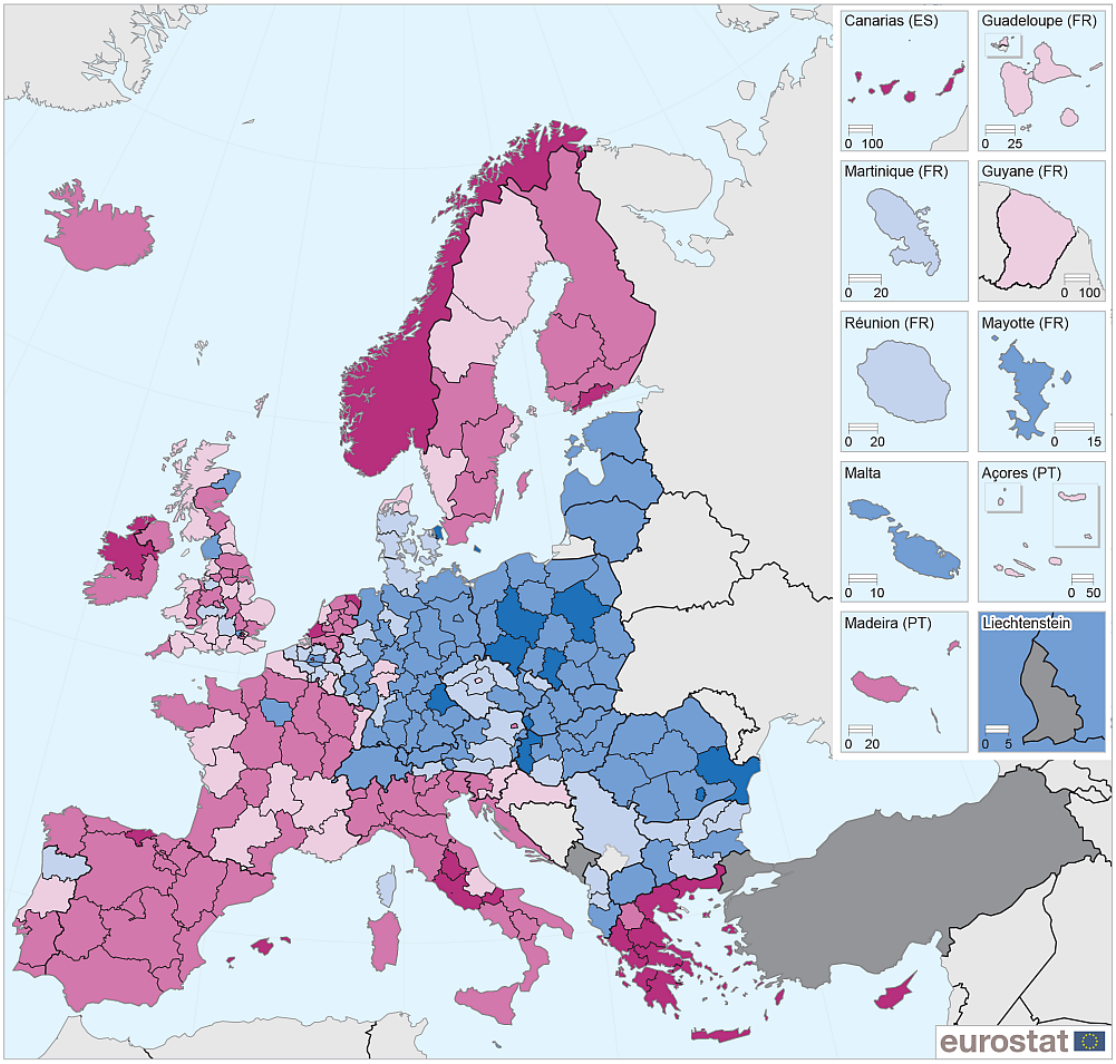


Source: Eurostat

The declining trend in the population is however not specific to the regional context where the bridge is located and in operation; it seems to be rather common to the country, as demonstrated by the analysis displayed in the map above.

Figure 6. GDP per capita change in the regions of the European Union

Change of gross domestic product (GDP) per inhabitant in purchasing power standards (PPS) in relation to the EU-28 average, by NUTS 2 regions, 2007–2015
(percentage points difference between 2007 and 2015)



(percentage points difference between 2007 and 2015)

EU-28 = 0
< -15
-15 – < -5
-5 – < 0
0 – < 5
5 – < 15
>= 15
Data not available

Administrative boundaries: © EuroGeographics © UN-FAO © INSTAT © Turkstat
Cartography: Eurostat - GISCO, 07/2017

0 200 400 600 800 km

Note. Ireland: 2007–2014. Albania: 2008–2014. Norway, Switzerland and Serbia: national data. Switzerland: provisional.
Source: Eurostat (online data codes: nama_10r_2gdp)

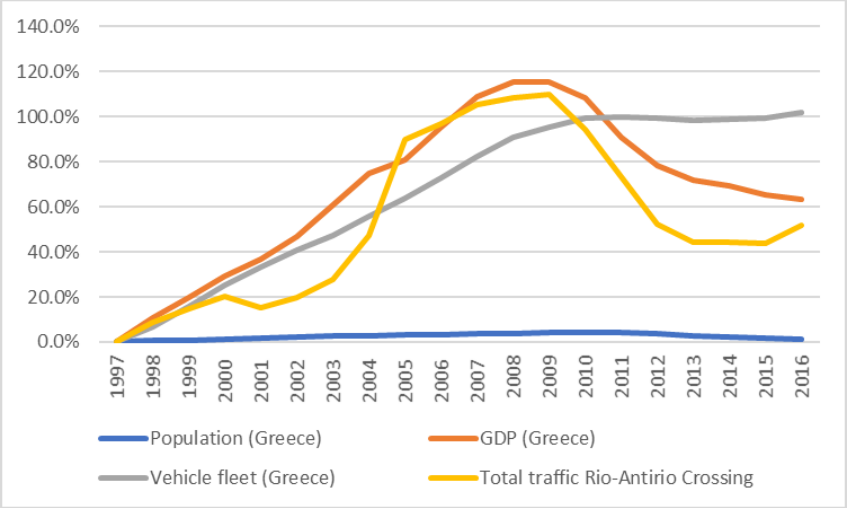
Source: Eurostat

Concerning macro-economic trends, the analysis of the GDP per capita between 2007 and 2015 in the above chart shows that Greece overall, including the local

context of operation of the bridge, has been significantly affected by the economic and financial crisis.

The graph below shows the trends in the main socioeconomic drivers of traffic growth and the traffic on the Rio-Antirio crossing, including both ferries and the road fixed link.

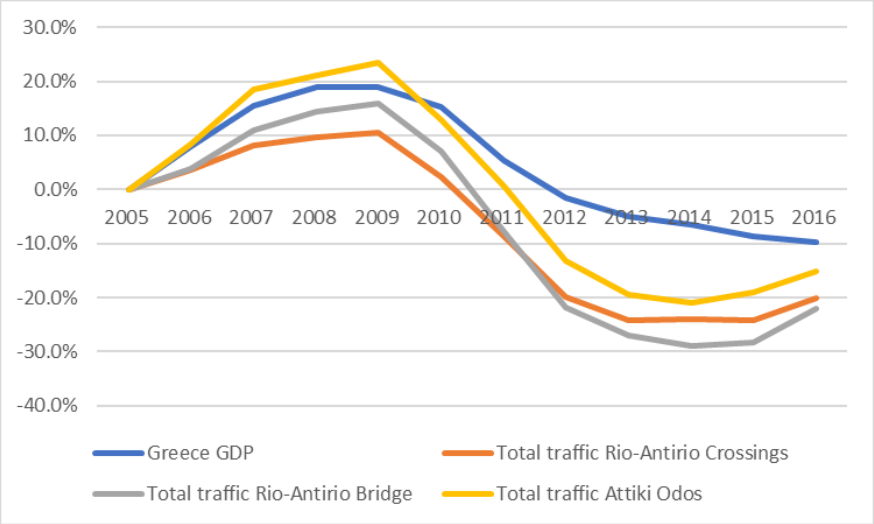
Figure 7. Main socioeconomic and traffic trends



Source: Authors, based on ELSTAT and Gefyra

The traffic trend of the Rio-Antirio is clearly correlated with the GDP and growth of the vehicles' fleet, much more than with the population. The traffic was particularly affected by the crisis since 2008. **At the comparison with other motorways in Greece,** i.e. the other PPP concession Attiki Odos also opened for traffic in 2004, **the Rio-Antirio bridge does not seem to show a significantly different performance in terms of overall trend**. Especially with reference to the financial crisis, it is noticeable that the operation of the two infrastructure was affected with a reduction of approximately 40% of the traffic. In addition, a recovery in traffic is also visible in the last three years which is again similar for the two projects, with an overall level of traffic which is still below the levels of the pre-recession period.

Figure 8. GDP and traffic trends



Source: Authors, based on ELSTAT, Gefyra and Attiki Odos

The overall similar pattern of traffic for the two concessions seems to point to similarities also in the use of the infrastructure, a mix of long-distance and regional/local traffic, where the regional component seems prevailing.

Table 3. Origin/Destination pairs by prefecture – Rio-Antirio Crossings – share of traffic in % of total traffic

OD PAIRS		BRIDGE 2015	BRIDGE 2013	FERRY 2015	FERRY 2013
ACHAIA	ETOLOAKARNANIA	45.2%	36.4%	41.4%	44.0%
ETOLOAKARNANIA	ATTICA	16.0%	21.8%	13.2%	14.8%
IOANNINA	ATTICA	5.8%	6.8%	5.8%	6.0%
ARTA	ATTICA	5.0%	4.4%	4.0%	3.4%
ACHAIA	FOKIDA	3.8%	3.0%	3.6%	3.0%
PREVEZA	ATTICA	2.8%	3.0%	1.0%	0.6%
ETOLOAKARNANIA	KORINTHOS	2.6%	1.4%	3.8%	2.2%
LEFKADA	ATTICA	2.4%	2.6%	0.8%	1.0%
ACHAIA	IOANNINA	2.2%	1.2%	3.0%	6.0%
ACHAIA	THESSALONIKI	2.0%	1.0%	0.4%	0.8%
CYCLADES	ATTICA	1.8%	2.4%	0.8%	0.8%
ACHAIA	ARTA	1.6%	1.0%	3.4%	2.2%
OUTER	ATTICA	1.6%	0.8%	5.4%	3.2%
ETOLOAKARNANIA	ILIA	1.4%	1.0%	5.2%	2.2%
ORIGIN OR DESTINATION IN ETOLOAKARNANIA, ACHAIA OR ATTICA		**94.2%**	**86.8%**	**91.8%**	**90.2%**
OTHER OD GENERATORS		**5.8%**	**13.2%**	**8.2%**	**9.8%**

Source: Gefyra

On the basis of the available data on the origins and destinations of the Rio-Antirio bridge, it is indeed worth to notice that the highest share of traffic is of regional nature. Actually, the highest percentage of flows concentrates between

the two prefectures of Etoloakarnania and Achaia, with over 40% of the traffic share at 2015 on both the bridge and the ferry crossings.

The analysis of the data shows that 9 out of 10 users either of the bridge or of the ferries have their origin or destination in Etoloakarnania, Achaia or Attica. More specifically (see table below) 6 out of 10 have their origin or destination in the mainland, 5 to 10 in Achaia and 3 to 10 in Attica.

Table 4. Origin or Destination – Rio-Antirio Crossings – share of traffic in % of total traffic with origin or destination in a given territory

ORIGIN or DESTINATION	BRIDGE 2015	BRIDGE 2013	FERRY 2015	FERRY 2013
ETOLOAKARNANIA	65.2%	60.6%	63.6%	63.2%
ACHAIA	54.8%	42.6%	51.8%	56.0%
ATTICA	35.4%	41.8%	31.0%	29.8%

Source: Gefyra

Table 5. Trip purpose – Rio-Antirio Crossings

PURPOSE	BRIDGE 2015	BRIDGE 2013	FERRY 2015	FERRY 2013
Professional	31.3%	32.8%	35.6%	35.4%
Personal	23.4%	37.8%	36.0%	24.1%
Recreational	32.5%	23.8%	25.9%	31.3%
Daily Work	12.8%	5.6%	2.5%	9.2%

Source: Gefyra

Regarding trip purposes, the share in terms of use of the Rio-Antirio Crossings is quite balanced between professional, personal and recreational purposes. Commuting represents the lowest share. Higher value of time (sensitivity to travel time savings) for recreation purposes together with reliability for professional and commuting trips could explain differences between the 2015 and 2013 data. The decrease in the share of trips related to personal purposes could be associated to higher sensitivity to operating costs in a persisting negative macro-economic context.

Table 6. Trip purpose – Period of the week

PURPOSE	MONDAY	TUESDAY	FRIDAY	SUNDAY
Professional	32.0%	36.0%	34.0%	33.0%
Personal	30.0%	36.0%	24.0%	26.0%
Recreational	24.0%	16.0%	34.0%	37.0%
Daily Work	13.0%	12.0%	9.0%	4.0%

Source: Gefyra

The distribution of the trips by purpose over the week period shows that practically no differences with respect to professional travels; personal and commuting trips are

higher over the week, whereas recreational journeys are more frequent during the week-ends.

In line with the prevailing component of regional traffic using the bridge and with the overall improvement of the accessibility of the prefectures in Western Greece from other regions, as further detailed at Chapter 3 below **most of the effects attributable to the project are generated at the local/regional scale**. The recent completion of the Ionia and Olympia Odos in 2017 are likely to further increase the capacity and magnitude of the benefits associated with the construction and availability of the bridge.

Whereas traffic data for Ionia Odos are not available at present, the analysis of the data for Olympia Odos for the period 2009-2017 shows that the completion of the works in 2017 has significantly contributed to the increase of the traffic on this road (almost 20% growth compared to 2016). **Whilst the positive rates registered by all the considered roads in recent times is also due to socioeconomic factors external to the network development, it is also clear that one of the factors that the bridge registers almost 10% increase in traffic in 2017 is also the result of the of the completion of the Olympia and Ionia Odos in 2017**. On this basis it is reasonable to expect a further increase in traffic on the bridge in the future thanks to network improvement and upgrading effects.

Table 7. Traffic trends on Olympia Odos

Year	Zevgoliato/Kiato to Patras			Rio-Patras to Athens			Both Directions	
	Light	Heavy	Total	Light	Heavy	Total	Total	Increase-Decrease
2009	3,647,444	554,668	4,202,112	3,007,641	483,505	3,491,146	7,693,258	
2010	3,243,414	518,577	3,761,991	2,553,048	427,984	2,981,032	6,743,023	-12.35%
2011	2,757,809	414,866	3,172,675	2,081,986	337,897	2,419,883	5,592,558	-17.06%
2012	2,354,272	349,929	2,704,201	1,753,376	286,070	2,039,446	4,743,647	-15.18%
2013	2,173,292	333,233	2,506,525	1,637,421	279,889	1,917,310	4,423,835	-6.74%
2014	2,100,340	366,672	2,467,012	1,606,037	302,715	1,908,752	4,375,764	-1.09%
2015	2,091,906	368,783	2,460,689	1,603,880	320,756	1,924,636	4,385,325	0.22%
2016	2,126,829	406,934	2,533,763	1,641,685	351,031	1,992,716	4,526,479	3.22%
2017	2,449,055	459,266	2,908,321	2,079,524	386,132	2,465,656	5,373,977	18.72%

Source: Olympia Odos, SA

1.2. *PROJECT OBJECTIVES*

The objectives of the major project are clearly specified in the introductory report of Law 2395/1996 for the ratification of the concession contract of the Rio-Antirio bridge. More specifically, the report specifically mentions the following 8 specific objectives:

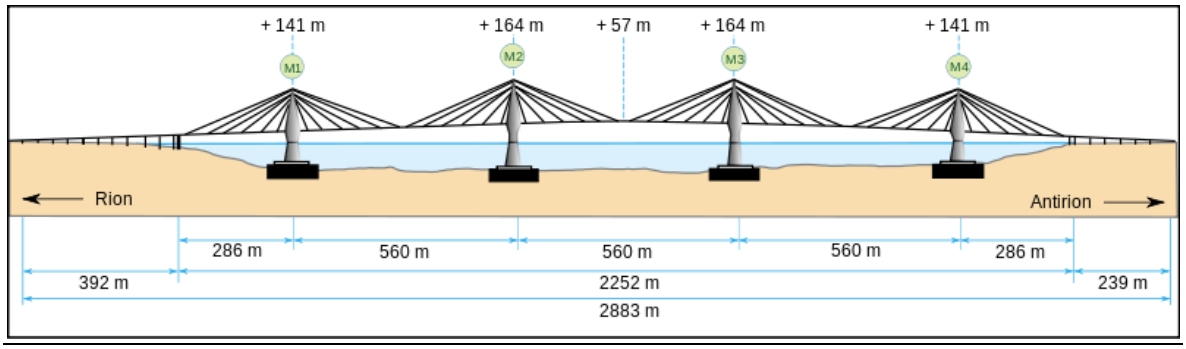
1. The connection between Rio and Antirio was undertaken by ferry-boats and the average crossing time was 45 minutes. The bridge aimed to decrease travel time providing, consequently, fast and safe movement of people and goods and a new prospect for the development of the regions of Peloponnese and Western Greece. **The bridge would decrease crossing travel time per car by about 40 minutes, and consequently the total cost of crossing the strait**.
2. **The bridge had to provide a segment of PATHE TEN-T (belonging to TEN-T Priority Axis 7 – nowadays Orient-East Mediterranean Corridor**).
3. **The bridge had to diminish the pollution and general unrest caused by the car and truck congestion in the ports of Rio and Antirio which would become free of congestion**.
4. **The bridge, as a part of the Western Road Axis from the Albanian border to Kalamata (on the South-West of Peloponnese), would have connected PATHE with Egnatia Road, which were the two TEN-T priority axes at that time, enhancing the country's connection to Italy and the rest of Western Europe through the ports of Patras and Igoumenitsa**.
5. **The new fixed link was expected to improve the comfort, reliability and quality of the crossing service and ensure the continuation of service regardless of weather conditions**.
6. **The bridge was assumed to contribute to the economic and cultural development of the geographical areas of Peloponnese, Western Greece (Etoloakarnania) and Epirus**.
7. **The project was also deemed to provide a basis for the housing development and the production restructuring of the wider area around the bridge**. For this purpose, special plans were foreseen to be conducted and applied for the Gulf of Corinth, the municipality of Rio and the prefectures of Achaia and Etoloakarnania, **as well as restoration works for the Byzantine castles of Rio and Antirio**.
8. **The bridge was finally expected to enhance the competitiveness of businesses and lead to the establishment of new ones in the isolated areas of the North-Western parts of the country as well as the socioeconomic and cultural development in these areas**.

1.3. *STRUCTURAL FEATURES*

The Rio-Antirio bridge is a five-span cable-stayed bridge with three inner spans of 560 m and two side spans of 286 m each. **It includes a fully suspended continuous deck of 2,250 m plus two approach viaducts**, one 392 m long on the Rio side and the other 239 m long on the Antirio side, resulting in a total length of

2,880 m. **The deck is 27.2 m wide and contains two traffic lanes plus a safety lane and a pedestrian walkway in both directions**.

Figure 9. Elevation Chart of the bridge



Source: Gefyra

The massive four bridge pylons measure 220 m (slightly smaller for the outer two) from the sea bottom to the pylon heads and rise to elevations of 155 m above sea level, providing ample shipping clearance (52 m in height) at the centre of the gulf between the two largest pylons.

Figure 10. Rio-Antirio bridge under construction

Source: Gefyra

The bridge life durability is 120 years. The Rio-Antirio bridge has been built to withstand the collision of a 180,000-ton oil tanker traveling at 16 knots (a horizontal impact load equal to 28,000 tons), winds of up to 250 km/hour, deck movements from seismic activity of up to 2m in all directions between two adjacent piers and tectonic fault spreading of approximately about 1.6 cm per year (2-5 m in 125 years). Lastly, with the incorporation of a stringent design for seismic loading, the bridge can withstand ground accelerations equal to 0.5 g, maximum spectral accelerations equal to 1.20 g between 0.2 and 1.0 seconds and earthquakes of magnitude 7 on the Richter scale.

The bridge received the 2006 Outstanding Structure Award from the International Association for Bridge and Structural Engineering. In 2011 the bridge was featured on TV in an episode of Richard Hammond's Engineering Connections. In 2015, construction of the bridge was chronicled in the first episode of the Science Channel series "Impossible Engineering".

The investment costs of the project, with reference to the main project elements are depicted in the table below: **the most relevant share of the budget is allocated to the bridge construction** (EUR 748.94 million out of approx. 888.3 million, corresponding to 84,32% of the total project cost).

Table 8. Investment cost breakdown by project component (EUR)

COST ITEM	NOMINAL VALUE (EUR)	PRESENT VALUE (EUR 2017)
Technical support	3,686,741	11,823,934
Land acquisition	60,505,762	171,039,790
Construction	824,066,646	2,216,323,161
Total	**888,259,149**	**2,399,186,885**

Source: Authors based on information provided by the Ministry

2. ORIGIN AND HISTORY

2.1. *BACKGROUND*

As summarised in a comprehensive report including a detailed description of the history elaborated by the OMEGA Centre for Mega Projects in Transport and Development of the Bartlett School of Planning at the University College London, as also confirmed with the Ministry of Transport and Gefyra, **the first conception of the Rio-Antirio bridge as a rail link project dates back to 1889, at the time the Greek railways were initially planned and developed**. For many years, the bridge had been a vision project, however, it took almost a whole century until the Greek State managed to invite tenders for building a fixed link between Northwest Peloponnese and the mainland. In 1964, initial geotechnical surveys were conducted in the strait between Rio and Antirio (Kaiafa, 2003) and from 1974 to 1977 two national and international conferences took place about the potential solutions for the implementation of a link, generating a serious scientific discourse (Gefyra S.A, 2005, Kouloumbis, 1078).

In 1980, the Greek State decided to invite tenders for building the fixed Rio-Antirio bridge. Unfortunately, this first invitation did not proceed beyond the first phase, which included expressions of interest and general suggestions, because there was no interest from the construction companies. As a result, the tender was cancelled (Law 2395/1996, Gefyra SA, 2005).

From 1981 to 1985, the centre-to-left wing political party “PASOK” (that won the national election in 1981) excluded the bridge from its initial agenda (Gefyra SA, 2005). However, **by 1986 and in view of the potential heavy EU funding that Greece was about to obtain thanks to its entry into the European Union, the same government (PASOK) started envisioning an ambitious program to modernize transport infrastructure and Rio-Antirio bridge re-entered the agenda**. The Ministry (MEPPW: Ministry of Environment, Planning and Public Works) started contacting invited teams from GTM (a French Engineering company acquired by the French construction company Vinci in 2001) and other large experienced constructors from abroad to explore the feasibility of potential large transport projects located mainly in Athens but also the bridge, in spite of the uncertainties related to the technical feasibility of the project, given the very high seismic activity of the area (Gefyra SA, 2005).

The feedback from GTM in early 1987 was that a link could be a cable stayed bridge, despite the great deal of unknown physical and environmental conditions in the strait (Gefyra SA 2005). The Ministry by mid-1987 had hired consultants and engineers to prepare the tender documentation and had also already commissioned geotechnical surveys, through- drillings under the seabed. The surveys proved that the subsoil was extremely unstable, so the idea of an underwater tunnel was abandoned (Gefyra SA, 2005). **In 1987, a new international tender call for the design, construction and financing of the project, through public work’s procurement, begun**. At the end of March 1988 five consortia submitted their proposals (Gefyra SA, 2005, Law 2395/1996) and after prolonged evaluations a French group (led by GTM) gained

ground (Gefyra SA, 2005). **However, the state had still doubts on some aspects of the technical offers and moreover had serious worries about how much the actual final cost of such a technically complex project would be and how this cost would be financed**.

Table 9. Main milestones in the history of the Rio-Antirio Bridge

YEAR	EVENT
1889	Charilaos Trikoupis, Greek Prime Minister, publishes a governmental program for the expansion of the railway network of West Peloponnese and West Sterea Ellada. However, the expansion of the rail link is not initiated (Law 2395/1996).
1964	A technical commission was established to conduct geotechnical surveys in the strait between Rio and Antirio but the effort did not show any significant progress (Kaiafa, 2003).
1975-1974	The Technical Chamber of Greece organises two conferences (one in early 1975 and another in late 1975) for potential solutions for a link between Rio and Antirio (Gefyra SA, 2005).
1977	An international conference is organised in Patras to investigate the potential implementation of a link between Rio and Antirio, where scientists are invited from all over the world, and a serious scientific debate is initiated (Gefyra SA, 2005, Kouloumbis, 1978).
1980	The first international call for proposals for the construction of the Rio-Antirio bridge as a public work is launched. All types of links would be accepted in the technical offer (tunnel, floating bridge, suspension or cable- stayed bridge) but the tender does not progress beyond the first phase involving expression of interest and proposals, since construction companies did not express adequate interest (Gefyra SA, 2005, Law 2395/1996).
1981	The centre-left wing political party PASOK won the national elections and excluded the bridge from its initial agenda (Gefyra SA, 2005). In general, the period from 1981 to 1985 is considered as anti-mega project, given the weaknesses of the state budgets and the prioritization of policies regarding social services and wages enhancement.
1986	In view of the potentially large amount of EU funding that Greece was about to obtain following its accession to the EU, the government (PASOK) envisions an ambitious program of modernisation of the transport infrastructure and the Rio-Antirio bridge re-appears on the agenda. The Government develop contacts with invited teams from GTM and other large experienced constructors from abroad to explore the feasibility of potential large transport projects located mainly in Athens as well as the bridge.
1987	The feedback from GTM in early 1987 was that a link could be a cable stayed bridge (Gefyra SA 2005). The Ministry by mid-1987 had hired the Greek engineering company Efpalinos Techniki and the British Rendel Palmer & Tritton to prepare the tender documentation, and had commissioned geotechnical surveys (through drillings under the seabed). The surveys proved that the subsoil was extremely unstable, so the idea of an underwater tunnel was abandoned (Gefyra SA, 2005). Before the end of 1987, the Ministry announced an international call for tender for the design, construction and financing of the bridge (not on a concession basis but on the basis of offset provisions) (Law 2395/1996).
1988	At the end of March 1988 five consortia submit proposals (Gefyra SA, 2005, Law 2395/1996). Two of them are disqualified before the opening of the financial bids, because they are not compatible with the tender requirements, while the remaining three offers had serious technical issues that required further investigation (Gefyra SA, 2005, Law 2395/1996). The three approved offers were submitted from the French company GTM and the German Krupp-Thyssen (both proposing the construction of a cable-stayed bridge), and a Greek-Italian group of companies proposing a suspended bridge (Gefyra SA, 2005, Law 2395/1996). However, the state still had doubts on some aspects of the technical offers and moreover had serious worries about how much the actual final cost of such a technically complex project would be and how this cost would be financed. According to Tzanavara (1996) the ministries asked the three bidders to further improve their offers and some more studying of the project took place in the following period.
1989	In early 1989, while PASOK was still the governing party, GTM initiated a discussion with the state about the benefits of a potential PPP arrangement for the procurement of the project. However, serious political unrest, from June 1989 onwards, resulted in the suspension of the procedures due to the reluctance of the transitional governments to make a decision for such a big project (Gefyra SA, 2005).
1990	The project is back on the spotlight, but in a new framework: the project will be tendered as a PPP concession and negotiations between the consortium led by GTM (acquired by Vinci in 2001) and the state started with the confidence that a concession was the best way to proceed to ensure the total cost did not burden the state budgets and also to transfer construction risk to the constructor

YEAR	EVENT
	(Gefyra SA, 2005).
1990	The second competition (launched in 1987) is cancelled (Gefyra SA, 2005, Law 2395/1996).
After 1990	Transportation between Greece and Western Europe through Yugoslavia has almost ceased because of the war. Now, the main non-air accessibility to Western Europe is through the Adriatic Sea and the ports of Igoumenitsa and Patras. So port traffic is increasing and the bridge together with the upgrade of the Western road axis and its integration with the national road network becomes of critical importance.
1991	The Ministry launches a new tender process, the third in sequence, for a concession-PPP for the design, construction, financing and operation of the project (Gefyra SA, 2005, Law 2395/1996). Seven groups express interest in this competition and six of them are pre-selected (Law 2395/1996).
Summer 1992	New drillings to investigate and appraise the sea bottom, required for the design of the bridge, were undertaken (Gefyra SA, 2005).
Autumn 1992	The new tender is released, but the risk-sharing proposed by the tender call is seen as inappropriate by both private parties and the banking sector. The group GEFYRA makes a series of comments and suggestions, several of which were accepted (Gefyra SA, 2005).
1993	The tender process is officially launched based on the results of investigations that have taken place and the proposals of bidders that were accepted (Gefyra SA, 2005).
	The Rio-Antirio bridge is appraised in the framework of a national transport study called GREECE 2010 that also provided an input for the 1994-2000 and the 2000-2006 EU Community Support Frameworks. The study produces a critical input for the accurate appraisal of the traffic of the bridge since it considers the impact of the gradual realisation of an upgraded national highway network linked with the bridge. The study refers to the Rio-Antirio bridge as a vital link of a national transportation network development plan that aims (Transport Research and Development International, 1995).
1993	After a number of postponements requested by the bidders, 1 December was set as the deadline for the submission of bids. Only two bids were submitted, the consortium Rio-Antirio (Greek- Dutch led by Boskalis and Parnon) and the GTM (acquired by Vinci in 2001) led consortium (French-Greek) GEFYRA (Law 2395/1996). The Competition Commission rejected the former as inconsistent with the terms of the tender because they proposed a tunnel while the tender requirements were for either a high or a floating bridge. So Gefyra became the preferred bidder (Gefyra SA, 2005).
1994	The EC Essen summit identifies 14 priority transport projects (TEN-T). These included the PATHE motorway. The Rio-Antirio bridge is incorporated into PATHE (Gefyra SA, 2005). This was regarded as an absolutely critical milestone for the realization of the bridge.
	The state and Gefyra maintained active communication and were working for a shared aim to find long-term lending for the project. They realized that the bridge had to be incorporated in the TEN-T priority projects; otherwise the EIB would not be willing to provide long-term lending and it would be rather impossible to find another lender, other than EIB, to provide a 20-25 years maturity loan on a project like this in Greece. The state, just a few months before the EC Summit in Corfu (where the Christophersen Group would put forward the priority projects), prepared together with Gefyra the required documentation to be handed to the Greek representative in the Christophersen Group. The Corfu EC Summit considered seriously the request for the Rio-Antirio bridge to be incorporated into the PATHE axis (as a vertical connection to PATHE before Patras) and the next EC Summit in Essen officially confirmed that the bridge belongs to the PATHE Priority project. Extremely critical had been the role of the Prime Minister Papandreou in promoting the project in the EC summits. After that decision, EIB had to revise its position regarding the funding of the bridge, according to the Community's interest in terms of the transport development priorities defined at the EC summit (EC 1994).
1995	The European Commission examined the lawfulness of the tender, after the appeals of competitors on the grounds of the tender procedures and the financial offer of Gefyra, which contradicted the tender requirements (and also that the technical offer was not based on a previous application and did not have a definite and finalised approach to various technical matters). A crucial issue of dispute was that the financial offer of Gefyra had significant inconsistencies with the demands of the tender call along with the fact that competition in the bidding was poor. However, Gefyra had informed the state at a very early stage that the tender call was not appropriate for a proper concession risk-sharing and that the offer that would be submitted would deviate at various issues that later would have to be legally fixed. The European Commission finally rejected the appeals.
1996	The concession contract is signed by the Greek Government and Gefyra SA (Gefyra SA, 2005, Trova and Koutras, 2001, Himoniti, 2003). In general, there were many issues that needed to be properly contractualised in order for the project to be bankable and for both Gefyra and the state to feel partners in a fair deal. Those issues had principally to do with the risk allocation balance and

YEAR	EVENT
	mechanisms such as risk allocation of force majeure, which had to be clarified, well defined and allocated properly. Another major issue was the control of the design and progress of work that had to be assigned to an independent checker and an independent supervisor since the state was not capable of carrying out such a job for such an innovative and technically complex project, despite the fact that the Ministry initially did not want to out-source and neutralise the control.
	A critical decision made just after signing the concession contract was the agreement between the state and the concessionaire to sign the so-called 'Contracts before the effective date'. These contracts, which were executed in the period between the signing of the Concession Contact and the financial close, allowed the implementation of geotechnical surveys in the subsoil of the seabed. These works were necessary for the confirmation of the construction design assumption and the progress of the final design and were paid for exclusively by the state. In the case that the financial close was achieved, the money paid by the state would be deducted from the state's subsidy; otherwise Gefyra SA would just deliver the full survey outcomes to the Ministry. These surveys were very costly but absolutely necessary because they played a very important role in the negotiation with the EIB, by demonstrating a maturity of the design for the risky construction.
1996	The concession is ratified by the parliament (Gefyra SA, 2005).
1996	The Executive Committee of the EIB approved the provision of the long-term loan to Gefyra SA. The Greek Government guaranteed a stand-by loan of ECU 75 million to the concessionaire, which could only be used in case the concessionaire could not fulfil their financial obligations to the EIB (interest and loan repayment) during the operation of the project. If the concessionaire was unable to pay for their obligations to the EIB, the amount to be paid could be drawn from the stand-by loan facility. If the total amount drawn from the concessionaire from this stand-by loan exceeded ECU 70 million the Greek Government would take over the operation of the bridge.
1997	The Master Facility Agreement of EUR 370 million and 25 years repayment period is signed between Gefyra SA and the EIB (Gefyra SA, 2005, 2004).
1997	Financial close and commencement of concession (Gefyra SA, 2005). The main factor delaying financial close during the previous year was the request by the EIB for guarantees during construction. This was achieved by the syndication of a number of commercial banks (led by the Bank of America and the Bank of Tokyo - Mitsubishi) which organised a consortium to guarantee the EIB loan to Gefyra S.A during construction.
1997	The Ratification Act of the concession contract states that, if any amendments were needed for the bankability of the project, they could be made by Presidential Decree, without going to the Parliament (Law 2395/96). This proved critical, since the concession contract had to be amended (by Presidential Decree 387/1997 in December 1997) for specific issues to be clarified and well defined according to the demands of the banks. Also, the amendment allowed for some financial and technical aspects to be articulated more concretely. It is appropriate here to mention that the practice of amending a law with a Presidential Decree could cause serious legal concerns with regard to the power and significance of a Law. However, it should be recognized as a confirmation of the importance of the role of banks and sponsors and their power over the original parties (Trova and Koutras, 2001).
1997	The concession of 42 years came into effect just after financial close. Thus, the project started operating, seven years after the beginning of the concession, on 24 December 2004 (Gefyra SA).
2000	The first base of the bridge was constructed (Gefyra SA, 2005).
2001	The first foundation was completed and ready to leave the dry dock to take its final position (Gefyra SA, 2005).
2004	The Constructor placed the final plate of the bridge. The two shores of the Corinthian Gulf were connected (Gefyra SA, 2005).
2004	The Olympic Flame passed over the bridge with its final destination the Athens Olympic Games beginning in five days' time (Gefyra SA, 2005).
2004	The bridge was opened to traffic (Gefyra SA, 2005).
2005	One of the cables caught fire, possibly after being hit by lightning. The bridge was closed to traffic.
2005	The bridge re-opened to traffic (initially a limited re-opening, with full re-opening after the repair of the cable stay) and extra anti lighting-hit protection systems were also installed.
2039	The end of the concession is set to 2039. The control and operation of the bridge is to be handed over to the Greek state. However, the concession will end earlier if the concessionaire achieves a predetermined Return on Equity as defined in the Concession contract (11.5%) (Law 2395/96).

Source: OMEGA Centre for Mega Projects in Transport and Development of the Bartlett School of Planning at the University College London

In early 1989, while PASOK was still the governing party, GTM initiated a discussion with the state about the benefits of a potential PPP arrangement for the procurement of the project. However, serious political unrest, from June 1989 onwards, resulted in the suspension of procedures due to the reluctance of the transitional governments to decide for such a big project (Gefyra SA, 2005). In April 1990 the project is back on the spotlight, but in a new framework: the project will be tendered as PPP concession. In December 1990 the competition that was launched in 1987 was cancelled (Gefyra SA, 2005, Law 2395/1996).

In 1991 the MEPPW launches a new tender process (by a call for an expression of interest), **for a PPP concession for the design, construction, financing and operation of the project** (Gefyra SA, 2005, Law 2395/1996). In summer 1992 new drillings to investigate and appraise the sea bottom were undertaken, which were necessary for the design of the bridge (Gefyra SA, 2005). **In autumn 1992 the new tender is released, but the risk-sharing proposed by the tender call is seen as inappropriate by both the private parties and the banking sector**. Some of the comments of bidders regarding risk - sharing and the results from investigations led to amendments of the tender documentation and, after a number of postponements that the bidders had asked for, the 1 December 1993 was decided to be the deadline for submission of the bids (Gefyra SA, 2005). **Only two bids were submitted and the group "Gefyra" (GTM led) became the preferred bidder since the other bidder was proposing a tunnel which was not consistent with the tender requirement for either a high or floating bridge** (Law 2395/1996).

In 1993 the Rio-Antirio bridge was appraised in the framework of a national transport study called GREECE 2010 that also provided an input for the 1994-2000 and the 2000-2006 EU Community Support Frameworks. The study produced a critical input for the accurate appraisal of the traffic of the bridge since it considered the gradual realization of an upgraded national highway network linked with the bridge. The study refers to Rio-Antirio bridge as a vital link of a national transportation network development plan (Transport Research and Development International, 1995).

In December 1994 the EC Essen summit identifies 14 priority transport projects (TEN-T). These included the PATHE motorway in Greece (Patras - Athens - Thessaloniki - Evzonoi/FYR Macedonia border). **The Rio-Antirio bridge was incorporated into PATHE** (Gefyra SA, 2005)**.** This was regarded as an absolutely critical milestone for the realization of the project since **it enabled the provision of the EIB loan to the project** (EIB would be the only bank that could provide a 20-25 years maturity loan on a project like this in Greece at that time). The EIB had a negative view regarding the necessity and the benefits of such a technically complex project but after the inclusion of the projects into TEN-T priority projects, the bank started considering their involvement in the project.

In March 1995 the European Commission examined the lawfulness of the tender, after the appeals of the bid competitors on the grounds of the tender procedures and the financial offer of “Gefyra” which was contradicting the tender requirements (and also that the technical offer was not based on a previous application and had not a definite and finalized approach to various technical matters). After a period of uncertainty and serious disputes, **the European Commission**

finally rejected the appeals. Some remaining issues of deviations between the tender call and the financial offer were left to be settled in the concession contract that would be ratified as a law by the Parliament so as to be immunised from appeals (Gefyra SA, 2005).

2.2. *FINANCING DECISION AND PROJECT IMPLEMENTATION*

In January 1996 the concession contract was signed by the Greek Government and Gefyra SA (Gefyra SA, 2005). In general, there were many issues that needed to be formally included in the contractual documentation in order for the project to be bankable and both "Gefyra" and the state to feel partners in a fair deal. Those issues had principally to do with the risk. Major issues were the definition and allocation of force majeure risks and the control of the design and progress of work that had to be assigned to an independent checker and an independent supervisor since the state was not capable to carry-out such a job for such an innovative and technically complex project, despite the fact that the Ministry initially did not want to outsource and neutralise the control.

A critical decision made just after signing the concession contract was the agreement between the state and the concessionaire to sign the so called "Contracts before the effective date". These contracts, which were executed in the period between the signing of the Concession Contact and the financial close, allowed the implementation of geotechnical surveys in the subsoil of the seabed. These works were necessary for the confirmation of the construction design assumption and the progress of the final design and were exclusively paid by the state. In the case that the financial close was achieved, the money paid by the state would be deducted from the state's subsidy; otherwise Gefyra SA would just deliver the full survey outcomes to the Ministry. **These surveys played a very important role in the negotiation with the EIB, since they were proving a maturity of the design of such a risky construction. Finally, in April 1996 the concession was ratified by the Parliament** (Gefyra SA, 2005).

In December 1996 the Executive Committee of the EIB approved the provision of the long-term loan to Gefyra SA. The EIB was initially not comfortable to provide the long-term loan. Nonetheless a new socioeconomic and financial appraisal of the project was performed, since the bridge was a TEN-T priority project. This time, a signed concession contract was in place, which according to the EIB's initial view was addressing risk-sharing in a secure way. Moreover, a new more advanced CBA had been conducted showing the socioeconomic benefit of the project. However, the EIB was still expressing a strong stance against assuming credit risk. The relevant issues were resolved mainly through: i) the provision, by the Greek Government, of a "stand by" loan to the concessionaire, which could only be used in case the concessionaire could not fulfil his financial obligations to the EIB during the operation of the bridge (Gefyra S.A.) and ii) the provision, by a syndication of commercial banks (led by the Bank of America and the Bank of Tokyo - Mitsubishi), of guarantees to the EIB loan to Gefyra S.A. during construction period (Gefyra S.A.). **In July 1997 the Master Facility Agreement of EUR 370 million and 25 years repayment period was signed between Gefyra SA and EIB** (Gefyra SA, 2005,

2004) **and in December 1997 the Financial Close was achieved and the concession commenced** (Gefyra SA, 2005).

The Ratification Act of the concession contract states that, if any amendments were needed for the bankability of the project, they can be made by Presidential Decree, without requiring the intervention of the Parliament (Law 2395/96). This proved critical, since the concession contract had to be amended (by Presidential Decree 387/1997 in December 1997) in order for specific issues to be clarified and well defined according to the demands of the banks. Also, the amendment allowed for some financial and technical aspects to be articulated more concretely. It is appropriate here to mention that the practice of amending a law with a Presidential Decree could cause serious legal concerns with regard to the power and significance of a Law. However, it should be recognized as a confirmation of the importance of the role of banks and sponsors and their power over the original parties.

In December 1997 the concession of 42 years came into effect just after the financial close. According to this agreement, the project had to start operating 7 years after the beginning of the concession, on the 24 December 2004 (Gefyra SA). **The end of the concession was set at December 2039** (the control and operation of the bridge is to be handed over to the Greek state). However, the concession could end earlier if the concessionaire achieves a predetermined Return on Equity as defined in the Concession contract (11.5%) (Law 2395/96).

After the financial close the site preparation and dredging activities began in July 1998, and subsequently the construction of the massive bridge supporting pylons started in 2000. These were completed in 2003, when the works began for the construction of the traffic decks. **On the 21 May 2004 the main construction was completed**; only equipment (sidewalks, railings, etc.) and waterproofing remained to be installed. The completion of these works occurred early August 2004 and **the bridge was opened for traffic on the 12 August 2004, the day before the inauguration of the 2004 Athens Olympic Games**.

In the meantime, the project started receiving funds from the European Commission, which according to the data provided by the Ministry finally amounted to EUR 253.2 million. The detailed financial structure of the bridge is reported below.

Table 10. Financial structure of the Rio-Antirio project

Private expenditure		Public expenditure	
Own capital	EIB Loan	National Funds	EC Funds
68,547,438	370,000,000	196,525,229	253,186,482
438,547,438		449,711,711	
888,259,149			
Private expenditure		**Total Public Expenditure**	**Community Participation**
Own capital	EIB Loan	National Funds	EC Funds
7.7%	41.7%	22.1%	28.5%
49.4%		50.6%	
100.0%			

Source: Authors based on information provided by the Ministry

2.3. *CURRENT PERFORMANCE AND OTHER INVESTMENT NEEDS*

The table below presents in detail the real observed traffic data on the Rio-Antirio Crossings between 1984 and 2016. Data are provided by vehicle category by distinguishing the vehicles in the categories of light (two-wheeled, passenger, vans) and heavy (trucks and buses). The distribution of the crossings on the bridge and the ferries is also provided.

Table 11. Development of Crossings in Rio-Antirio Strait (1984-2016)

YEAR	FERRY			BRIDGE			LINK TOTAL		
	LIGHT	HEAVY	TOTAL	LIGHT	HEAVY	TOTAL	LIGHT	HEAVY	TOTAL
1984	1,098,952	450,961	1,549,913				1,098,952	450,961	**1,549,913**
1985	1,221,640	450,625	1,672,265				1,221,640	450,625	**1,672,265**
1985	1,263,321	466,999	1,730,320				1,263,321	466,999	**1,730,320**
1987	1,294,579	473,893	1,768,472				1,294,579	473,893	**1,768,472**
1988	1,393,092	498,227	1,891,319				1,393,092	498,227	**1,891,319**
1989	1,602,625	560,746	2,163,371				1,602,625	560,746	**2,163,371**
1990	1,602,911	552,506	2,155,417				1,602,911	552,506	**2,155,417**
1991	1,615,916	558,100	2,174,016				1,615,916	558,100	**2,174,016**
1992	1,755,579	583,101	2,338,680				1,755,579	583,101	**2,338,680**
1993	1,770,706	584,955	2,355,661				1,770,706	584,955	**2,355,661**
1994	1,921,612	605,175	2,526,787				1,921,612	605,175	**2,526,787**
1995	1,950,608	605,594	2,556,202				1,950,608	605,594	**2,556,202**
1994	2,017,427	614,656	2,632,083				2,017,427	614,656	**2,632,083**
1997	2,071,770	634,121	2,705,891				2,071,770	634,121	**2,705,891**
1998	2,250,608	688,862	2,939,470				2,250,608	688,862	**2,939,470**
1999	2,548,696	555,912	3,104,608				2,548,696	555,912	**3,104,608**
2000	2,727,838	525,061	3,252,899				2,727,838	525,061	**3,252,899**
2001	2,710,859	412,227	3,123,086				2,710,859	412,227	**3,123,086**
2002	2,729,127	504,874	3,234,001				2,729,127	504,874	**3,234,001**
2003	2,698,981	754,129	3,453,110				2,698,981	754,129	**3,453,110**
2004	1,676,571	536,158	2,212,729	1,610,950	157,213	1,768,163	3,287,521	693,371	**3,980,892**
2005	565,897	224,055	789,952	3,918,896	431,834	4,350,730	4,484,793	655,889	**5,140,682**
2005	568,952	246,160	815,112	4,069,674	444,653	4,514,327	4,638,626	690,813	**5,329,439**
2007	510,045	221,337	731,382	4,348,208	474,917	4,823,125	4,858,253	696,254	**5,554,507**
2008	414,493	239,063	653,556	4,463,572	515,007	4,978,579	4,878,065	754,070	**5,632,135**
2009	416,839	216,310	633,149	4,607,735	438,654	5,046,389	5,024,574	654,964	**5,679,538**
2010	399,186	206,446	605,632	4,226,159	432,560	4,658,719	4,625,345	639,006	**5,264,351**
2011	482,407	203,230	685,637	3,628,988	378,828	4,007,816	4,111,395	582,058	**4,693,453**
2012	524,453	191,747	716,200	3,063,225	336,642	3,399,867	3,587,678	528,389	**4,116,067**
2013	552,710	169,070	721,780	2,839,476	338,340	3,177,816	3,392,186	507,410	**3,899,596**
2014	623,668	196,944	820,612	2,747,926	340,847	3,088,773	3,371,594	537,791	**3,909,385**
2015	602,426	173,937	776,363	2,755,379	363,335	3,118,714	3,357,805	537,272	**3,895,077**
2016	537,898	172,833	710,731	2,964,367	431,108	3,395,475	3,502,265	603,941	**4,106,206**
2017e	434,952	171,475	606,427	3,277,449	450,584	3,728,033	3,712,401	622,059	**4,334,460**

Source: POADEP, Gefyra. Authors estimate for 2017

The analysis of the above observed data shows that the opening of the bridge was unexpectedly followed by a strong increase of traffic crossing the strait. This is considered to represent demand attracted by the fixed link due to its specific functional features, allowing to overcome a natural barrier providing a reliable and quick solution to the users. **Representing a more competitive solution to the ferries, despite the higher price of the tolls on the bridge, the latter became since the beginning the preferred solution for the road users**. Finally, **the economic crisis since 2008 has negatively affected the positive trends registered by the bridge**. Still in 2016 the traffic on the crossing (both ferry and bridge) is below the total volume registered in 2005, the first full year of operation of the Rio-Antirio bridge.

Table 12. Percentage allocation of crossings ferries VS bridge

YEAR	FERRIES			BRIDGE		
	LIGHT	HEAVY	TOTAL	LIGHT	HEAVY	TOTAL
2005	12.6%	34.2%	15.4%	87.4%	65.8%	84.6%
2005	12.3%	35.6%	15.3%	87.7%	64.4%	84.7%
2007	10.5%	31.8%	13.2%	89.5%	68.2%	86.8%
2008	8.5%	31.7%	11.6%	91.5%	68.3%	88.4%
2009	8.3%	33.0%	11.1%	91.7%	67.0%	88.9%
2010	8.6%	32.3%	11.5%	91.4%	67.7%	88.5%
2011	11.7%	34.9%	14.6%	88.3%	65.1%	85.4%
2012	14.6%	36.3%	17.4%	85.4%	63.7%	82.6%
2013	16.3%	33.3%	18.5%	83.7%	66.7%	81.5%
2014	18.5%	36.6%	21.0%	81.5%	63.4%	79.0%
2015	17.9%	32.4%	19.9%	82.1%	67.6%	80.1%
2016	15.4%	28.6%	17.3%	84.6%	71.4%	82.7%

Source: Authors

The distribution of crossings in the strait between the bridge and the ferries shows a greater share of the Rio-Antirio bridge, with the following remarks:

- Up to 2010 the bridge held an average of 87% percentage of crossings all years which is exceptionally high;
- After 2010 a sharp fall is observed, that even up to the year 2014 had a steady downtrend, reaching 79% of the total traffic;
- The opposite happens as regards the ferries - Looking at the distribution of crossings separately for heavy and light vehicles, it is clear that the most important role is the behaviour of light vehicles that gradually, an average of 5.68% is transferred from the bridge to the ferries.

More considerations on the traffic and on the comparison between the ex-ante estimates and real observed data are provided in Section 4.4 below.

Regarding other investments, it shall be noted that **all the relevant motorway projects belonging to the network interconnecting with the bridge are nowadays complete**, including the Olympia and Ionia Odos. The completion of these projects is expected to amplify the magnitude of the effects generated by the bridge. Other projects of local scale are in any case worth mentioning, i.e. the interconnections of Agrinio and Mesolongi with the Ionia Odos, which according to

interview with relevant stakeholders are expected to play a key role in further increasing the effects and benefits generated by the project at the regional scale. Particularly the effects of the project on wider economic benefits at the local and regional scale, the comments received from some stakeholders concerning the tariff scheme applied on the bridge are worth mentioning which may also further increase the socioeconomic performance of the major project in the future. The possibility to reduce the costs of the use of the bridge for frequent users or of round trip cards by either extending the time of the return trip or the price of the card could further promote cross-gulf mobility and thus economic development (see also Section 3.2).

3. DESCRIPTION OF LONG-TERM EFFECTS

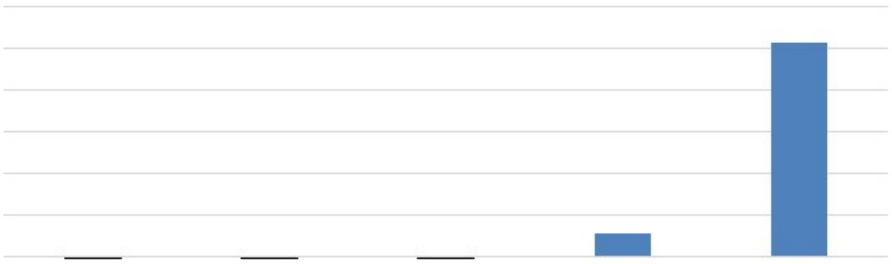
In this chapter the main long-term effects produced by the project are presented and discussed. First, a summary of the effects produced along the various categories is described. Then, the most significant ones are discussed and supported by available evidence.

3.1. *KEY FINDINGS*

The long-term contribution of this project shall be considered under the following four main categories: economic development, quality of life and well-being, environmental sustainability and distributional effects.

The economic growth aspect includes the quantifiable benefit derived from reduced time for crossing the Gulf of Corinth. This effect is incorporated in the CBA in the form of consumers-surplus, including: travel time savings for the users, and operating cost savings (calculated considering the incremental costs for the diverted and induced demand and the fee savings for users of the ferries due to the reduction in the increase of the ferry fees following the competition with the bridge as described in the previous sections). Furthermore producers-surplus have been considered which include the additional revenues from the tolls paid by the bridge users and the additional vehicle operating costs for the induced demand. Other non-quantifiable economic effects include wider economic benefits and the development of a more modern institutional system supporting private investment in the transport infrastructure sector in Greece.

Figure 11. Main socioeconomic benefits (EUR 2017, discounted)



	Road safety	Greenhouse Gas Emissions	Environmental Externalities (air and noise)	Producers' surplus	Consumers' surplus
Present Value	-22,648,959	-15,625,692	-4,941,839	269,018,984	2,558,770,429

Source: Authors

The chart above summarises the main benefits associated with the implementation of the major project, including the aggregate figures for the consumers-surplus and producers-surplus benefits, whereas the table below provides detailed figures on the calculation of the consumers-surplus and producers-surplus related effects.

Table 13. Percentage allocation of crossings ferries VS bridge

	EUR NPV 2017
Consumers' Surplus	**2,558,770,429**
Travel time savings	2,470,722,770
Vehicle operating cost (incremental tolls for diverted and induced users on the bridge and fee savings for the users of the ferries)	88,047,660
Producers' Surplus	**269,018,984**
Vehicle operating costs for the induced demand	-150,648,699
Revenues from tolls	419,667,684

Source: Authors

Under the heading of social well-being and quality of life negative impacts were identified on safety and noise due to the induced traffic, while non-quantifiable positive effects relate to the improved journey comfort and the aesthetic and cultural value of the new bridge.

Among the environmental sustainability effects, negative effects are again associated with the induced traffic. As further commented at Section 3.4, positive effects are instead identified, albeit not quantified due to absence of relevant data and information for their calculation/estimation, due to the reduced air emission in proximity of the two ports in Rio and Antirio, as well as other minor impacts related to changes in the marine ecosystem.

As for the distributional effects, a positive effect on territorial cohesion is identified and discussed in a qualitative way.

Based on the assessment of the quantifiable impacts, **the socioeconomic indicators for the project are well above the thresholds required for an investment to be deemed beneficial for the society** (ENPV is at EUR 2.2 billion and the EIRR is at 6.87%). As shown below, the benefit to users is by far the main benefit, and alone is sufficiently large to justify the project. Also, the risk analysis indicates that there is a nil probability for the ENPV to be less than zero and a probability of nearly 49% that the expected ENPV and EIRR are less than the reference ones.

In addition to these measurable impacts, there are also other effects difficult to be captured in monetary terms, but relevant for the comprehensive assessment of the project, which are discussed in the following sub-chapters.

The table above summarises the nature and strength of the project's effects classified under the above referred four categories (economic growth, quality of life and well-being, environmental sustainability and distributional issues), as well as the territorial levels where these are visible, and the time-horizon of their materialisation.

Table 14. Summary of nature and strength of effects (the effects highlighted in green are those included in the ex-post CBA)

Category	Effect	Strength	Level
Economic growth	Travel time savings	+5	Local – regional - global
	Vehicle operating costs	+3	Local – regional - global
	Reliability of journey time	+5	Local – regional
	Wider economic impacts	+2	Local – regional
	Institutional learning	+5	National – International
Quality of life and well-being	Safety	-1	Local – regional
	Noise	-1	Local – regional
	Service quality	+5	Local – regional
	Security	N.R.	
	Crowding	N.R.	
	Aesthetic value	N.R.	
	Urban renewal	N.R.	
Environmental sustainability	Air Pollution	-1	Local – regional
	Climate change	-1	Local – regional – global
	Biodiversity	N.R.	
	Water pollution	N.R.	
Distributional issues	Social cohesion	+3	Local – regional
	Territorial cohesion	+3	Local – regional

*Note: * the strength score reflects the weight that each effect has with respect to the final judgment of the project. In particular:*
-5 = the effect is responsible of the negative performance of the project;
-4 = the effect has provided a negative contribution to the overall performance of the project;
-3 = the effect has contributed in a negative way to the performance but it was outweighed by other positive effects;
-2 = the effect has a slightly negative contribution to the project performance;
-1 = the effect is negative but almost negligible within the overall project performance;
0 = the effect has no impact on the project performance;
+1= the effect is positive but almost negligible within the overall project performance;
+2 = the effect has a slightly positive contribution to the project performance;
+3 = the effect has contributed in a positive way to the performance but it was outweighed by other positive effects;
+4 = the effect has provided a positive contribution to the overall performance of the project;
+5 = the effect is responsible of the positive performance of the project

3.2. *EFFECTS RELATED TO THE ECONOMIC GROWTH*

Measurable effects

With regard to the socioeconomic consequences of the investment, **the most significant effects are the direct benefits to users, and in particular the reduction of travel time** for all the bridge vehicles and passengers, which save from 40 minutes the minimum (since the sea travel link and the overall delays mount to 45 minutes and through the bridge 3-5 minutes), up to more than 60 minutes (depending on the time that the ferries would depart, on the weather conditions, etc.). Based on our calculations, as described in Annex II, this benefit provides alone a justification for the project being positive under a socioeconomic perspective, as the present value of consumers' surplus savings offset the investment and operational costs.

Included in the estimate of the consumers' surplus there is also the positive effect generated by the bridge in terms of competition in the transit regime of

the Strait of Rio-Antirio. Given that by the summer of 2004 ferryboats had the exclusive exploitation of the strait and that since then the two means of transport (the ferries and the bridge) have been operating in parallel, it appears that new competitive conditions have been created for the passage of the strait. Users can now choose between the ferries and the bridge, which have completely different characteristics in terms of length, reliability, safety, comfort.

The analysis of the evolution of ferry prices in the period before and after the bridge entered into operation is meaningful in this regard. The deviation of the pricing method is very large, the bridge having contributed significantly to its rationalization.

In the period before the bridge, the ferry price increases were very high: between 1991 and 2003, their prices rose at an annual rate of 10.5% on average, i.e. 4% more than annual inflation (CPI 1991-2003: 6.5% per year), both for passenger cars and for trucks and buses. From the availability of the bridge crossing (2004) onwards, ferry prices, under the pressure of competition, stopped this upward trend. On this basis, it is quite likely that if the bridge had not been constructed and the ferry remained as the sole means of crossing the Strait of Rio-Antirio, the continuation of the monopoly would also allowed the operators to further increase their tolls. This translates into savings for the users of the ferry services that thanks to the construction of the bridge benefit of lower prices for the crossings[5].

Producers' surplus also includes the additional revenue to the operators due to incremental tolls paid by users. For the existing and diverted demand, this benefit offsets an equivalent negative impact for the consumers, while for the induced traffic the two terms do not net out, due to the application of the rule of half in the calculation of the consumers' surplus (see Annex II for a more detailed description of the calculations and assumptions).

Non measurable effects

Another remarkable effect which has been observed after completion of the project is the increased reliability of journey time. Improved reliability, quality of service, continuation of service regardless of weather conditions have been achieved thanks to the availability of the bridge. The ferry service between Rio and Antirio is occasionally halted mainly due to severe wind conditions that do not allow the ferries to cross the strait. As reported by the Port Authority in Rio the average annual closure of the sea strait (completely interrupting the service of ferry boats) corresponds to about 15 days per year. Hence, the bridge made the permanent connection feasible. Although relevant, this effect was not included in the CBA analysis due to lack of comprehensive statistics on the exact level of unreliability of the ferry connections during the operating days.

Other direct effects that were not explicitly assessed due to lack of information relate to the potential saving in the operating and maintenance costs of the port infrastructure for ferries (access roads, piers, maritime and road traffic management and so on). The potential savings are however presumably

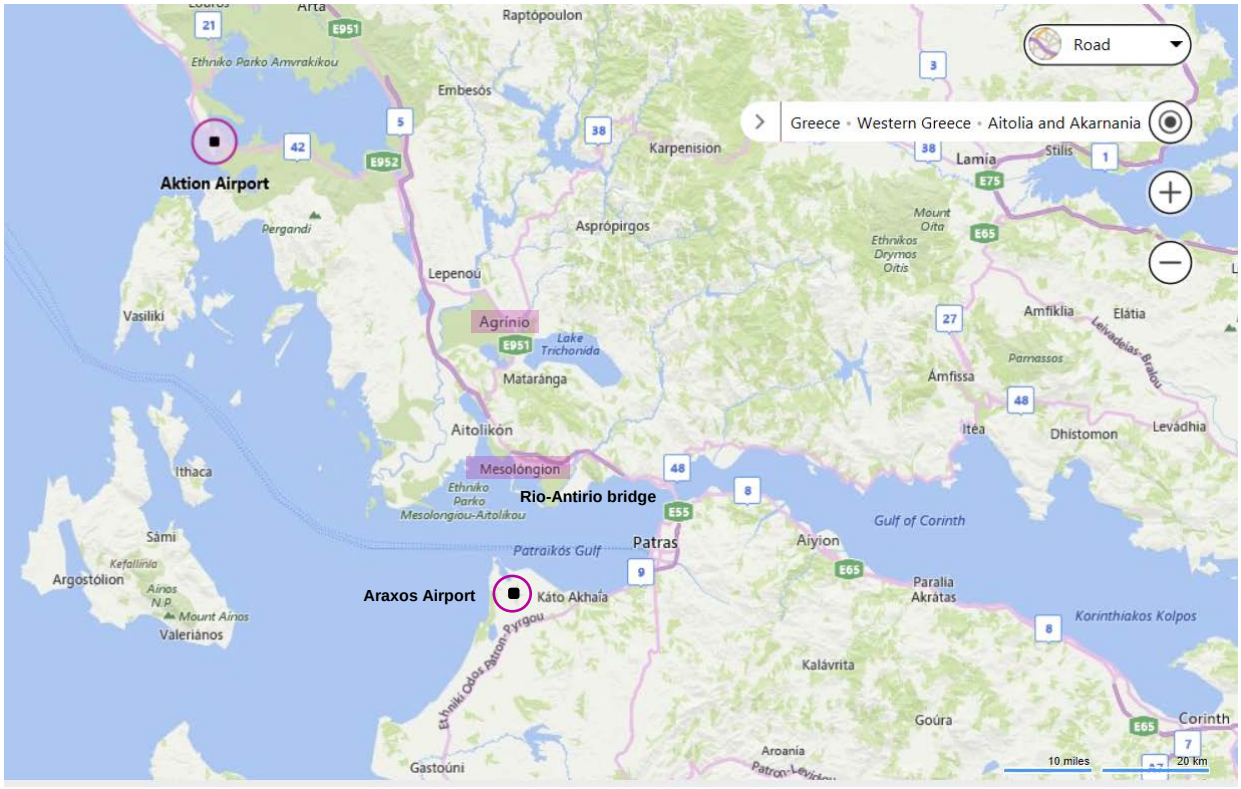
[5] It shall be noted that this benefit is of distributional nature, as from the point of view of the entire society the savings for users are offset by less revenue for the operators. A net benefit still remains, but only to the extent this discount has supported demand growth, but this second-order effect was not taken into consideration in the CBA.

marginal, in consideration that the ferry service is still operated, albeit at a lower intensity.

Other economic benefits that were expected to be generated by the project and that are mentioned by studies on the impact of the bridge and by some of the interviewed stakeholders **concern the wider economic impact of the project**. Such impacts, as discussed in the vast literature, may be generated by large investments as a consequence of transport's impact on economic geography: better transport increases proximity, making economic agents closer together and may also trigger relocation of economic activities and households.

> ***Thanks to the availability of the Rio-Antirio bridge the accessibility to the Aktion and Araxos airports is likely to have improved. The airport traffic in Greece has increased in the past years. Albeit difficult to attribute this growth to the bridge only, the fixed crossing is deemed to offer alternatives to travel and accommodation choices for passengers and tourists*** *(Deputy Airport Director)*

Figure 12. Aktion and Araxos Airports and Agrinio and Mesolongi Municipalities



Source: Authors based on HERE 2018 maps available on www.bing.com (Microsoft 2018)

Together, these changes may create potential "wider economic benefits", for instance by supporting cooperation of economic entities, by inducing additional developments and influencing land use or finally enabling labour force participation. Previous studies and some stakeholders reported that the project supported the creation of employment in important sectors of the Greek industry such as construction materials, aggregates and that relevant increase in property prices in the area was observed.

> ***Easy and more direct accessibility provided by the Rio-Antirio bridge is a likely consequence of the increase of tourism stays in Pyrgos. Also, Western Greece businesses have benefited from the construction of the bridge, despite the relatively high tolls applied*** *(President of the Municipality of Pyrgos Hotel Association)*

Although interesting, this partial and to a certain extent anecdotical information cannot constitute a reliable basis to assess such effects. On the other side, **the amount of the induced traffic observed on the bridge shows that the project had a relevant impact on mobility at the regional scale**, and thereby on the geography of the local economy. Albeit not allowing for quantification, this suggest that **positive wider economic impacts were likely generated by the project**, although more precise socioeconomic data would be needed to comment on the specific effects triggered.

> ***The bridge contributes to stimulating mutual trade in goods and tourism while removing the social exclusion of Northern regions in Greece. Its impact on regional development in the country is decisive, the bridge allows the physical and economic integration of the Western Peloponnese, Central Greece and Epirus. The growth in the volume of freight and passenger transport has helped increasing the production activity of several manufacturing sectors also in the municipality of Agrinio. Thanks to the recent completion of the Ionia Odos the positive effects of the bridge are likely to increase. However specifically regarding Agrinio, which represents the largest centre in Etoloakarnania with over 100,000 inhabitants, a direct interconnection with Ionia Odos is currently missing which is deemed to represent an obstacle to its economic development and fully exploitation of the availability of the bridge. Projects for the development of a better interconnection of this city with Ionia Odos have been already identified which shall be considered towards the full economic development of the territories in Western Greece thanks to its availability. This will be particularly beneficial for tourism which is the sector expected to benefit most from the further and better integration of Agrinio with the relevant road network*** *(Mayor and General Secretary of Agrinio Municipality)*

> ***The effects in Etoloakarnania will intensify in the future thanks to the completion of the Olympia and Ionia Odos. Further to these major roads, accessibility to local municipalities shall also be considered for improvement so that the local territories can fully benefit from the availability of the Bridge. More specifically the accessibility to Ionia Odos from Agrinio is nowadays only possible using a 24 km long road passing through crowded villages. Mesolongi is also suffering from lack of a direct connection to the Ionia Odos. The improvement of the interconnection with Ionia Odos will***

> ***further increase the magnitude of the effects of the bridge in Etoloakarnania*** *(President of the Chamber of Commerce of Etoloakarnania)*

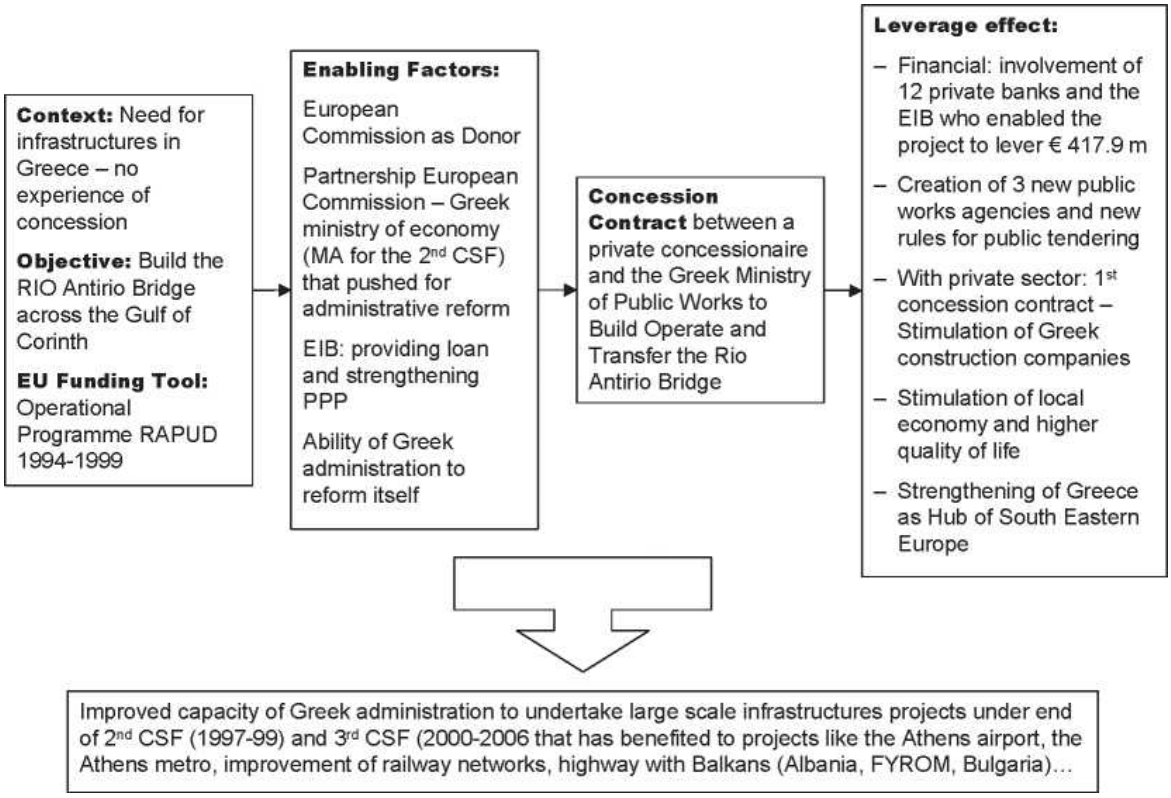
As a final effect relevant for economic growth, it is worth mentioning that **the major project together with the other two above mentioned pioneering PPP initiatives in the transport sector in Greece namely, the Athens Eleftherios Venizelos International Airport and Attiki Odos, contributed to changes to policy and practice within the Greek administration in the way public works are assigned and carried out, which has been later applied to other projects**:

- **Modernisation of the administration**. Because of its size, unprecedented in the recent history of Greece, the project required new procedures and mechanisms to facilitate its implementation. Thus, the Special Service of Public Works EYDE SAE was founded with the aim of managing the construction, maintenance and exploitation of the Rio-Antirio bridge (and the Attica ring road). This helped to overcome several of the major bottlenecks of the Greek administration: i) the lack of qualified civil servants who were able to take management decisions and could provide sound project management, ii) the splitting of competence over many hierarchically organized levels iii) the insufficiency of human and material resources and iv) the lack of fundamental management principles such as the cycle of planning - organizing - controlling - feedback - re-planning. Another important actor created in 1996 at the time of the Rio-Antirio bridge was the Special Consultant for Quality Control, ESPEL, an independent organisation established under law 2372/96. This organisation was set up for the implementation of the OP RAPUD including major infrastructure projects initiated under the 2nd CSF. Finally, in 1995, the Ministry of National Economy created the Joint Guidance Committee for public works (MEK), a sub-committee of the CSF PMC. Its main task was to improve the public works production system in terms of technical conditions and studies, legislation, quality, tender procedures and project management. In this context, MEK produced a set of useful tools in the form of guidelines which codified and simplified all relevant legislation and procedures for monitoring, amongst others, the following aspects of the programme: quality of projects, environmental conditions, legal alternatives and public contracts. These guides also proved their worthiness as tools to be used by other contractors working on the Road Axes development programmes. A significant development of the regulatory activity at the institutional level concerning the development, implementation and operation of PPP infrastructure, complementing basic legislation on public works is also worth mentioning which was the result of the implementation of the major project.
- **Cooperation with the private sector**. The Rio-Antirio bridge was one the first projects in the history of Greek public works in which public funding was complemented by private funding. The effectiveness of the BOT method in terms of timely execution of the works and quality of construction has led to its gradual acceptance and wider deployment in the realisation of infrastructure projects under the scope of the third CSF (2000-2006). In the case of the Rio-Antirio bridge, another innovative aspect of the cooperation with the private sector lied in the involvement of many foreign consultancy firms. The Greek

Government hired a mix of foreign consultants specialized in legal and technical aspects of such projects. Their input was considered necessary, because no prior experience existed in either the Greek private or public sectors about project financing. The expertise of engineering companies and universities in specialised works like the foundations was also deemed of very high quality and added value by passing this knowledge on to the Greek engineers.

In general, this new institutional framework with the introduction of specialised procedures for public contracts, quality control and project management has changed significantly the way that major public infrastructure projects are handled in Greece by creating flexible and efficient management institutions and capabilities in the public sector and by providing the opportunity for the transfer of knowledge from overseas consultants to the local professionals and for the mainstreaming of modern project financing methods.

Figure 13. Rio-Antirio bridge Graph on leverage effect



Source: OIR-Managementdienste GmbH (2007). The Leverage Effects of European Cohesion Policy under the Structural Funds – Final Report

3.3. *EFFECTS ON QUALITY OF LIFE AND WELL-BEING*

Under the heading of quality of life and well-being, some measurable effects on transport safety and noise are considered together with effects on attitudes and perceptions of the project impacts not expressed in monetary terms.

Measurable effects

The quantifiable impacts of the project relate to the negative effects on road safety and noise due to the induced traffic. The induced traffic, in fact, do not only include the distance travelled on the bridge, but the full distance travelled by road between the origin and destination, assuming the trips induced on the bridge would not have occurred at all in the do-nothing scenario[6].

In the CBA, we estimated that these impact amounts to around EUR 27.5 million in present value, which, albeit not insignificant, is largely marginal compared to the overall benefits generated by the project.

Non measurable effects

Although difficult to quantify, in consideration of the high safety standards of the new bridge and its access roads, in comparison to the roads accessing the ferry piers, the re-routing of traffic from the ferry to the bridge has presumably also contributed to improved traffic safety for the existing traffic.

Another well documented, although non-quantifiable, effect of the bridge is the improvement in journey comfort for travellers crossing the Gulf of Corinth. This both due to the lower comfort of the ferries, especially in case of bad weather or strong wind and to the fact that the bridge ensures a seamless travel, with no interruption or transfer.

The aesthetic value of the bridge is also worth mentioning as a positive effect related to well-being and quality of life. The bridge constitutes a landmark of modern Greece holding world records, which attract tourists and contributed improving the perception of this region in Europe. Although no comprehensive indicators are available in this regard, it is for instance relevant noting that the bridge currently is classified as the second most popular attraction in the Aetolia-Acarnania Region by TripAdvisor[7], ahead of historical sites such as the Venetian Castle of Nafpaktos or natural attractions such as the Xiliadou Beach.

3.4. *EFFECTS ON THE ENVIRONMENTAL SUSTAINABILITY*

Measurable effects

As in the case of safety and noise effects, **the quantifiable impacts of the projects relate to the negative effects on air pollution and GHG emissions due to the induced traffic.** These impacts were estimated at approximately EUR 15.6 million in present value.

Non-measurable effects

It shall be noted that building a bridge to link Rio with Antirio was considered a more environmentally-friendly alternative compared to the ferry services. In fact, not only the frequent trips back and forth heavily pollute the marine

[6] This is clearly a conservative assumption to the purpose of the project appraisal, as it is quite likely that part of these trips would have occurred also in the do-nothing scenario, possibly with different destinations not implying crossing the Gulf of Corinth.

[7] https://www.tripadvisor.com/Attractions-g3226014-Activities-Aetolia_Acarnania_Region_West_Greece.html#ATTRACTION_SORT_WRAPPER

environment but also, during periods of high traffic, cars and trucks would release emissions while idling for hours in both ports. In this respect, **the bridge is reported to have reduced the pollution and congestion caused by the vehicles in the proximity of the ports of Rio and Antirio**, by diverting traffic from these urban areas to the trunk road network. This impact, which is of a rather local nature, is difficult to quantify due to the lack of real observed data and monitoring information, but it is reported by other studies and by the local stakeholders.

It is also worth mentioning that construction techniques were employed to minimize the environmental impact during construction. The use of the dry and wet docks for construction of the pier bases and main piers, as opposed to constructing these elements in-situ, was also instrumental in minimizing disturbances to the seabed and local marine ecosystem.

"Green" solutions are also incorporated into bridge operations. State-of-the-art technologies are used to mitigate greenhouse gas emissions, which are deployed in the lighting and heating/ventilation systems used in operations facilities, as well as the operating company's vehicles. Such applications have influenced marine environmental protection policies and activities in the Gulf of Corinth, and the operating company continues to promote awareness and educational campaigns regarding eco-driving.

There have been several investigations covering the environmental consequences caused by the bridge in terrestrial ecosystems and the climate conditions of the region. Analyses and assessments were performed concerning the levels of pollution in the atmosphere, waste sources under development of the project, and the movement of the water and surface sediments. Lately, an environmental impact assessment study, requested by Gefyra SA and implemented by the Technological Institute of Patras (TEI) provided an analysis of the environmental factors, data processing and further investigation. These revealed that:

- The operation of the Rio-Antirio bridge has not led to changes in the flora in the mountainous and lowland areas of the region and has not changed the range of ambient temperatures in the range of the project development;
- The amount of trash disposed in the sea decreased and this is attributed to the lower traffic handled by the ferry boats between Rio and Antirio, since the bridge is available;
- A change to a certain extent due to the bridge of the currents of the region was observed resulting in the reordering of the surface layer sediment; additional studies would be however required to analyse the possible effects on fish population and benthic fauna;
- The operation of the bridge does not appear to affect the rate of influx of geo-materials in the sea and there is no measurable effect on input sources of such materials in the study area;
- Environmental burden index Igeo is negative, so the area is not polluted by heavy metals (Ag, As, Ba, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, U, V, Zn).

3.5. *EFFECTS RELATED TO DISTRIBUTIONAL ISSUES*

The activities by the Observatory of Road Networks in Western Greece and Peloponnese (POADEP) are worth to mention with respect to the analysis of distributional impacts. In particular, a recent study[8] focusses on the effects generated by the bridge, including the analysis of social cohesion and spatial imacts. **The main findings of these analyses, seems to support the conclusion that the project is positively contributing to social cohesion and development at different territorial levels, especially thanks to an improved accessibility of the peripheral regions**:

- The project seems to have relevant spatial effects, due to the change of the pattern of the transport of freights and mobility of persons, for work, leisure, tourism etc. (due to improved accessibility). These spatial effects positively affect income and working conditions in the territories surrounding the bridge and remove the limits of social exclusion;
- The developed economic and econometric analyses suggest a positive impact on employment and GDP, both in the construction period and after the opening of the bridge, in all zones of influence, both in the short-term and long-term;
- The above effects are diversified geographically and exert greater intensity, i.e. generate greater benefits, in less developed and socially excluded areas (example Etoloakarnania) and smaller benefits in urbanised and richest areas (example Achaia).

3.6. *TIME-SCALE AND NATURE OF THE EFFECTS*

The project was opened for traffic on the 12 August 2004, therefore the discussed effects materialised in a period of 12 years. These are expected to be maintained in the long-run with a higher magnitude due to the completion of the surrounding major trunk road network, i.e. Ionia Odos, Corinth-Patras and the Patras-Pyrgos-Kalamata, as well as the roads interconnecting these major axes with the main socioeconomic centres in Etoloakarnania (e.g. Agrinio and Mesolongi).

With reference to the spatial scale of the effects the vast majority are of a regional nature, in line with the fact that the majority of the traffic is of local and regional nature or has in any case its origin and destination in the prefectures in Western Greece (see Section 2.3). Some of the effects related to economic growth, like time savings may also have wider impact, even at the national and international level especially when combined with the complementary roadway investments.

In consideration of the predominant use of the bridge at the regional/local scale, the capacity of the major project to generate additional benefits, especially in terms of wider economic effects, might also occur further increasing the attractiveness of the use of the bridge to frequent users and/or other users by reducing the costs of the

[8] POADEP (2017) *The social and economic impacts of the Rio-Antirio bridge. Economic Crisis and Mobility*. Study coordinated by Professor Athanasios Bellas, chairman of the Observatory.

epasses and return trips. This could likely further increase regional mobility and accordingly support regional economic activities and development.

Table 15. Temporal dynamics of the effects

CATEGORIES OF EFFECTS	Short run (1-5 years)	Long run (6-12 years)	Future years	COMMENT
Economic growth	+++	+++	+++	High time savings, increased quality and reliability of service; continuous service not affected by weather without delays; Efficient and effective operations and cooperation of institutions: Government and Private Sector.
Quality of life and well-being	++	++	+++	Good level of satisfaction of travellers not only locally, but lately regionally and at a national level.
Environmental sustainability	+	+	+	Bridge overall assumed to generate more positive effects than a negative impact; no impact on biodiversity.
Distributional issues	++	++	+++	Improved accessibility to travellers for the regional society due to extended network.

Note: + = slight positive, ++ = positive, +++ = strongly positive, +/- = mixed effect.

4. MECHANISMS AND DETERMINANTS OF THE OBSERVED PERFORMANCE

In this section the key mechanisms and determinants of the long-term effects discussed in the previous chapter are illustrated and discussed along the different phases of the project cycle. Finally, the importance of each determinant for the project's final performance and the interplay between them and the observed outcomes is discussed.

Table 16. Determinants of project outcomes

DETERMINANT	STRENGTH*
Relation with the context	+4
Selection process	+4
Project design	+5
Forecasting capacity	+5
Project governance	+5
Managerial Capacity	+4

*Note: * the strength score reflects the weight of the role that each determinant played with respect to the final judgment of the project. In particular:*

-5 = the determinant is responsible of the negative performance of the project;

-4 = the determinant provides a negative contribution to the overall performance of the project;

-3 = the determinant contributes in a moderate negative way to the overall performance of the project;

-2 = the determinant has a slightly negative contribution to the project performance;

-1 = the determinant plays a negative but almost negligible role to explain the overall project performance;

0 = the determinant does not play a role on the project performance;

+1= the determinant plays a positive but almost negligible role to explain the overall project performance;

+2 = the determinant has a slightly positive contribution to the project performance;

+3 = the determinant contributes in a moderate positive way to the performance;

+4 = the determinant provides a positive contribution to the overall performance of the project;

+5 = the determinant is responsible of the positive performance of the project.

4.1. *RELATION WITH THE CONTEXT*

The lack of a modern and efficient fixed link in the Rio-Antirio strait was a real problem perceived by the public administration and the citizens since a long time ago. As already described above a permanent crossing across the Gulf of Corinth has been envisioned more than a century ago by the Greek Prime Minister, Charilaos Trikoupis. Many were the Prime Ministers of Greece who attempted to implement this vision, and in 2004 this plan eventually became reality with the opening of the new bridge.

The opportunity to develop the link became more concrete after the accession of Greece to the European Union in 1981 and more specifically after the definition of the TEN-T policies and priority projects during the 1990s. The

project was indeed responding to the need for Greece and the European Union to modernise the main strategic motorway axes. The infrastructure development was supported and accompanied by an overall positive context of socioeconomic development, which was however unexpectedly designated to change with the start in 2008 of the still persisting economic and financial crisis. These elements were favourable with respect to one of the two main obstacles of developing the crossing, namely the availability of sufficient financial resources for such a mega project.

Apart from the difficulties of finding adequate funding, the second obstacle to developing the bridge related to the technical feasibility of the project. Thanks to several activities and studies financed by Greece over the course of the 1990s, the technical feasibility was gradually fine-tuned.

Another important context factor which supported the accomplishment of the bridge, at least concerning its completion time-schedule, was the selection of Greece by the Olympic Games Committee to host the 2004 Olympic Games. In this regard a contract was signed with Gefyra in 2004 to speed up the completion of the works, which effectively occurred. The bridge was open for traffic on the 12 August 2004, right before the start of the Olympic Games on the 13 August 2004. The link was originally expected to be completed by concession agreement on the 24 December 2004.

On the basis of the above, **the context in which the project was conceived was particularly favourable**.

4.2. *SELECTION PROCESS*

Selection process is understood as the institutional and legislative framework that determines how public investment decisions are taken, i.e. which is the process in place and the tools used to select among alternative projects.

The Rio-Antirio major project was a unique public work of its kind in Greece for both the financial and technical difficulties associated with its construction. As detailed at Chapter 2 above, it's implementation actually required the identification of a specific legislation and regulatory framework as well as the setup of dedicated institutions and ad hoc special organizational solutions. As a matter of fact, **the most challenging element of the selection process for the implementation of the bridge was represented by the setup of a flexible but effective framework of rules and responsibilities enabling the development and implementation of a project** characterised by a number of uncertainties or in any case elements to be ultimately defined during all stages of development and implementation of the project.

In this regard **the main enabling factor appear to be a very close vertical partnership between the Ministry of National Economy and the European Commission**. **These two bodies** were particularly concerned with the availability and the performance of the required supporting structures and throughout the implementation period they **put forward modifications to the institutional arrangements and monitored the overall implementation system**. Also, **the EIB helped to elaborate the right arrangements, in particular with respect to**

the financial aspects. Finally, the cooperation between **many foreign and Greek firms permitted the injection of expertise, without which the project would have been neither technically feasible nor financially viable**.

During the project preparation and selection process, the solutions of all critical aspects associated with the project implementation were found. The financial difficulties have been resolved with the support of the EU CSF program and furthermore with the BOT approach, which proved to be very successful in this project. It has to be noted that **the European Union has insisted that new departments within the Ministry of Public Works being established**, that they will operate almost autonomous (under the auspices of the Minister) and they can monitor day in and day out all phases of the development, from the contract negotiations, the designs, the changes required, the construction and the various techniques, the operation and maintenance plans, the ITS systems to be established, the environmental impacts, and so on. Accordingly, **the Special Secretariat of Public Works for Operation and Maintenance of Concession Projects** (EYDE/LSEP previously EUDE/SERA) **was set up to follow on a day by day basis the concession and the implementation of the project**. Many legal and regulatory measures were put in place allowing an overall flexible approach to the management of the PPP, but in an overall clear and firm context of roles, risks and responsibilities, also clearly defined in the concession agreement (see also Section 4.5).

Concerning the technical issues, a critical decision made just after signing the concession contract was the agreement between the state and the concessionaire to sign the so called "Contracts before the effective date". These contracts, which were executed in the period between the signing of the Concession Contact and the financial close, allowed the implementation of geotechnical surveys in the subsoil of the seabed. **These activities were necessary for the confirmation of the construction design assumption and the progress of the final design and were exclusively paid by the state.** These surveys played a very important role in the negotiation with the EIB, since they were proving the maturity of the design of such a risky construction.

Turning to the option analysis, several options for most of the project components were considered both at the design and construction stages, all of them were analysed from the technical-technological, location, environmental and social point of view.

As far as the PPP contract award method is concerned, **the choice of the concessionaire was made primarily based on capabilities**, **that would ensure the project's success in all phases**. At the same time, **the cost of the project,** defined for the owner as the length of the concession agreement combined to the amount that had to be invested, **was considered for the final decision**. The proposed cost and financial structure of the project was probably the reason that Gefyra was preferred from the other consortium that submitted the proposal.

4.3. *PROJECT DESIGN*

Project design refers to the technical capacity to properly design the infrastructure project.

The Rio-Antirio bridge represented a challenging infrastructure project non-only in financial terms and under the legal and institutional stand point. It was also **a challenging project under the technical point of view**, its structure, presenting exceptional features in terms of design and construction methods, mainly commanded by its seismic resistance.

Due to the peculiar conditions of the strait, several unique engineering problems needed to be considered and overcome. In particular, the most significant features of the strait are the following: the water depth reaches 65 m, the seabed is mostly of loose sediment, the seismic activity and possibility of tectonic movement is significant, the Gulf of Corinth is expanding at a rate of about 30 mm a year and the hills on either side create a wind tunnel where 70 mph winds are common.

For these reasons, special design and construction techniques were applied. Beneath each pier the seabed was first reinforced and stabilized by driving 200 hollow steel pipes vertically into the ground. The pier footings were not buried into the seabed, but rather rest on a bed of gravel meticulously levelled to an even surface (a difficult endeavour at this depth). During an earthquake, the piers can move laterally on the sea floor with the gravel bed absorbing the energy. The bridge decking is connected to the pylons using jacks and dampers to absorb movement; too rigid a connection would cause the bridge structure to fail in the event of an earthquake and too much lateral leeway would damage the piers. There is also provision for the gradual widening of the strait over the lifetime of the bridge. Protection from the effect of high winds on the decking is provided by the use of aerodynamic spoiler-like fairing and on the cables by the use of spiral Scruton strakes. The seismic conditions in the area along with the impact of a tanker (180.000 dwt) to hit one of the pylons (worst case scenario) were considered at the design stage.

A structural health monitoring system was also installed during construction on the bridge. Still operating, **it provides a 24/7 surveillance of the structure**. The system has more than 100 sensors **and features the ability to detect and specifically treat earthquake events**.

No particular issues have been reported to have occurred during the project implementation which would have caused delays impacting on the overall project time-schedule.

The project set numerous world records including:

- Longest cable-stayed suspended bridge deck 2,288 m;
- Deepest bridge foundations set at sea depths of 65 m;
- Largest bridge foundations - each pylon base is 90 m in diameter;
- First use of deep steel pipe inclusions to reinforce weak subsurface foundation soils; and
- Most innovative foundation system of “floating” pier bases bearing on a gravel bed over reinforced soils.

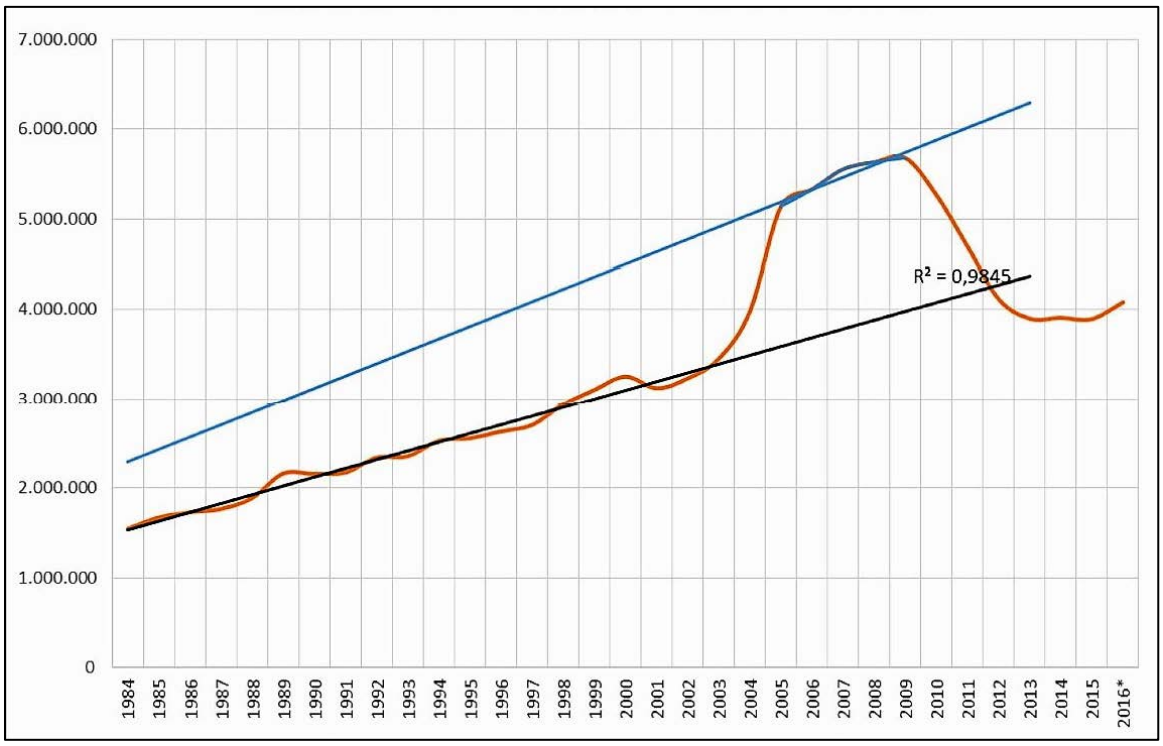
For these technical achievements the project was awarded the 2005 ASCE Outstanding Civil Engineering Achievement Award (OPAL). It was the first time that a project outside the U.S. has received the OPAL. The project has received widespread media coverage including specials on the Discovery and National Geographic channels.

4.4. *FORECASTING CAPACITY*

Forecasting capacity is understood as the possibility and capacity to predict future trends and forecast the demand level and estimate the technical challenges, thus estimating correctly the required resources (e.g. looking at the dangers of over predicting demand and under-predicting construction costs).

The graph below provides a comparison between the demand forecast and the real observed data for the crossings in the Straits of Rio-Antirio, up to 2016.

Figure 14. Yearly Evolution of Rio-Antirio strait Crossings



Source: POADEP

The data in the chart shows that in the first period between 1984 and 2004 travel trends remain firmly upward with an average growth rate of 4.5%. The analysis of growth gives as a result R^2=0.9845, which is extremely high, meaning that the average rate does not show significant variations per year featuring a linear progression.

Immediately after the construction of the bridge and within more than a year of operations (August 2004 - 2005) there was an increase of 48.8% at the crossings, corresponding to 1,687,572 vehicles (years 2003-2005). This traffic can be defined as induced (i.e., the traffic due to improved traffic conditions and not the movement that depends on the general economic conditions and possible changes in freight activity).

The traffic evolution in the strait, after the construction of the bridge and for the period 2004 to 2009, remains firmly upward with an average growth rate of 6.5% that is slightly higher than the rate observed in the previous two decades (1984-2004), 4.5%.

The financial crisis in Greece started in 2008 and is still in place today. This caused a substantial reduction of the total traffic in the strait. From 1984 to 2003 (a year before the opening of the bridge) the traffic increased by 4.38% per year (average). **The total traffic in the strait between 2009 and 2015 reduced by 31.42% and the bridge traffic reduced by 38.20%** which shows that, within the financial crisis, the higher toll prices played an important role in shifting some vehicles back to the ferries (reduction in the ferry lines was 22.62%).

After 2013 the strait traffic remains almost unchanged while **in year 2016 a growth trend of 4.8%** appears, even though it is mainly due to the **significant increase of heavy vehicles. The increase for the bridge was 8.9% for 2016 and 9.8% for 2017, providing an upward trend**. As explained at section 2.3 above, **this is also the effect of the completion of the Ionia and particularly Olympia Odos in 2017**.

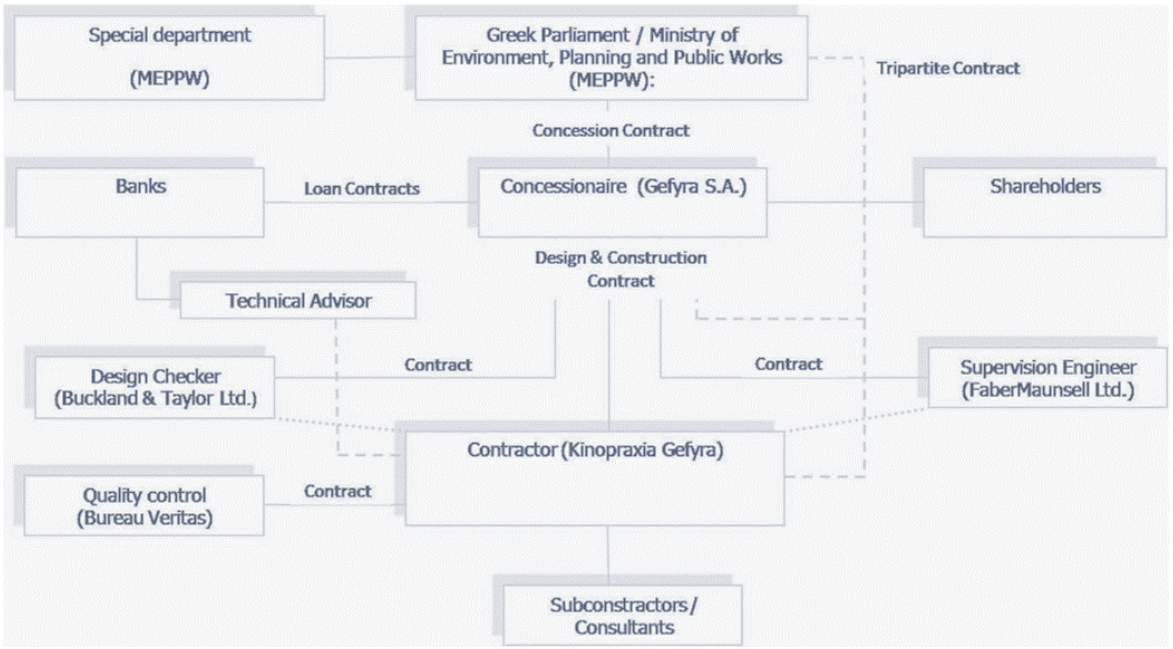
Notwithstanding this significant decline due to the unforeseen global recession, the current traffic volumes are only marginally lower than the traffic projections developed in the ex-ante phase. On this basis, it can be concluded that **the ex-ante traffic forecasts for the Rio-Antirio bridge were prudential enough to mitigate the risks of unforeseen market challenges**. **The fact that the concession contract was based on these forecasts represents a relevant mitigating factor for the financial performance of this PPP BOT project of the effects of the economic crisis**.

Concerning the forecasted financial resources and time schedule, it is worth noting that the scope of the concession agreement for the implementation of the Rio-Antirio project did not change considerably over time. The first change which occurred concerns the realisation of additional works including the development of the access road and the moving of the power cables in the strait. At the time the contract was signed, the State maintained the responsibility over these works. Subsequently they were actually awarded to the concessionaire who also performed additional works which were identified in line with the provisions of the contract that foresaw the possibility to perform extra works in an amount equal to the 5% of its lump sum value. Another change was the State request to Gefyra to complete in advance the construction of the bridge − on the basis of an economic compensation − in order to have it operational before the start of the 2004 Olympic Games

4.5. *PROJECT GOVERNANCE*

The project governance concerns the number and type of actors involved during the project cycle and how responsibilities are attributed and shared. In this respect, **the Rio-Antirio bridge was a project with a high number of stakeholders involved during the entire project cycle**. The figure below shows the organizational chart with all the participating entities in this project.

Figure 15. Project governance



Source: Gefyra

The Greek **Ministry of Development, Competitiveness, Infrastructure, Transportation and Networks** was involved **as the contracting authority. The supervising authority on behalf of the Ministry is the Special Secretariat of Public Works for Operation and Maintenance of Concession Projects** (EYDE / LSEP previously EUDE / SERA).

The legal basis for the concession was represented by Law 1418/84 **(public works law)** and Presidential Decree 609/85 **(public works contracting)**. The Greek Parliament was responsible for the ratification of the concession contract expressed in Law 2395/96 **(ratification by law of the concession contract)** and Presidential Decree 387/97 **(amendment of the concession contact and the Tripart Agreement).** These relevant legal and contractual documents appropriately identify and rule the roles, risks and responsibilities attributable to the public and private parties involved in the development, implementation and operation of the project: all risks (design, maintenance, exploitation and commercial risk) are to be borne by the private sector. The Government is responsible for any amendments of the initial regulatory system. Finally, force majeure risks are shared.

The Concessionaire - Private Party is "G.E.F.Y.R.A. S.A." with shareholders VINCI Concessions- Leader, Hellenic Technodomiki, J &P – Avax S.A., Athena S.A., Proodeytiki S.A. & Pantechniki S.A.[9]

The construction joint venture "KINOPRAXIA GEFYRA" undertook the design and construction of the bridge. Members of KINOPRAXIA GEFYRA were: VINCI Construction Grands Projects, AKTOR A.T.E, J& P-Avax S.A., Athena S.A., Proodeytiki S.A., and Pantechniki S.A. Subcontractors were Freyssinet, Advitam and other

[9] Today, GEFYRA S.A. has the following shareholders: VINCI Concessions S.A.A, AKTOR Concessions S.A., & J &P – AVAX S.A.

external engineers and advisors.

Project finance consisted of: Private equity (Concessionaire), Greek State and EU subsidy, EIB Loans. During the construction phase, the EIB loan was guaranteed by a consortium of commercial banks led by the Bank of America and the Bank of Tokyo - Mitsubishi (BTM – Europe, Ltd was the inter-creditor Bank Agent).

Furthermore, two independent engineering firms reporting to the Concessionaire and to the Greek State filled the roles of Design Checker and construction Supervision Engineer. **Backland & Taylor acted as design checker and Faber Mansell as supervision Engineer**. The Design Checker provided an independent confirmation of the design developed by the Contractor including design reviews, approvals and certifications; they were assisted by an impressive group of highly-regarded geotechnical and seismic Technical Advisors/specialists, which included Dr. R.B. Peck, Prof. R. Dobry, Prof. N. Priestley, Prof. F. Seible, and Prof. M. Calvi. The Supervision Engineer had the primary responsibility of monitoring the progress of the works, the workmanship, and conformance with the specifications and construction documents. **The Lender's Technical Advisors (Langan and Parsons Transportation Group) provided independent technical review for the financial partners prior to Financial Closing and throughout the design and construction periods**. The role of all the Technical Advisors, who were interacting with and reporting to both the Concessionaire and the Lenders, was critical to this project given the number of innovative design solutions and unique construction techniques employed.

In addition, **GEFYRA SA was also the Operator of the project.**

In the case of Rio-Antirio bridge there appeared some conditions that enabled or hindered risk and uncertainty mitigation and context sensitivity. **Those conditions are linked with the degree of competence of the directly involved institutions / companies / stakeholders but also with the communication between the decision-makers and the existence (or not) of formal and informal mechanisms that assist the converging to wise decisions at times of changing circumstances and challenges**. It can be said that those conditions had been prepared in advance because there was a risk and context-sensitive decision-making "regime" especially between the state and the concessionaire. This has to do with the fact that the responsibilities on the key risks, emanating from the technical and financial challenges of the project, were known well before the initiation of the project implementation. In this sense, there was time for concentration of resources, consensus building and familiarization of the strengths and weaknesses of the two parties. All those aspects of decision-making have been discussed as beneficial to the success of the decision - making processes and outcomes. **The smooth planning process is first of all the result of the good forecasting capacity of the Ministry of Public Works, which benefitted from the previous experience in similar projects i.e., Attiki Odos**. **Another factor which had a positive influence on the planning process is related to the fruitful institutional relationship between the project's stakeholders which resulted in an overall effective partnership over the course of the project and its phases**, including the definition of the project idea, selection of the most appropriate project options and design solutions, all this making also possible that the

Rio-Antirio bridge opened 12 August 2004 instead of 31 December 2004.

Due to its success, **the administrative heritage of the Rio-Antirio bridge has been exploited in the implementation of Road Axes projects under the third CSF (2000-2006).** In particular, **the positive experience of the BOT project financing method has led to its widespread use in motorway infrastructure projects in the 2000-2006 programming period**. The most significant outcome of the implementation system created was the change in attitudes towards the new organization of management structures in the context of public utilities and services.

4.6. *MANAGERIAL CAPACITY*

The managerial capacity refers to the professional ability to react to changes in the context/needs as well to unforeseen events during the project implementation and afterwards as well as to the professional capability to manage the project ensuring the expected level of service in the operational phase.

GEFYRA S.A., as Concessionaire, is responsible for the design, construction, financing, maintenance and operation of the bridge during the 42-year concession period. To fulfil its commitments, it has signed more than 50 agreements to date, including the construction contract with the Construction Joint Venture and the numerous detailed financing agreements with the Lenders.

Particularly **regarding the development phases of the project the decision by Gefyra of assembling an international team of professionals was crucial not only to tackle the technical challenges of this mega-project but also to ensure transparency and generate consensus between all the involved parties and enforce integrity throughout the delicate initial stages of the development and implementation process**. The structure of the team enabled an effective system of checks and balances, helping to encourage innovation while bolstering efficiency, facilitate dynamic communication, and safeguard the diverse interests of the many stakeholders involved.

In view of the start of the construction works, Gefyra also undertook a proactive approach with the establishment of an onsite training centre and program designed to develop a skilled labour pool of foremen, group leaders and labourers necessary to meet the demands of the project. The Contractor opted to train locally rather than import skilled labour due to language advantages and the local workers' good spirit and willingness to learn. While proper training may have caused some initial delays in the early stages of construction, the long-term benefit has been justified. This solution proved to be very appropriate and beneficial as there was a shortage of skilled labourers for the unique type of work involved in this project, and the Concessionaire was also required to work with strong labour unions in Greece.

During the construction period, the Concessionaire ensured the sound comprehensive management of the entire financial scheme for the project including its day-to-day financing needs. **Since August 2004, when the construction period ended, and until the expiry of the concession period, GEFYRA S.A. is responsible for the smooth operation of the project (within the framework of the concession agreement), its maintenance and all necessary improvements**.

GEFYRA LITOURGIA SA is the company that operates the Rio-Antirio bridge within the framework of a multi-annual contract entered into with the Concessionaire GEFYRA SA **and is responsible for the toll management, the traffic management and the routine maintenance of the Rio-Antirio bridge**. The shareholders of GEFYRA LITOURGIA S.A. are the same companies that participate in GEFYRA S.A.

In addition, **a rational management plan has been developed in order to prevent and minimize the risk of structural deterioration of the bridge**. Complementary methods to visual monitoring methods (visual inspections) are implemented such as material and instrumented monitoring. The results of all type of monitoring are analysed by the structural maintenance engineers, the Designer and other specialized Suppliers/Consultants. Then every finding is assessed and any necessary actions to be taken are defined.

In relation to safety, the maximum safety level of the Rio-Antirio bridge is achieved thanks to the use of latest developments in the field of bridge management classifying it as one of the most innovative bridges even in this field - in addition to the other design & construction innovations.

Under the commercial stand point, it is worth noticing that over the past 13 years of operation of the bridge, the company has managed to keep the bridge service competitive maintaining over time a stable 80% or higher share of the total traffic across the strait. Since November 2004 and April 2005, in line with recent practices introduced in the toll road sector all over European countries, **Gefyra has introduced a system of epass subscriptions and other beneficial packages for the users**. This allows frequent users to reduce the cost of each single transaction. **The solution is aimed at keeping the service competitive against the ferries**.

With reference to the capacity of the operator to successfully cope with operational issues, it is worth mentioning that six months after the opening of the bridge, **on 28 January 2005, one of the cable links of the bridge snapped from the top of the M1 pylon and came crashing down on the deck**. **Traffic was immediately halted**. The first investigation claimed that a fire had broken out on the top of the M1 pylon, after a lightning strike in one of the cables. **The bridge reported no damages. The cable was immediately restored and the bridge reopened**.

The managerial capacity of the operator is assessed at high level, since the quality and the level of service, the maintenance, the safety and ability to respond timely and efficiently in every issue.

4.7. *PROJECT BEHAVIORAL PATTERN*

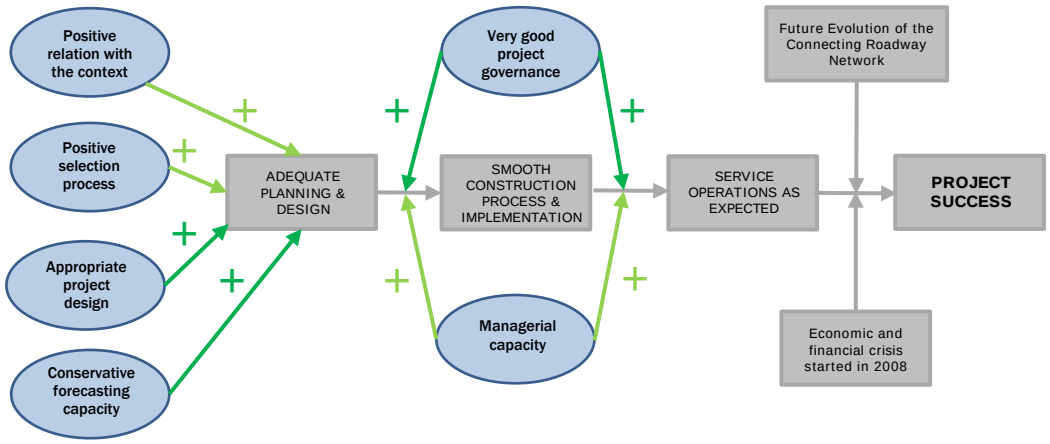
Following the identification of the typical determinants of project performance and the main project outcomes, the final step entails describing the chain of interlinked causes and effects determining the project performance over time.

The behavioural pattern of the project under assessment is provided in the following figure. The round boxes in light blue indicate the projects' determinants, the rectangular boxes in light grey refer to the observed events, the '+' signs next to the

green arrows indicate that the factor has positively influenced the project performance. In particular, arrows in green indicate factors that had a stronger influence on the project, arrows in light green indicate instead factors that had a positive but less strong influence. There are no project internal elements that seems to have affected the project negatively.

The Rio-Antirio bridge is an example of a satisfactory and successful ambitious project concerning the development of a more than 2 km long bridge over the sea strait of Rio-Antirio, which had a significant impact on the overall transport network between Peloponnese and Northern Greece (mainland). **The project overall positive performance is the result of a combination of factors**: a good start after lengthy negotiations, good planning and design, a well-grounded selection process, a profitable involvement and commitment from all the relevant stakeholders.

Figure 16. Behavioural pattern of the Rio-Antirio bridge – Bright Star



Source: Authors

In terms of project determinants, **context is without doubt one the most important pre-requisite of the project's performance**. The Rio-Antirio bridge was in fact in line with the context needs and the objectives of the relevant transport strategies in Greece and within the European context, as it is part of TEN-T and it has adequate demand for the service. On the face of it, **good managerial capacity and effective project governance were able to promptly provide an adequate response and make financial and technical capacity available for the initiation, implementation and operation of the project**.

The whole project definition and selection process managed by the Ministry of Public Works Special Secretariat EYDE/SERA (now called EYDE/LSEP) **have also been crucial for the appropriate definition and performance of the PPP BOT scheme adopted to implement and operate the project**.

The project preparation and design proved to be very effective, also in the adaptation of the construction solutions at the stages of detailed design and project construction. **The total costs for the construction of the project was in line with the expected estimates**. **The project time-schedule was also respected** and actually the concessionary company was able to react to a request by the Greek Authorities to speed up the completion of the works in time for the start of the

Olympic Games on the 13 August 2004. The bridge opened for traffic the day before the inauguration of the games.

Further to an overall correct estimation of the total project cost and implementation time-schedule, **the project also proved to be based on prudent traffic and revenue forecasts**. **This resulted in the maintaining of the project financial sustainability** even in the current challenging economic environment, considering that the economic crisis started in 2008 has overall caused a decline in traffic by 40%. **The development and completion of the motorway network interconnected with the bridge, particularly Attiki Odos and Iona Odos, as well as the infrastructure interconnecting these motorways with the main local municipalities in Etoloakarnania (e.g. Agrinio and Mesolongi) is likely to increase the socioeconomic benefits generated by the project**.

5. FINAL ASSESSMENT

Based on the different findings produced by the project analysis both in terms of effects generated and measured through the CBA or qualitatively discussed as well as of the factors affecting the generation of those effects, the final assessment of the project performance is presented here after along a set of evaluation criteria.

5.1. *PROJECT RELEVANCE AND COHERENCE*

The project has been envisioned for more than 100 years. The connection of the strait Rio-Antirio with a bridge would solve many problems, in relation to the connection of Peloponnese to the mainland. In addition to local population, the bridge on the strait was expected to positively affect national mobility since the strait is part of the national network connecting Peloponnese and the mainland. Before the project was implemented, the best alternative to cross the Gulf of Corinth was represented by ferries. However, **ferries were not operational when the weather conditions did not allow navigation across the strait and this often caused delays of hours, sometimes days**.

Despite its relevance from the functional standpoint, the construction of the bridge was delayed due to technical difficulties and the significant amount of resources required for its realisation. **The opportunity to develop the link became more concrete after the accession of Greece to the European Union in 1981 and the implementation of the development programmes supported by the EU Structural Funds. The definition of the TEN-T policies and priority projects, also including the bridge were also fundamental for its development**.

During the 1990s studies intensified to investigate the technical and financial feasibility to construct a bridge. **In 1993 the Rio-Antirio bridge was appraised in the framework of a national transport study called GREECE 2010 that also provided an input for the 1994-2000 and the 2000-2006 EU Community Support Frameworks. In 1994 the bridge was included in the TEN-T priority project No. 7 and it was subsequently included as a major project in the Operational Programme 2000-06 "Road Axes, Ports, Urban Development", eligible for substantial grants from ERDF.** In this regard it is worth noticing that the construction of the bridge was synergic with the development of many new highways interconnecting the strait with the other parts of Peloponnese and the mainland, creating a scheme that would dramatically change the national transport infrastructure system.

The bridge is nowadays part of the main motorway network of Greece and belongs to the alignment of the Orient-East Mediterranean Core Network Corridor. **The bridge fully responded and still is coherent with the overall general strategic objectives of the national and European policies on transport and mobility**. It is functionally well integrated with the operation of the main national and European strategic road network.

5.2. *PROJECT EFFECTIVENESS*

Eight objectives have been identified associated with the implementation of the bridge which are specified in the introductory report of Law 2396/1995 for the ratification of the concession contract of the Rio-Antirio bridge.

These objectives include 5 targets that were strictly related to the expected output of the bridge as a transport infrastructure, such as generating travel time savings, completing a missing link in the PATHE TEN-T axis (belonging to TEN-T Priority Axis No. 7 – nowadays Orient-East Mediterranean Core Network Corridor) and enhancing international connections to Italy and Western Europe, reducing congestion and pollution in the ports of Rio and Antirio and improving comfort, reliability and quality of the crossing service. Based on the results of the ex-post CBA analysis and the qualitative evidence collected during our interviews, **all these objectives can be considered fully accomplished**.

The results of the ex-post CBA — with ENPV at the level of nearly EUR 2.2 billion and ERR equal to 6.87% — confirm that **the expected effects have materialised to such an extent that the project provides a good social return of the invested resources, making it worthwhile form the point of view of the EU society. Additionally, the risk analysis shows that under the socioeconomic perspective the project has a negligible risk level**, i.e. with negative variations from the reference case of the values of critical variables, there is no probability that the ENPV of the project become negative and a probability of nearly 50% that the expected ENPV and ERR are less than the reference one.

These positive results have been achieved despite delays in the implementation of the Olympia Odos and of Ionia Odos motorways, which have been completed only by mid-2017. **The opening for traffic of these two important infrastructure and the further interconnection of these trunk roads with the main local socioeconomic centres in Etoloakarnania** (e.g. Agrinio and Mesolongi) **are likely to further increase the effectiveness of the project, by maximising its network effect at the national and reginal/local levels**.

Three out of the identified eight project objectives identified which related to wider economic benefits. The implementation of the bridge was indeed also aimed at supporting local and regional development, contributing to the economic and social development of the territories of Peloponnese, Western Greece (Etoloakarnania) and Epirus, as well as housing development and production sites of the wider area around the bridge. The new crossing was expected to enhance the competitiveness of the existing businesses and lead to the establishment of new ones in the isolated areas of the North-Western parts of the country.

While reaching these targets is not solely attributable to the bridge, **the original project concept implied that the project would contribute to achieving those objectives**, all of them relating to wider - in both spatial range and temporal horizon - development goals for the Prefectures of Achaia and Etoloakarnania and the regions of Western Greece, Peloponnese and Epirus. In this regard the analysis performed as part of this ex-post assessment of the Rio-Antirio major project is hampered by the overall limited availability of fact-based evidences concerning most of these wider

objectives. However, **the amount of the induced traffic observed on the bridge shows that the project had a relevant impact on the mobility at the regional scale**, and thereby on the geography of the local economy. **Furthermore, interviews have been performed as part of this ex-post assessment which seem confirming that the project is contributing to the achievement of the objectives relating to territorial cohesion and socioeconomic development**. Albeit not allowing for quantification, this suggests that positive wider economic and social impacts were likely generated by the project, although more precise socioeconomic data would be needed to comment on the specific triggered effects.

5.3. *PROJECT EFFICIENCY*

The project was implemented on time and at the expected costs. As of the PPP BOT model adopted for its development, implementation and operation, the project proved to be a success and pave the way for other investments in Greece.

The financial sustainability has been assessed for the project based on 2004-2017 data and is positive. The project investment was co-financed by the EU (CF) and national contribution. The overall level of EU co-funding for this project was 28.5% of the total project costs. Other 22.1% of public funds were provided by the national authorities, while the remaining 49.4% were private funds, secured partly by the private equity of the investor (7.7%) and by an EIB loan (41.7%).

The financial structure of the project proved to be resilient to the effects of the downturn in the EU and especially national economy, due to a combination of prudent traffic and revenue assumptions at the tendering stage and a relatively low share of the private equity. It shall be in fact noticed that, despite the decline in traffic volumes after 2008, the rate of return on the private equity (estimated at 9.30% in our analysis) is still acceptable and in line with the highway construction sector and the assumptions on which the original tender was based. This is also in line with the maximum ROE foreseen in the concession contract (11.50%), which, if reached before 35 full operational years, would trigger the end of the concession period.

5.4. *EU ADDED VALUE*

The implementation of a large and complex project like the Rio-Antirio bridge through a Public Private Partnership represented an unprecedented process for the public decision-making system. Since major road projects were implemented as purely public projects co-funded by Structural Funds, the project was amongst the first major concession contracts implemented in the transport sector in the country. This required the development and setup of a specific institutional learning process by the involved institutions, which was guided and ultimately supervised by the European Commission.

Due to the specific project implementation process**, international expertise has been utilized through the concessionaire and it has also been possible to**

raise the necessary funds (EIB loan, concessionaire's participation) in addition to public expenditure (EU and National) that made the project financially feasible. This is of particular importance since the technical specifications of the project provided an increased risk for the investment. Moreover, EIB's involvement, with special expertise in financing major projects, besides ensuring valuable resources, resulted in the creation of such a financial design model that minimised any risks in case of non-completion of the project.

The successful delivery of the project within the expected deadlines and budget, which at the time was a challenge for EU co-funded programmes, highlighted it as a 'good practice' model. The Rio-Antirio bridge was amongst the first three projects to be procured as Private Public Partnerships in Greece with the support of EU Structural Funds and EIB's long-term lending. It opened the way for the adoption of a new method of project delivery, both from the government and the public in general. A direct result of this development was the improvement of capacity building in the public sector (Ministries, Managing Authorities of EU co-funded programmes, etc.) and the familiarisation of the business world with this system for the delivery of public works.

5.5. *FINAL ASSESSMENT*

In conclusion, **the major project represents a good example of a unique road transport bridge, implemented by means of a PPP initiative. The Rio-Antirio fixed link is a relevant project for Greece and its regions, as well as the European Union.** Its completion in 2004 was a significant progress towards the implementation of the Trans-European Transport Network (TEN-T), which also contributed to overcome the isolation of Western Greece, while providing growth prospects in the region. The project is generating high positive socioeconomic effects by significantly reducing travel times across the Rio-Antirio strait. It has furthermore increased mobility at the regional scale likely supporting the development of socio-economic activities in the prefectures interconnected by the bridge in Western Greece. **The major project seems effectively contributing to the achievement of the expected objectives including the ones relating to regional economic development, although the lack of relevant data hampers the accurate quantification of the wider effects associated with the operation of the bridge**. Part of the wider national and international road transport network, the recent completion of the Olympia Odos and Ionia Odos motorways by mid-2017, is likely to increase long-distance traffic across the bridge and thus also the effects generated by the bridge also at the wider national and international scale. At the same time the completion of these trunk roads and possibly the development of a better interconnection of the main socioeconomic centres in Etoloakarnania with the Ionia Odos (e.g. Agrinio and Mesolongi), are expected to further increase the positive results so far achieved by the bridge at the regional scale. **Notwithstanding the challenging negative economic context as of 2008 the analysis seems confirming the financial sustainability of the project and the viability of the PPP BOT scheme adopted for the development, implementation and operation of the fixed link**. **The project was furthermore implemented on time and at the expected costs. This was both due to the use of international expertise**

through the concessionaire and the set-up of a number of legal, regulatory, institutional and administrative measures tailored at supporting the development of this and other relevant PPP infrastructure projects in Greece. This process was implemented by the Greek Government under the supervision and advice of the European Commission. Accordingly, **the major project also represents a relevant example of EU added value, specified that the involvement of the European Union in the financing of the PPP initiative (Cohesion Fund and EIB loan) ultimately made the project financially viable and its implementation possible**.

Table 17. Evaluation matrix

CRITERIO	EQ	ASSESSMENT	SCORE (*)
Relevance	To what extent the original objectives of the examined major project matched: • the existing development needs, • the priorities established at the programme, national, and/or EU level.	The project was and over the years remained fully in line with the development needs and the established priorities	5
Coherence	• Are the project components in line with the stated project objectives? • To what extent the examined the projects were consistent with other national and/or EU interventions carried out in the same field and in the same area?	Fully consistent	5
Effectiveness	• Has the examined major project achieved the objectives stated in the applications for Cohesion policy support? • Was the actual implementation in line with the foreseen time schedule? • What factors, including the availability and the form of finance and to what extent influenced the implementation time and the achievement observed? • What has changed in the long run as a result of the project (for example, is there evidence showing contribution of the project to the private sector investments)? • Were these changes expected (already planned at the project design stage, e.g., in terms of pre-defined objectives) or unexpected (emerged, for instance, as a result of changes in the socioeconomic environment)? • How have these changes matched the objectives set and addressed the existing development needs, the priorities established at the programme, national and/or EU level? • Did the selected project turn out to be the best option among all feasible alternatives?	The project has achieved all the infrastructure and functional expected objectives in line with the foreseen time schedule. Some objectives related to the wider effects of the project on the territory are not possible to be fully assessed, due to the lack of available evidences	4
Efficiency	• Are there any significant differences between the costs and benefits in the original cost-benefit analysis (CBA) and what can be observed once the project has been finalised?	The ex-post CBA proves that the project adds value to society	**5**

	• To what extent have the interventions been cost effective?		
EU added value	• What is the EU added value resulting from the examined major project (in particular, could any of the major projects examined, due to its risk profile, complexity or scope, have not been carried out if not for the EU support)? • Did the examined major projects achieve EU-wide effects (e.g. for preserving the environment, building trans-European transport networks, broadband coverage etc.)? • To what extent do the issues addressed by the examined interventions continue to require action at EU level?	High EU added value, i.e. the project achieved positive effects which would have been hardly reached without the EU support. The institutional, legal and regulatory framework set up for this project (as well as Attiki Odos), was a relevant experience for the subsequent extension of PPP schemes to other projects in the transport sector as well as in other sectors.	5

*Note: * scores range from 1 to 5. Source: Authors*

6. CONCLUSIONS AND LESSONS LEARNED

The ex-post assessment of the Rio-Antirio bridge major project supports the conclusion that **the project was overall technically sound under both the infrastructural and functional stand points**, contributing to the main targets and objectives of the EU transport and cohesion policies. **The results of the ex-post CBA are positive also confirming that the project is adding value to the EU society**, notwithstanding the challenging negative economic context as of 2008. **The analysis seems confirming the financial sustainability of the project and the viability of the PPP BOT scheme** adopted for the development, implementation and operation of the project.

Since late 19th century, **the implementation of the Rio-Antirio bridge** was a national dream and a project going far beyond local boundaries. Its implementation in 2004 **was a big step towards the completion of the Trans-European Transport Network (TEN-T)**, which also contributed **to overcome the isolation of Western Greece,** while providing growth prospects in the region. **The recent completion of the Olympia Odos and Ionia Odos motorways by mid-2017** (as well as the better interconnection of the main socioeconomic centres in Etoloakarnania with these major trunk roads, e.g. Agrinio and Mesolongi) **is expected to further increase the positive results so far achieved by the bridge**.

The following relevant considerations and lessons can be learned from the ex-post assessment of this major project:

- This case study points to the fact that **major projects can have a pivotal role in promoting new solutions**. Actually, the total project under the planning, design, financing and of course construction stand points provided many innovative solutions which led to numerous international awards.
- The history of the project shows that **for private financing the adoption of a solid and resilient financial structure is essential to ensure the project remains viable also in the event of negative economic conditions**. In particular the Rio-Antirio major project is proving to be resilient to the effects of the downturn in the EU and especially national economy, due to a combination of prudent traffic and revenue assumptions at the tendering stage and a relatively high portion of institutional financing from the EIB, in addition to the contribution from the EU and from the State.
- **The project is an example of the relevant role of public institutions in setting a favourable legal context and regulatory framework for the deployment of PPP solutions** in the development, implementation and operation of public infrastructure and services. In these terms the major project is also representing a pioneering example of the use of innovative financial instruments, which are currently a priority on the agenda for the development of the TEN-T core network corridors.
- **In order to maximise the impacts and magnitude of the benefits generated by major projects network effects are worth to be considered**. In this regard the bridge is part of the wider national and European strategic road network; the completion of Olympia and Ionia Odos

are worth to mention which are expected to further amplify the positiveness of the major project in terms of socioeconomic impacts also at the wider national and international scales. Further to the trunk road interconnected network, the ex-post assessment seems also to point to the relevance of ensuring appropriate interconnection between the trunk road network and the main socioeconomic centres located in in Etoloakarnania served by the long-distance infrastructure (i.e. Agrinios and Mesolongi municipalities). This is expected to further increase the positive results so far achieved by the bridge at the regional scale. In consideration of the predominance of the use of the bridge at the regional and local scales as proved by the analysis of the demand using the bridge, the possible further reduction of the tariffs, especially for frequent users or for round trips might further amplify the magnitude of the effects generated by the bridge at the regional/local scale especially in terms of regional and economic development.

Whilst the major project shows very positive socioeconomic results with reference to the main quantitative effects measured by the CBA, limited fact-based evidences are available concerning the wider socioeconomic effects on the territory. The size of the project would have probably justified the implementation of a set of Key Performance Indicators (KPIs) and monitoring processes in this regard. Far from being a project specific issue, the absence of such information reveals the low maturity of the institutional practice of project monitoring and particularly the lack of structured guidance and obligations on the ex-post assessment of major projects.

ANNEX I. METHODOLOGY OF EVALUATION

This Annex summarises the methodological approach undertaken for carrying out the project case studies and presented in the First Intermediate Report of this evaluation study. The main objective is to provide the reader a concise account of the evaluation framework in order to better understand the value and reach of the results of the analysis as well as to enable him/her, if interested, to replicate this methodology.[10]

The Annex is divided into four parts, following the four building blocks of the methodological approach (mapping of effects; measuring the effects; understanding effects; synthesis and conclusions) laid down in the First Intermediate Report. Three evaluation questions, included in the ToR, guided the methodological design. They are:

- **What kind of long-term contribution** can be identified for different types of investment in the transport field?
- **How is this long-term contribution generated** for different types of investments, i.e., what is the causal chain between certain short-term and long-term socioeconomic returns from investments?
- **What is the minimum and average time** needed for a given long-term contribution to materialise and stabilise? What are these time spans for different types of investments in the transport field?

A I.1 Mapping the effects

The Team developed a classification of long-term effects, with the aim of identifying all the possible impacts of transport investments on social welfare. Under four broad categories, a taxonomy of more specific long-term development effects of investment projects has been developed. The definition of each type of effect is provided in the table below.

Far from being exhaustive, this list is intended to guide the evaluators in identifying, in a consistent and comparable way, the most relevant effects that are expected to be identified and included in the analysis. Additional effects could possibly be relevant in specific cases and, if this is the case, they can be added in the analysis.

In researching all the possible long-term effects of project investments, it is acknowledged that there could be a risk of duplication. In addition, the allocation of some effects under different categories is to some extent arbitrary and thus it may happen that categories overlap. That said, caution will be paid in order to avoid double counting when performing the ex-post CBA.

[10] Specific recommendations which may enable application of the same evaluation methodology to future projects are discussed in the Final Report of this evaluation study.

Table 18. Taxonomy of effects

	DIRECT EFFECTS	DESCRIPTION
FFECTS ON ECONOMIC GROWTH	Travel time	Reduction in travel time for business travellers, shippers and carriers (including the hours gained because of a reduction of congestion) is a typical positive outcome of transport project, except those that specifically aim at environmental or safety benefits.
	Vehicle operating cost	Vehicle operating cost savings for the travellers (fuel costs, fares) and for transporters of goods (this refers to the distance-dependent transport costs) are relevant if the project aims at reducing congestion and/or the journey distances.
	Reliability of journey time	It means reduced variation in journey times. Reliability benefits are potentially important for many projects, unless journey times are already quite reliable. However, often forecasting models or other information for the impacts on and through reliability are missing (de Jong and Bliemer, 2015)
	Income for the service provider	It includes the revenues (e.g. rail ticket income increase) accrued by the producer (i.e. owner and operators together) as well as the operational cost savings. To some extent it can reflect the previous aspects (i.e. the service fare is increased to reflect a better service allowing for significant time saving for the users) so double counting shall be avoided. This aspect might be particularly relevant for public transport projects or toll road projects, especially if the project is expected to feature significant traffic (generated or induced) or a substantial change in fares.
	ADDITIONAL EFFECTS	**DESCRIPTION**
	Wider economic impacts	It refers to the agglomeration effect on productivity (the productivity of the economy is increased because the project leads to a clustering of economic activities together in a core city which makes these sectors produce more or better goods and services together than before). Agglomeration effects are unlikely to occur for small projects and even for large projects there are specific pre-conditions (see for instance Chen and Vickerman, 2017). Wider economic impacts (agglomeration effects) depend on whether the project makes a potential economic cluster location substantially more accessible. This is only possible if the infrastructure network before the project had important missing links which the project effectively removes.
	Institutional learning	It refers to wider spillover effects that any investment project may bring to the Public Administration and other institutions at national or regional levels in terms of expertise gained by working on large

		scale projects. Learning may lead to productivity gains by stimulating the improvement of existing technical know-how, improved policy-making, competitive tendering and divert resources towards the most growth enhancing projects.
EFFECTS RELATED TO QUALITY OF LIFE AND WELL-BEING	**DIRECT EFFECT**	**DESCRIPTION**
	Travel time	Leisure time saving relates to projects that provide a reduction in travel time for non-business travellers.
	Safety (accident savings)	It relates to the amount of fatalities, serious and slight injuries, damage-only accidents. Safety impacts should possibly be included in all project evaluation.
	Security	Safety of travellers in the vehicle and at stations, platforms and stops, safety of the goods transported (often damaged or stolen). Security impacts are often neglected in project evaluation, but for public transport projects (both urban and intercity) they can be of considerable importance.
	Noise	It refers to the exposure of population to noise measured in dB
	ADDITIONAL EFFECT	**DESCRIPTION**
	Crowding	A reduction of crowding in public transport is mainly relevant for projects that provide significant additional capacity in public transport.
	Service quality (other than crowding)	It refers mainly to the availability of specific service features increasing the journey comfort e.g. smoother movement of the vehicles, more comfortable seats, provision of electricity, Wi-Fi, catering.
	Aesthetic value	This relates to projects that provide infrastructure with positive visual effects (e.g. a beautifully constructed bridge) or when public transport provide a better image in the eye of the public. Also, it refers to projects that lead to a less attractively looking landscape (e.g. constructing high walls).
	Urban renewal	It refers to the spillover effects of urban transport projects on residents (not necessarily users of the project) due to an improved local context and possibly reflected in an increase in real estate values.
EFFECTS ON THE ENVIRONMENT	**DIRECT EFFECT**	**DESCRIPTION**
	Local air pollution	Local air pollutants are typically small particles, NO_x, VOCs and SO_2. The increased/decreased volume of local air emissions is a typical effect of transport projects.
	Climate change	Climate change refers to the volume of greenhouse gases (GHG) emitted by transport infrastructure. The increased/decreased volume of GHG emissions is a typical effect of transport projects.

	ADDITIONAL EFFECTS	DESCRIPTION
	Biodiversity	This refers to the reduction of biodiversity through the extinction of species in a specific area. It is not a common effect but it can be relevant in selected cases.
	Water pollution	Emissions of substances, e.g. from the road, into watercourses, that are harmful for people (as drinking water) or for life in the water
EFFECTS RELATED TO DISTRIBUTIONAL ISSUES	**ADDITIONAL EFFECTS**	**DESCRIPTION**
	Social cohesion	It encompasses the allocation of the main benefits over income and social groups
	Territorial cohesion	It encompasses the allocation of the main benefits over central (core) and peripheral areas

Source: Authors

A I.2 Measuring of effects

Because of the variety of effects to be accounted for, a **methodological approach firmly rooted on CBA (complemented by qualitative analysis** when necessary) is adopted in order to grasp the overall long-term contribution of each project.

In terms of their measurement level, the effects can be distinguished into:

A. **Effects that by their nature are already in monetary units** (e.g. transport costs savings). These can therefore be easily included in a cost-benefit analysis (CBA).
B. **Effects that are quantitative, but not in money units, and that can be converted into money units in a reasonably reliable way** (e.g. transport time savings, accidents, air pollution). These effects can also be included in the CBA.
C. **Effects that are quantitative, but not in money units, for which there are no reasonably reliable conversion factors to money**. We propose not to try to include such effects in the CBA, but to discuss them in a qualitative way together with the overall outcome of the CBA.
D. **Effects that are difficult to measure in quantitative (cardinal) terms but do lend themselves for ordinal measurement** (a ranking of the impact of different projects on such a criterion can be provided, such as very good, good, neutral, bad, very bad). We propose to discuss these effects in qualitative terms.
E. **Effects that might occur but that are subject to a high degree of uncertainty:** these will be treated as part of the risks/scenario analysis that will be included in the CBA.
F. **Effects that might occur but that we cannot even express in an ordinal (ranking) manner:** they are residual effects that can be mentioned in qualitative description in case study report.

In short, all the projects' effects in A and B are evaluated by doing an ex-post cost-benefit analysis (CBA). Reasonably, these represent the most significant share of long-term effects. Then the outcome of the CBA (e.g. the net present value or benefit-costs ratio) is complemented by evidence from C and D, while E is used for descriptive purposes. Moreover, qualitative techniques are used to determine why certain effects are generated, along what dimensions, and underlying causes and courses of action of the delivery process (see below).

Section 3 of each case study includes a standardised table in which scores are assigned to each type of long-term effect. Scores ranging from -5 to +5 (5 = very strong negative effect; 0 = no effect; 5 = very strong positive effect) are given in order to intuitively highlight which are the most important effects generated for each case study.

A I.3 Understanding the effects

Once the project effects have been identified and measured, and the causal chain linking different categories of short-term and long-term effects has been investigated, the third building block of the methodological approach entails reasoning on the elements, both external and internal to the project, which have determined the observed causal chain of effects to take place and influenced the observed project performance.

Taking inspiration from the literature on the success and failure of projects, and particularly on costs overruns and demand shortfalls, and on the basis of the empirical evidence which develops from European Commission (2012) six stylised determinants of projects' outcomes and their development over time have been identified (see table below).

The interplay of such determinants may reinforce or dilute one effect over the other. Moreover, each determinant may contribute, either positively or negatively to the generation/speed up/slow-down of certain short-term or long-term effects. For this reason, it is important not only to understand the role that each determinant has on the observed project outcome, but also their interplay in a dynamic perspective.

In doing this, it is useful to refer to stylised, typical "paths" of project behaviours outlined in the following table. Such patterns capture common stories and reveal recurring patterns of performance, as well as typical problems that may arise and influence the chronicle of events. Case studies test the validity of such archetypes and are used to specify in better nuances or suggest possible variations or additions.

Section 4 of each case study includes standardised tables in which scores are assigned to each determinant. Scores ranging from -5 to +5 are given in order to intuitively highlight which are the most relevant determinants explaining the project outcomes (5 = very strong negative effect; 0 = no effect; 5 = very strong positive effect). Moreover, section 4 of each case study includes a graph describing the project's behavioural pattern, i.e. describing the chain of interlinked causes and effect determining the project performance over time.

Table 19. Stylised determinants of projects' outcomes

DETERMINANT	DESCRIPTION
Relation with the context	It includes the considerations of institutional, cultural, social and economic environment into which the project is inserted, was the project appropriate to this context?; is there a problem that the project can solve?; does the project remain relevant over the years?
Selection process	It refers to the institutional and legislative framework that determines how public investment decisions (and especially those co-financed by ESIF) are taken, i.e. which is the process in place and the tools used to select among alternative projects. The selection process is influenced by incentive systems that can lead politicians and public institutions to either take transparent decisions or strategically misrepresent costs and/or benefits at the ex-ante stage.
Project design	it refers to the technical capacity (including engineering and financial expertise) to properly design the infrastructure project. Under a general standpoint, we can distinguish: • the technical capacity to identify the most appropriate conceptual design, which best suits the need of a specific context. Even when a region really is in need of the project, it usually requires a well-designed project to solve the observed problems. This, in turn, involves that different alternatives are considered and the best option in terms of technical features and strategical considerations is identified; • the technical capacity to develop the more detailed level of design (preliminary and detailed), thus identifying most effective and efficient detailed infrastructure solutions and construction techniques, thus avoiding common pitfalls in the construction stage (such as introducing variants that are not consistent with the original conceptual design) and the risk of cost overruns during the construction phase by choosing inappropriate technical solutions.
Forecasting capacity	It regards the possibility and capacity to predict future trends and forecast the demand level and estimate the technical challenges, thus estimating correctly the required resources (e.g. looking at the dangers of over-predicting demand and under-predicting construction costs). In particular, technical forecasting capacity is related to the quality of data used and forecasting/planning techniques adopted. At the same time, forecasting capacity includes the ability of the project promoter and technical experts not to incur in the planning fallacy (the tendency to underestimate the time or cost needed to complete certain tasks) and optimism bias (the systematic tendency to be overly optimistic about the outcomes of actions).
Project governance	It concerns the number and type of stakeholders involved during the project cycle and how responsibilities are attributed and shared. This is influenced by the incentive mechanisms. If bad incentives exist, this can lead different actors involved in the project management to provide benefits for their members, thus diverting the funds away from their optimal use, or forcing them to delegate responsibilities according to a non-transparent procedure.

Managerial capacity	It refers to the: • professional ability to react to changes in the context/needs as well as to unforeseen; • professional capability to manage the project ensuring the expected level of service in the operational phase. To ensure a project success, it is not enough that it is well planned and designed, but also that the organizations in charge of the management and operations provide a good service to the end users (e.g. ensuring a good maintenance of the infrastructure).

Source: Authors

Table 20. Behavioural patterns archetypes

Behavioural patterns are illustrated by use of diagrams linking determinants and project outcomes in a dynamic way

TYPE	DESCRIPTION
Bright star	This pattern is typical of projects where the good predictions made ex-ante (both on the cost side and demand side) turn out to be accurate. Proper incentive systems are in place so that the project actually delivers value for money and success. Even in the event of exogenous negative events, the managerial capacity ensures that proper corrective actions are taken and a positive situation is restored.
Rising sun	This pattern is typical of projects which, soon after their implementation, are affected by under capacity issues because of a combination of low demand forecasting capacity, weak appropriateness to the context, and weak technical capacity to design the infrastructure. However, due to changed circumstances or thanks to responsible management and good governance the project turns around to reap new benefits.
Supernova	This pattern is typical of projects for which the good predictions made ex-ante (both on the cost and demand side) turn out to be accurate. However, due to changed circumstances or because of weak management capacity and/or governance the project eventually turns out to be unsuccessful.
Shooting star	This pattern is typical of projects starting from an intermediate situation and resulting in a failure. This outcome can be explained by a low forecasting capacity affected by optimism bias which yields a cost overrun. Then during project implementation, because of low managerial capacity and/or poor governance (also due to distorted incentives) corrective actions are not implemented, this leading to project failure. The situation is exacerbated if unexpected negative events materialise during the project implementation.
Black-hole	This pattern is typical of projects that since the beginning of their life fail to deliver net benefits. This is a result of a combination of ex-ante bad factors (i.e. low technical capacity for demand forecasting, optimism bias, inappropriateness to the local context and bad incentives affecting both the selection process and the project governance) and careless management during the project implementation or bad project governance (e.g. unclear division of responsibilities, bad incentive schemes).

Source: Authors

A I.4 Synthesis and conclusions

Qualitative and quantitative findings are integrated in a narrative way, in order to develop ten project 'histories' and to isolate and depict the main aspects behind the project's long-term performance. A final judgment on each project is then conveyed in the case studies with an assessment structured along a set of evaluation criteria, as suggested in the ToRs. Evaluation criteria are the following:

- Relevance (were the project objectives in line with the existing development needs and the priorities at the programme, national and/or EU level?);
- Coherence (with other national and/or EU interventions in the same sector or region);
- Effectiveness (were the stated objectives achieved, and in time? Did other effects materialise? Were other possible options considered?);
- Efficiency (costs and benefits relative to each other and to their ex-ante values);
- EU added value (was EU support necessary, EU-wide effects, further EU action required?).

ANNEX II. EX-POST COST-BENEFIT ANALYSIS REPORT

This Annex illustrates the ex-post CBA of the project under assessment, undertaken to quantitatively assess the performance of the project. Calculations are based on the "Guide to Cost Benefit Analysis of Investment Projects" published by the European Commission in 2014. The unitary values and parameters for the calculation, as well as the specific methodology related to an ex-post assessment, are based on the guidelines provided in the First Interim Report. This annex aims to present in more detail the assumptions, results of the CBA and the scenario analysis for the project under consideration.

A II.1 Methodology, assumption and data gathering

In what follows, the main assumptions and the procedure of data gathering are described in detail.

- *Project identification:*
  The unit of analysis of this CBA is the construction of the Rio-Antirio bridge in Greece, located in the Region of Western Greece and connecting the Peloponnese with mainland Greece across the Gulf of Corinth. The bridge links the towns of Rio at the outskirts of the city of Patras (Prefecture of Achaia, South coast) with Antirio (Prefecture of Etoloakarnania, North coast). The project was implemented by means of a PPP initiative and got support from the European Commission and the EIB. Under the accountancy and financial standpoints, the expenditures related to the project implementation activities lasted between 1994 and 2010 as detailed in the following table.

Table 21. Synthesis of the interventions

ACTIVITY	IMPLEMENTATION PERIOD
Technical support	1994-2006
Land acquisition	1998-2010
Construction Works	1998-2005

Source: Authors

- *Time horizon:*
  In line with the original CBA, the time horizon for the CBA of the project is set equal to the length of the concession awarded to the private implementing entity (Gefyra, www.gefyra.gr), corresponding to 35 years of operations. The total time horizon is thus of 46 years (1994-2039), inclusive of 10 years of construction before the opening for traffic in August 2004, and 35 full years of operations (2005-2039). It shall be mentioned that the technical life of the bridge is 120 years of operations, thus by far longer than the analysis period. This is duly taken into consideration in the estimate of the residual value.
- *Constant prices and discount rates*
  In line with the guidelines of the First Interim Report, the CBA was performed using constant values at the price level of 2017. Historical or forecasted values provided in nominal prices have been converted based on historical or expected inflation rates.

Consistently with the choice of using constant prices, financial and social discount rates have been adopted in real terms. Specifically, inflows and outflows of financial analysis - for both the backward and forward periods of analysis – have been discounted and capitalized using a 4% real rate, as suggested in the EC CBA Guide (2014). Regarding the economic analysis, a real backward social discount rate of 1.24% and a real forward social discount rate of 3.86%, specifically calculated for Greece (see the First Interim Report for the calculation), have been adopted. The backward value is quite lower than the usual reference values adopted for ex-ante analysis following the EU guidelines, due to the negative trend in the national economic growth in the last decade.

- *Without the project scenario:*
  The reference scenario for the CBA (Without the project scenario) is a "Do nothing" scenario, namely it does not change the original situation, where the connection between the two coasts of the Gulf of Corinth is provided by means of ferry boats. It is worth mentioning that ferry services have been continuously operated also after the opening of the bridge, albeit serving a somewhat residual demand.
- *Data sources:*
  The analysis relies on data provided by the Ministry of Transport of Greece. Important insights were provided by the experts interviewed. Additional information has been gathered from a review of documents available online and from the local press.

A II.2 Future scenario

Demand analysis

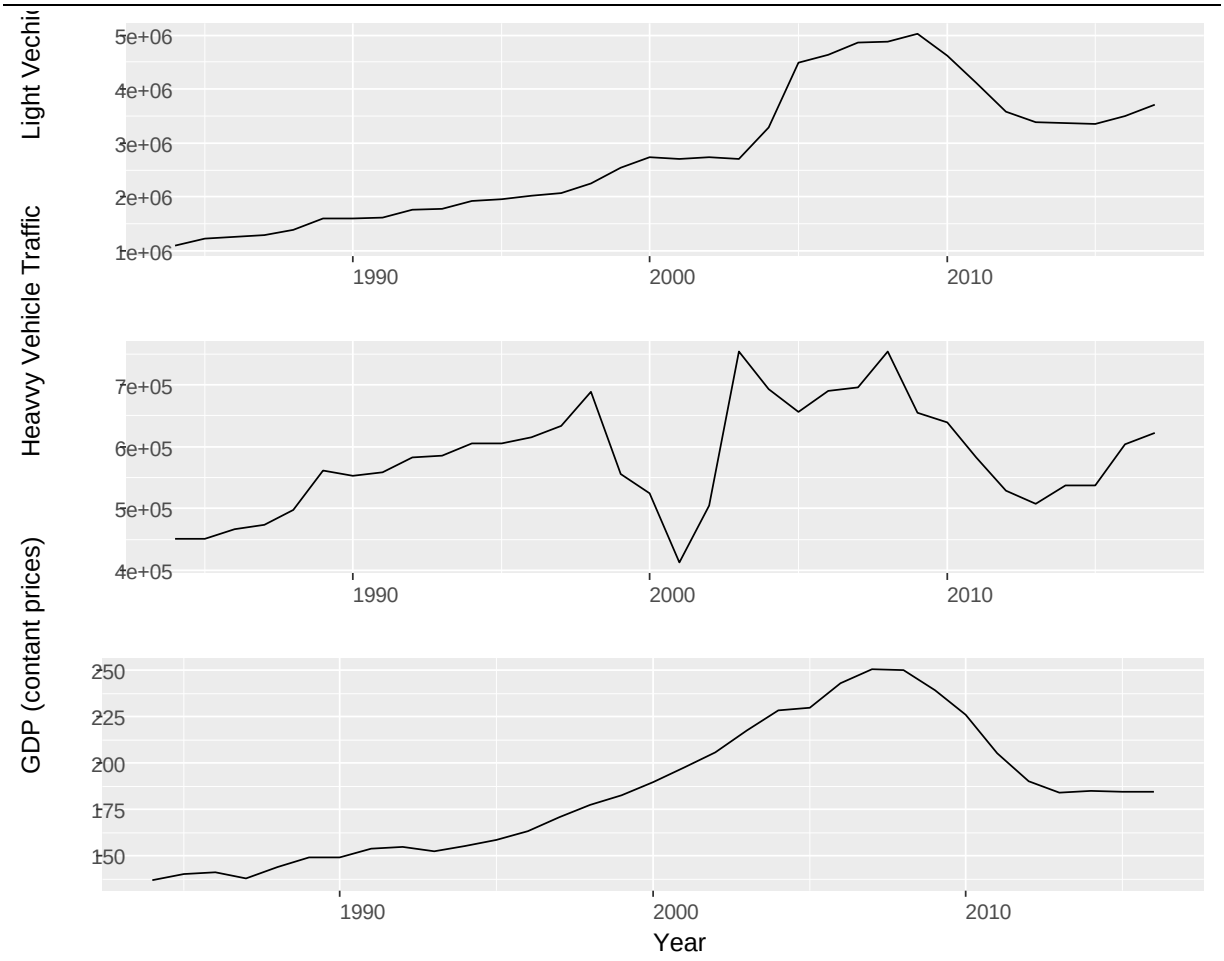
Demand is by far the most critical input in a CBA, especially in the road transport sector, where direct benefits to users generally represents the lion's share of the benefits generated by a project. Uncertainty in demand forecasting is also a main question mark on the level of reliability in the results of financial and economic appraisal, especially for greenfield projects. Luckily, in the case of an ex-post assessment such as the Rio-Antirio bridge, we already have a relatively long time-series (1984-2017) of observed traffic flows on the road link and on its sole alternative (ferries), which we have used to build our traffic projections for the remaining time horizon of the analysis (2018-2039). Although this mitigates to a certain extent the forecasting envelope, sources of uncertainties remain such as the traffic growth rates from 2017 on and the size of the induced demand, i.e. the additional demand that would not have materialised on the corridor should the project not have been implemented.

We have developed our independent traffic forecasts by implementing an ARIMAX time series model (AutoRegressive Integrated Moving Average model with eXogenous variables) to estimate the total demand crossing between Rio and Antirio. The regression was performed with the statistical package Forecast[11], developed in the R open-source statistical computing platform. While taking into consideration autocorrelation in the time series, the prediction model mostly relies on exogenous explanatory variables, that in our case is the national GDP, which allows explaining the observed decline in traffic since

[11] Hyndman R, Bergmeir C, Caceres G, O'Hara-Wild M, Razbash S and Wang E (2018). forecast: Forecasting functions for time series and linear models. R package version 8.3, http://pkg.robjhyndman.com/forecast.

2009, because of the economic crisis. As discussed in the main text of this report, such effect is in fact not specific to the traffic on the bridge, but rather common to the entire Greek motorway network.

Figure 17. Passengers per day – Forecasts based on 2008-2017 observed traffic



Source: Authors

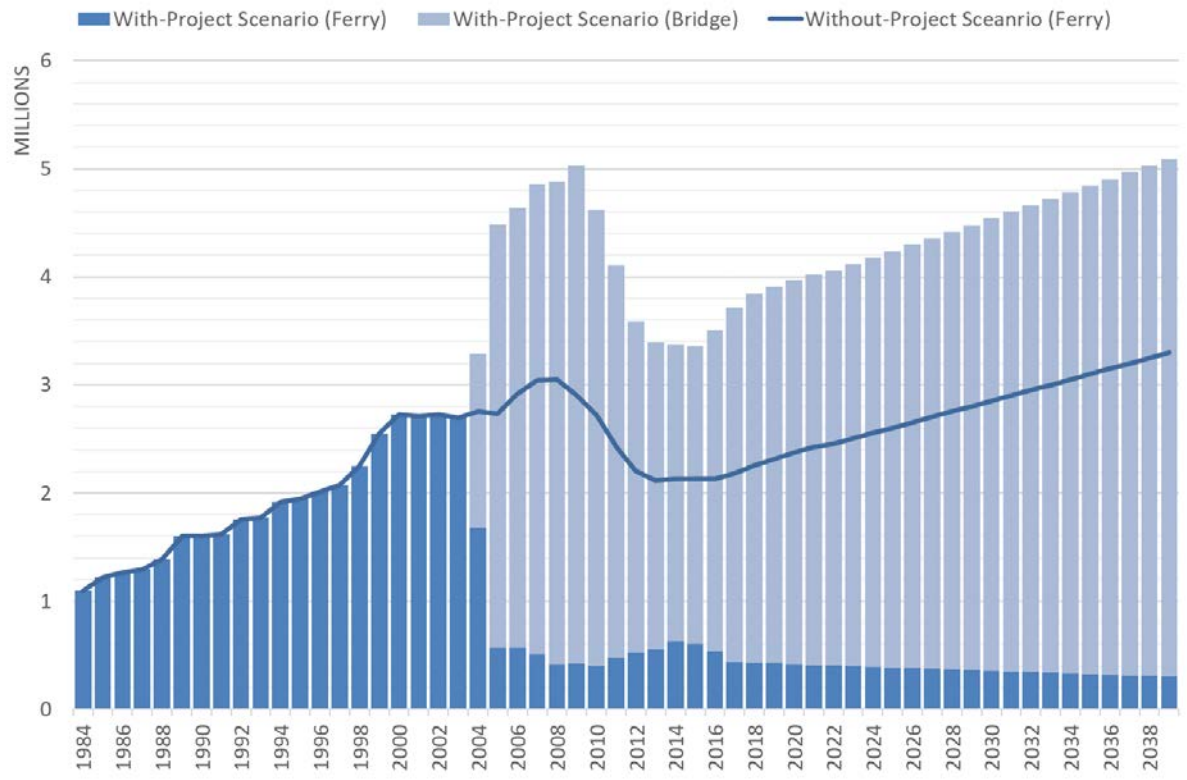
In addition, a logit-type model was fit to the observed data to predict the trend in the market share between the bridge and the ferry. Also, in this case, the relative share was found correlated to national macro-economic indicators (GDP per capita), which is a proxy for the change over time in the users' willingness to pay for either one or the other alternative (being the bridge more expensive).

Finally, it should be mentioned that macroeconomic forecasts for the period 2018-2022 were sourced from the last IMF World Economic Outlook (October 2017); after this period, macroeconomic trends were extrapolated assuming a linear trend (and hence with progressively diminishing growth rates). As the economic outlook of Greece is currently not very favourable, especially when compared to past pre-recession growth, also the expected growth rates of traffic on the bridge are relatively lower than the one observed during the first decades of the available time series (1984-2004).

The estimated demand growth for light and heavy vehicles is shown in the graphs overleaf. It should be noted that buses are included in heavy traffic (as in the original

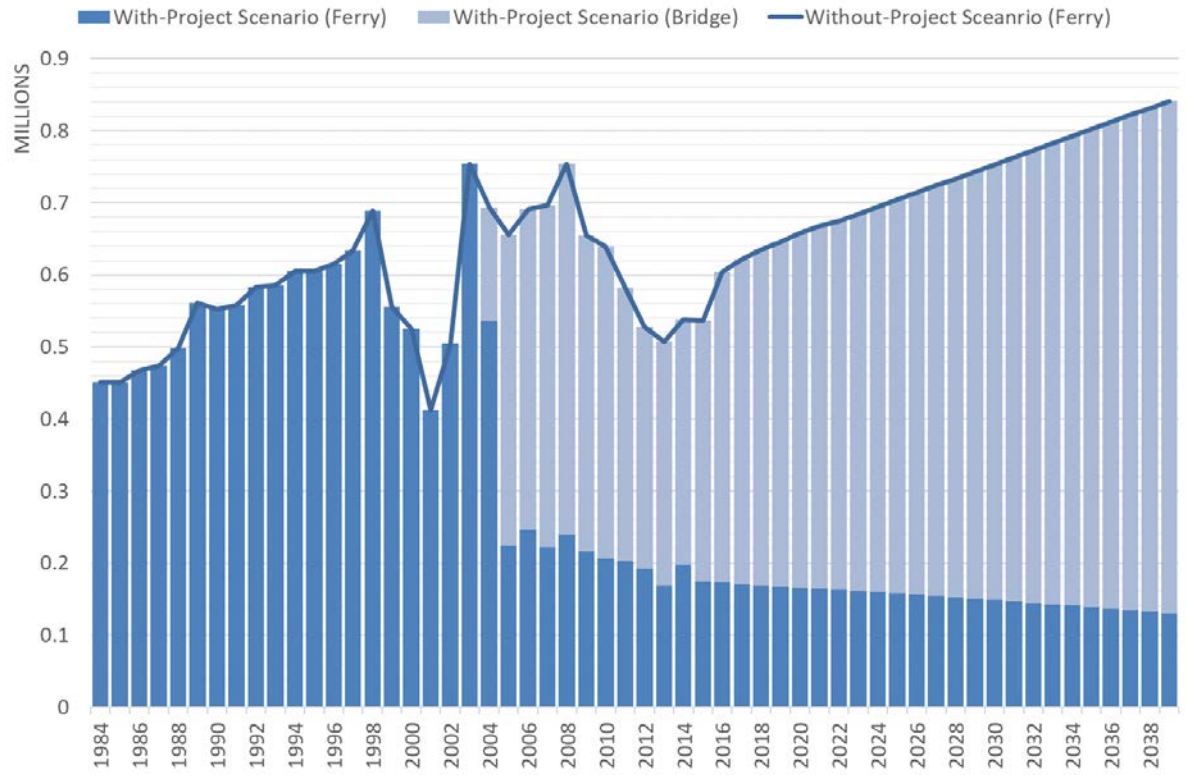
data at our disposal) and that our analysis does not consider induced traffic for heavy vehicles.

Figure 18. Light Vehicle Annual Traffic – Forecasts based on 1984-2017 observed traffic



Source: Authors

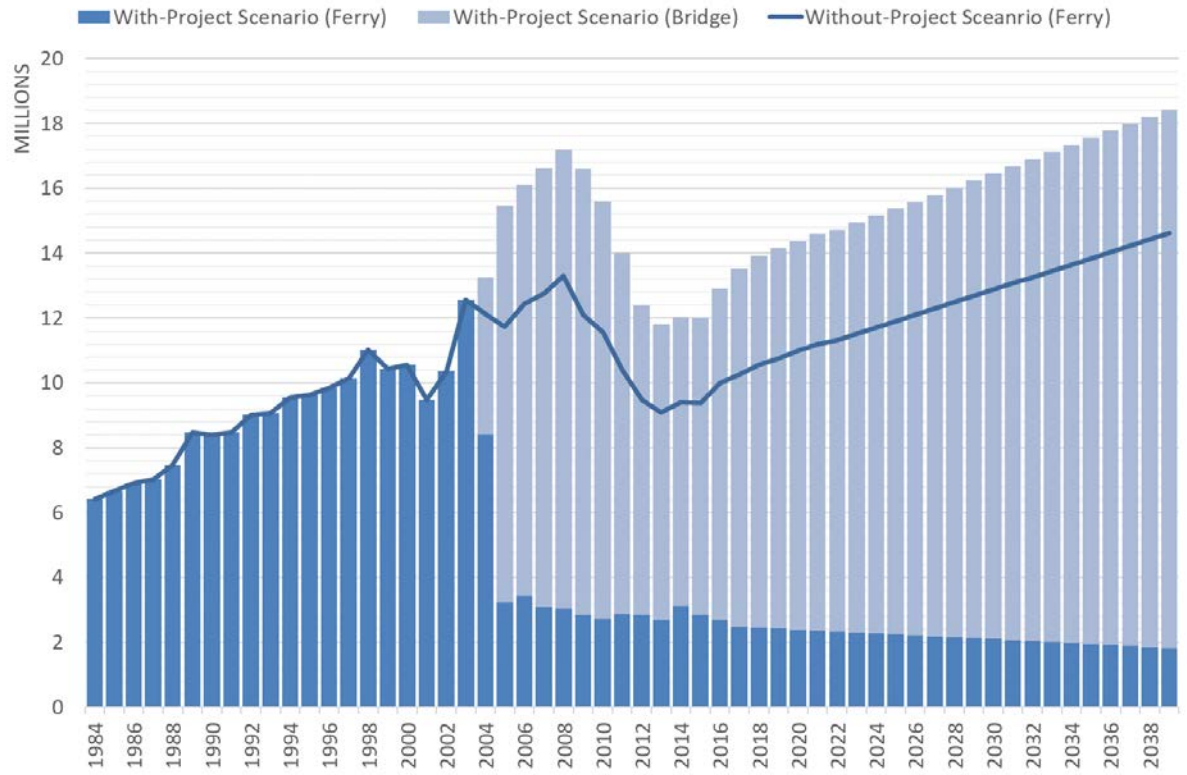
Figure 19. Heavy Vehicle Annual Traffic – Forecasts based on 1984-2017 observed traffic



Source: Authors

Based on average occupancy rates for vehicles (2.2 for cars and 26.2 for buses, based on previous studies and own estimates respectively), the annual flow of passengers is reported in the graph below and shows that the throughput reached a maximum of 17 million passengers per year in 2008 before the recession, and then declined to around 12 million. Passenger traffic is now recovering fast since 2015, however the pre-recession peak is expected to be reached again only in 2035.

Figure 20. Passengers Annual Traffic– Forecasts based on 1984-2017 observed traffic



Source: Authors

A II.3 Financial analysis

Investment cost

The table below summarizes the breakdown of the investment costs according to the main cost categories as provided by the national authorities.

Table 22. Investment cost breakdown by work component

COST ITEM	NOMINAL VALUE (EUR)	PRESENT VALUE (EUR 2017)
Technical support	3,686,741	5,610,782
Land acquisition	60,505,762	86,071,799
Construction	824,066,646	1,150,684,362
Total	**888,259,149**	**1,242,366,943**

Source: Authors

In line with the approach described in the First Interim Report, the present value is expresses at a price level of 2017 and discounted to the base year of analysis, which is also 2017. Due to these adjustments, the present value is significantly higher than the nominal value of the investment incurred by the project promoter.

Residual value

The bridge connecting the two side of the Gulf of Corinth was designed and constructed with a technical life of 120 years. On this basis, the residual value of the project is then calculated as the net present value of the financial flows at the end of project reference period, considering the 2040-2124 interval. A similar approach is adopted to estimate the economic residual value of the investment. Given the very long residual technical life of the bridge, the high financial and economic flows generated by the project and the relatively low discount rate, the residual value of the project is very high, especially for the economic analysis.

Operating & Maintenance costs

Two main categories of operating costs are included in the perimeter of analysis: operating expenses and ordinary annual maintenance for the new section (the bridge and the access roads as included in the concession). To the purpose of this ex-post evaluation, real data for the period 2004-2017 were provided by the Concessionaire, which also provided cost projections for the residual time horizon (2018-2039).

Operating revenues

The main revenue of the project is the revenue from toll rates paid by users, although also some limited ancillary revenue has been reported by the Concessionaire and included in the analysis. The ex-post evaluation relies on real data on revenues from the first year of operation; revenue projections were also provided by the Concessionaire according to its own financial plan, but these have been recalculated based on the growth rates independently estimated for this assignment.

Project's Financial Performance

On a financial basis, the profitability of the project is negative. The Financial Net Present Value (NPV) of the investment is equal to EUR -960 million (at a discount rate of 4%, real). These values confirm that the project needed EU funding since no private investor would have been motivated to implement it without an appropriate financial incentive. The financial results are negative also at the national perspective, while positive under the standpoint of the private investor, confirming the financial viability of the PPP initiative.

Table 23. Financial performance indicators of the project

INDICATOR	VALUE
FNPV/C (EUR)	-958,522,834
FRR/C (%)	1.86
FNPV/K (EUR)	-217,503,692
FRR/K (%)	3.36
FNPV/Kp (EUR)	219,255,283
FRR/Kp (%)	9.30

Source: Authors

It shall be noted that the rate of return on the private equity is acceptable and in line with the highway construction sector and the assumptions on which the original tender was based. This is also in line with the maximum ROE foreseen in the concession contract

(11.50%), which, if reached before 35 full operational years, would trigger the end of the concession period. This result is reached thanks of financing secured by the EIB loan, that covered 84% of the total private investment. Hence, the amount of the private equity was relatively limited, as shown in the table below.

Table 24. Financial structure of the Rio-Antirio project (Nominal EURO)

Private expenditure		Public expenditure	
Own capital	**EIB Loan**	**National Funds**	**EC Funds**
68,547,438	370,000,000	196,525,229	253,186,482
438,547,438		449,711,711	
888,259,149			
Private expenditure		**Total Public Expenditure**	**Community Participation**
Own capital	**EIB Loan**	**National Funds**	**EC Funds**
7.7%	41.7%	22.1%	28.5%
49.4%		50.6%	
100.0%			

Financial Sustainability

Since its opening, the revenues generated by the project fully cover its operational costs and the service to the debt, meaning that the project is sustainable under a financial standpoint. Due to the decrease in revenue, in 2014 the cover ratio of the debt service was very close to 1, with a relatively small margin; this financial result however improved in the following years.

Table 25. Financial return on investment (EUR)

It.		Present value	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	OPEATIONAL INCOME	1,518,824,672	0	0	0	2,819	1,123,582	660,298	2,415,721	1,330,930	1,115,516	388,679	24,030,460	49,300,327	50,951,684	55,736,966	57,218,600	56,482,290
1.1	Income from tickets	1,482,403,562	0	0	0	0	0	0	0	0	0	0	23,579,356	48,818,648	50,229,369	53,808,715	54,887,189	54,878,563
1.2	Income from other sources	36,421,110	0	0	0	2,819	1,123,582	660,298	2,415,721	1,330,930	1,115,516	388,679	451,104	481,680	722,315	1,928,251	2,331,411	1,603,727
2	CAPEX	2,399,186,885	110,817	881,631	14,481,252	179,468,352	106,029,590	206,164,196	101,858,496	218,010,586	165,900,628	148,955,099	88,433,827	9,222,978	551,623	993,010	37,178	637,352
2.1	Technical support	11,823,934	110,817	881,631	914,000	811,125	394,269	1,280,498	283,649	201,847	216,470	169,743	173,494	108,484	64,754	0	0	0
2.2	Land acquisition	171,039,790	0	0	0	0	50,716,068	5,199,896	16,013,929	202,566	55,881	1,559,748	528,240	9,010,735	486,868	993,010	37,178	637,352
2.3	Construction	2,216,323,161	0	0	13,567,252	178,657,227	54,919,253	199,683,802	85,560,918	217,606,173	165,628,278	147,225,608	87,732,093	103,759	0	0	0	0
3	OPEX	420,606,250	0	0	0	0	0	0	0	0	0	0	0	13,572,472	14,603,493	13,367,331	14,140,456	16,040,741
3.1	Operating expenses	361,784,052	0	0	0	0	0	0	0	0	0	0	0	13,261,579	13,791,356	12,581,020	12,461,727	14,257,236
3.2	Ordinary annual maintenance for the new section	58,822,198	0	0	0	0	0	0	0	0	0	0	0	310,893	812,138	786,311	1,678,729	1,783,505
4	Residual value	342,445,630	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Total (1-2-3+4)	-958,522,834	-110,817	-881,631	-14,481,252	-179,465,533	-104,906,008	-205,503,898	-99,442,775	-216,679,656	-164,785,112	-148,566,420	-64,403,367	26,504,877	35,796,568	41,376,625	43,040,966	39,804,196

It.		Present value	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	OPEATIONAL INCOME	1,518,824,672	49,445,339	42,135,561	35,373,552	33,285,659	33,385,619	34,506,361	37,258,739	40,225,952	41,781,199	42,713,870	43,603,670	44,465,215	44,989,024	45,835,341	46,581,711	47,445,813
1.1	Income from tickets	1,482,403,562	48,564,642	41,490,696	35,053,549	32,900,696	32,509,614	33,323,807	36,793,861	39,722,000	41,258,841	42,203,964	43,126,597	43,999,237	44,519,899	45,368,227	46,230,234	47,099,678
1.2	Income from other sources	36,421,110	880,696	644,866	320,003	384,963	876,005	1,182,554	464,878	503,952	522,357	509,906	477,073	465,978	469,125	467,114	351,477	346,135
2	CAPEX	2,399,186,885	630,328	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.1	Technical support	11,823,934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	Land acquisition	171,039,790	630,328	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.3	Construction	2,216,323,161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	OPEX	420,606,250	15,616,414	13,623,281	12,956,003	13,264,355	13,539,998	12,363,413	12,970,228	13,537,000	14,791,451	12,118,506	13,023,760	12,300,056	13,699,803	12,173,886	13,202,951	15,417,555
3.1	Operating expenses	361,784,052	13,500,961	11,897,222	11,393,499	11,722,953	11,744,479	10,776,854	10,761,281	11,034,000	11,556,345	10,135,601	10,675,077	10,335,751	11,058,273	10,313,926	10,842,985	11,960,687
3.2	Ordinary annual maintenance for the new section	58,822,198	2,115,453	1,726,059	1,562,504	1,541,402	1,795,519	1,586,559	2,208,948	2,503,000	3,235,105	1,982,904	2,348,682	1,964,305	2,641,530	1,859,960	2,359,967	3,456,868
4	Residual value	342,445,630	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Total (1-2-3+4)	-958,522,834	33,198,597	28,512,281	22,417,549	20,021,304	19,845,621	22,142,948	24,288,510	26,688,952	26,989,748	30,595,364	30,579,911	32,165,159	31,289,221	33,661,455	33,378,760	32,028,258

It.		Present value	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
1	OPEATIONAL INCOME	1,518,824,672	48,314,240	49,175,785	50,046,917	50,920,647	51,793,233	52,664,866	53,562,360	54,456,622	55,350,776	56,244,085	57,136,690	58,028,870	58,919,702	59,810,438
1.1	Income from tickets	1,482,403,562	47,972,899	48,848,053	49,724,308	50,601,314	51,478,911	52,357,000	53,235,492	54,114,296	54,993,315	55,872,452	56,751,611	57,630,701	58,509,631	59,388,317
1.2	Income from other sources	36,421,110	341,341	327,732	322,609	319,333	314,322	307,867	326,868	342,326	357,462	371,633	385,079	398,169	410,071	422,121
2	CAPEX	2,399,186,885	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.1	Technical support	11,823,934	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	Land acquisition	171,039,790	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.3	Construction	2,216,323,161	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	OPEX	420,606,250	12,973,478	12,973,513	12,973,339	12,972,945	12,973,114	12,973,015	12,973,399	12,973,473	12,973,234	12,973,388	12,973,196	12,973,334	12,973,097	12,973,134
3.1	Operating expenses	361,784,052	10,744,750	10,744,750	10,744,750	10,744,750	10,744,750	10,744,750	10,744,750	10,744,750	10,744,750	10,744,750	10,744,750	10,744,750	10,744,750	10,744,750
3.2	Ordinary annual maintenance for the new section	58,822,198	2,228,728	2,228,763	2,228,589	2,228,195	2,228,364	2,228,265	2,228,649	2,228,723	2,228,484	2,228,638	2,228,446	2,228,584	2,228,347	2,228,384
4	Residual value	342,445,630	0	0	0	0	0	0	0	0	0	0	0	0	0	811,568,333
5	Total (1-2-3+4)	-958,522,834	35,340,762	36,202,271	37,073,579	37,947,702	38,820,119	39,691,851	40,588,961	41,483,149	42,377,542	43,270,696	44,163,494	45,055,536	45,946,605	858,405,636

Source: Authors

Table 26. Financial return on national capital (EUR)

It.		Present Value	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	Inflow	1,861,270,302	0	0	0	2,819	1,123,582	660,298	2,415,721	1,330,930	1,115,516	388,679	24,030,460	49,300,327	50,951,684	55,736,966	57,218,600	56,482,290
1.1	Revenue	1,518,824,672	0	0	0	2,819	1,123,582	660,298	2,415,721	1,330,930	1,115,516	388,679	24,030,460	49,300,327	50,951,684	55,736,966	57,218,600	56,482,290
1.2	Residual value	342,445,630	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Outflow	2,078,773,994	48,427	385,275	6,328,346	99,657,958	50,639,928	107,119,608	52,461,310	195,078,972	147,032,524	137,141,631	73,613,716	17,602,939	14,844,554	13,801,279	14,156,703	16,319,266
2.1	National financing	1,658,167,743	48,427	385,275	6,328,346	99,657,958	50,639,928	107,119,608	52,461,310	195,078,972	147,032,524	137,141,631	73,613,716	4,030,466	241,061	433,948	16,247	278,525
2.2	Operating expenditure	420,606,250	0	0	0	0	0	0	0	0	0	0	0	13,572,472	14,603,493	13,367,331	14,140,456	16,040,741
3	TOTAL (1-2)	-217,503,692	-48,427	-385,275	-6,328,346	-99,655,138	-49,516,347	-106,459,310	-50,045,590	-193,748,042	-145,917,008	-136,752,952	-49,583,256	31,697,389	36,107,130	41,935,686	43,061,897	40,163,024

It.		Present Value	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	Inflow	1,861,270,302	49,445,339	42,135,561	35,373,552	33,285,659	33,385,619	34,506,361	37,258,739	40,225,952	41,781,199	42,713,870	43,603,670	44,465,215	44,989,024	45,835,341	46,581,711	47,445,813
1.1	Revenue	1,518,824,672	49,445,339	42,135,561	35,373,552	33,285,659	33,385,619	34,506,361	37,258,739	40,225,952	41,781,199	42,713,870	43,603,670	44,465,215	44,989,024	45,835,341	46,581,711	47,445,813
1.2	Residual value	342,445,630	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Outflow	2,078,773,994	15,891,868	13,623,281	12,956,003	13,264,355	13,539,998	12,363,413	12,970,228	13,537,000	14,791,451	12,118,506	13,023,760	12,300,056	13,699,803	12,173,886	13,202,951	15,417,555
2.1	National financing	1,658,167,743	275,455	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	Operating expenditure	420,606,250	15,616,414	13,623,281	12,956,003	13,264,355	13,539,998	12,363,413	12,970,228	13,537,000	14,791,451	12,118,506	13,023,760	12,300,056	13,699,803	12,173,886	13,202,951	15,417,555
3	TOTAL (1-2)	-217,503,692	33,553,470	28,512,281	22,417,549	20,021,304	19,845,621	22,142,948	24,288,510	26,688,952	26,989,748	30,595,364	30,579,911	32,165,159	31,289,221	33,661,455	33,378,760	32,028,258

It.		Present Value	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
1	Inflow	1,861,270,302	48,314,240	49,175,785	50,046,917	50,920,647	51,793,233	52,664,866	53,562,360	54,456,622	55,350,776	56,244,085	57,136,690	58,028,870	58,919,702	871,378,771
1.1	Revenue	1,518,824,672	48,314,240	49,175,785	50,046,917	50,920,647	51,793,233	52,664,866	53,562,360	54,456,622	55,350,776	56,244,085	57,136,690	58,028,870	58,919,702	59,810,438
1.2	Residual value	342,445,630	0	0	0	0	0	0	0	0	0	0	0	0	0	811,568,333
2	Outflow	2,078,773,994	12,973,478	12,973,513	12,973,339	12,972,945	12,973,114	12,973,015	12,973,399	12,973,473	12,973,234	12,973,388	12,973,196	12,973,334	12,973,097	12,973,134
2.1	National financing	1,658,167,743	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	Operating expenditure	420,606,250	12,973,478	12,973,513	12,973,339	12,972,945	12,973,114	12,973,015	12,973,399	12,973,473	12,973,234	12,973,388	12,973,196	12,973,334	12,973,097	12,973,134
3	TOTAL (1-2)	-217,503,692	35,340,762	36,202,271	37,073,579	37,947,702	38,820,119	39,691,851	40,588,961	41,483,149	42,377,542	43,270,696	44,163,494	45,055,536	45,946,605	858,405,636

Source: Authors

Table 27. Financial return on private capital (EUR)

It.		Present Value	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	Inflow	1,518,824,672	0	0	0	2,819	1,123,582	660,298	2,415,721	1,330,930	1,115,516	388,679	24,030,460	49,300,327	50,951,684	55,736,966	57,218,600	56,482,290
1.1	Revenue	1,518,824,672	0	0	0	2,819	1,123,582	660,298	2,415,721	1,330,930	1,115,516	388,679	24,030,460	49,300,327	50,951,684	55,736,966	57,218,600	56,482,290
1.2	Residual value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Outflow	1,299,569,389	0	0	0	5,894,057	1,195,123	4,726,755	2,206,855	30,759,642	27,525,565	27,541,899	18,685,586	47,265,836	27,503,580	29,557,391	44,372,715	35,855,943
2.1	Private Equity	169,276,378	0	0	0	5,894,057	1,195,123	4,726,755	2,206,855	27,709,752	20,692,829	20,002,734	9,708,180	0	0	0	0	0
2.2	Operating expenditure	973,990,897	0	0	0	0	0	0	0	3,049,891	6,832,736	7,539,164	8,977,406	47,148,465	27,002,333	29,398,751	34,932,898	31,917,267
2.3	Taxes	156,302,114	0	0	0	0	0	0	0	0	0	0	0	117,371	501,247	158,640	9,439,817	3,938,676
3	TOTAL (1-2)	219,255,283	0	0	0	-5,891,238	-71,541	-4,066,457	208,865	-29,428,713	-26,410,048	-27,153,219	5,344,874	2,034,491	23,448,104	26,179,574	12,845,885	20,626,347

It.		Present Value	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	Inflow	1,518,824,672	49,445,339	42,135,561	35,373,552	33,285,659	33,385,619	34,506,361	37,258,739	40,225,952	41,781,199	42,713,870	43,603,670	44,465,215	44,989,024	45,835,341	46,581,711	47,445,813
1.1	Revenue	1,518,824,672	49,445,339	42,135,561	35,373,552	33,285,659	33,385,619	34,506,361	37,258,739	40,225,952	41,781,199	42,713,870	43,603,670	44,465,215	44,989,024	45,835,341	46,581,711	47,445,813
1.2	Residual value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Outflow	1,299,569,389	40,209,385	37,863,243	31,774,124	31,022,192	32,029,941	31,309,981	32,401,274	39,626,000	39,513,534	40,698,019	42,275,722	41,675,627	44,486,294	43,383,501	45,840,848	48,228,758
2.1	Private financing	169,276,378	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	Operating expenditure	973,990,897	33,309,179	32,596,931	31,110,777	30,821,855	32,029,941	31,309,981	32,401,274	33,534,000	35,375,882	33,304,383	37,097,751	37,110,933	39,054,838	37,908,675	39,202,050	41,596,395
2.3	Taxes	156,302,114	6,900,206	5,266,312	663,347	200,338	0	0	0	6,092,000	4,137,652	7,393,636	5,177,971	4,564,694	5,431,456	5,474,827	6,638,798	6,632,363
3	TOTAL (1-2)	219,255,283	9,235,954	4,272,318	3,599,428	2,263,467	1,355,679	3,196,379	4,857,465	599,952	2,267,664	2,015,851	1,327,948	2,789,588	502,730	2,451,840	740,863	-782,945

It.		Present Value	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
1	Inflow	1,518,824,672	48,314,240	49,175,785	50,046,917	50,920,647	51,793,233	52,664,866	53,562,360	54,456,622	55,350,776	56,244,085	57,136,690	58,028,870	58,919,702	59,810,438
1.1	Revenue	1,518,824,672	48,314,240	49,175,785	50,046,917	50,920,647	51,793,233	52,664,866	53,562,360	54,456,622	55,350,776	56,244,085	57,136,690	58,028,870	58,919,702	59,810,438
1.2	Residual value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Outflow	1,299,569,389	38,627,960	32,486,521	27,849,962	23,563,834	22,138,227	22,025,746	22,794,892	23,164,307	23,528,330	23,897,523	24,271,917	24,650,188	25,033,127	25,990,939
2.1	Private financing	169,276,378	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	Operating expenditure	973,990,897	31,815,476	24,138,171	19,327,105	14,717,853	12,973,114	12,973,015	12,973,399	12,973,473	12,973,234	12,973,388	12,973,196	12,973,334	12,973,097	12,973,134
2.3	Taxes	156,302,114	6,812,484	8,348,350	8,522,857	8,845,981	9,165,113	9,052,731	9,821,493	10,190,834	10,555,096	10,924,135	11,298,721	11,676,854	12,060,030	13,017,804
3	TOTAL (1-2)	219,255,283	9,686,280	16,689,264	22,196,955	27,356,813	29,655,005	30,639,120	30,767,468	31,292,315	31,822,447	32,346,562	32,864,773	33,378,682	33,886,575	33,819,499

Table 28. Financial sustainability of the project (EUR)

It.		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1.1	Financial Resources	110,817	881,631	14,481,252	179,468,352	106,029,590	206,164,196	101,858,496	218,010,586	165,900,628	148,955,099	88,433,827	9,222,978	551,623	993,010	37,178	637,352
1.2	Revenue	0	0	0	2,819	1,123,582	660,298	2,415,721	1,330,930	1,115,516	388,679	24,030,460	49,300,327	50,951,684	55,736,966	57,218,600	56,482,290
1.3	Subsidy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	Total inflows	110,817	881,631	14,481,252	179,471,171	107,153,172	206,824,494	104,274,216	219,341,515	167,016,144	149,343,779	112,464,288	58,523,305	51,503,306	56,729,975	57,255,778	57,119,643
2.1	Investment costs	110,817	881,631	14,481,252	179,468,352	106,029,590	206,164,196	101,858,496	218,010,586	165,900,628	148,955,099	88,433,827	9,222,978	551,623	993,010	37,178	637,352
2.2	Operating costs	0	0	0	0	0	0	0	3,049,891	6,832,736	7,539,164	8,977,406	47,148,465	27,002,333	29,398,751	34,932,898	31,917,267
2.3	Loan repayments	0	0	0	0	0	0	0	3,049,891	6,832,736	7,539,164	8,977,406	33,575,993	12,398,839	16,031,419	20,792,442	15,876,526
2	Total outflows	110,817	881,631	14,481,252	179,468,352	106,029,590	206,164,196	101,858,496	224,110,367	179,566,100	164,033,428	106,388,639	89,947,435	39,952,795	46,423,180	55,762,517	48,431,145
	Net cash flow (1-2)	0	0	0	2,819	1,123,582	660,298	2,415,721	-4,768,852	-12,549,956	-14,689,649	6,075,648	-31,424,130	11,550,512	10,306,796	1,493,260	8,688,498
	Cumulated net cash flow	0	0	0	2,819	1,126,401	1,786,699	4,202,420	-566,432	-13,116,387	-27,806,036	-21,730,388	-53,154,518	-41,604,007	-31,297,211	-29,803,951	-21,115,453

It.		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1.1	Financial Resources	630,328	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.2	Revenue	49,445,339	42,135,561	35,373,552	33,285,659	33,385,619	34,506,361	37,258,739	40,225,952	41,781,199	42,713,870	43,603,670	44,465,215	44,989,024	45,835,341	46,581,711	47,445,813
1.3	Subsidy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	Total inflows	50,075,666	42,135,561	35,373,552	33,285,659	33,385,619	34,506,361	37,258,739	40,225,952	41,781,199	42,713,870	43,603,670	44,465,215	44,989,024	45,835,341	46,581,711	47,445,813
2.1	Investment costs	630,328	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	Operating costs	33,309,179	32,596,931	31,110,777	30,821,855	32,029,941	31,309,981	32,401,274	33,534,000	35,375,882	33,304,383	37,097,751	37,110,933	39,054,838	37,908,675	39,202,050	41,596,395
2.3	Loan repayments	17,692,765	18,973,651	18,154,773	17,557,500	18,489,943	18,946,568	19,431,046	19,997,000	20,584,432	21,185,878	24,073,992	24,810,877	25,355,035	25,734,789	25,999,099	26,178,840
2	Total outflows	51,632,272	51,570,582	49,265,550	48,379,355	50,519,884	50,256,549	51,832,320	53,531,000	55,960,314	54,490,261	61,171,743	61,921,810	64,409,874	63,643,464	65,201,148	67,775,234
	Net cash flow (1-2)	-1,556,605	-9,435,020	-13,891,998	-15,093,696	-17,134,264	-15,750,189	-14,573,581	-13,305,048	-14,179,115	-11,776,391	-17,568,072	-17,456,595	-19,420,850	-17,808,123	-18,619,437	-20,329,421
	Cumulated net cash flow	-22,672,059	-32,107,079	-45,999,077	-61,092,773	-78,227,037	-93,977,226	-108,550,807	-121,855,855	-136,034,970	-147,811,361	-165,379,434	-182,836,029	-202,256,878	-220,065,001	-238,684,438	-259,013,860

It.		2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
1.1	Financial Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.2	Revenue	48,314,240	49,175,785	50,046,917	50,920,647	51,793,233	52,664,866	53,562,360	54,456,622	55,350,776	56,244,085	57,136,690	58,028,870	58,919,702	59,810,438
1.3	Subsidy	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	Total inflows	48,314,240	49,175,785	50,046,917	50,920,647	51,793,233	52,664,866	53,562,360	54,456,622	55,350,776	56,244,085	57,136,690	58,028,870	58,919,702	59,810,438
2.1	Investment costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	Operating costs	31,815,476	24,138,171	19,327,105	14,717,853	12,973,114	12,973,015	12,973,399	12,973,473	12,973,234	12,973,388	12,973,196	12,973,334	12,973,097	12,973,134
2.3	Loan repayments	18,841,998	11,164,658	6,353,766	1,744,908	0	0	0	0	0	0	0	0	0	0
2	Total outflows	50,657,474	35,302,829	25,680,871	16,462,761	12,973,114	12,973,015	12,973,399	12,973,473	12,973,234	12,973,388	12,973,196	12,973,334	12,973,097	12,973,134
	Net cash flow (1-2)	-2,343,234	13,872,956	24,366,046	34,457,886	38,820,119	39,691,851	40,588,961	41,483,149	42,377,542	43,270,696	44,163,494	45,055,536	45,946,605	46,837,304
	Cumulated net cash flow	-261,357,094	-247,484,138	-223,118,092	-188,660,206	-149,840,087	-110,148,236	-69,559,275	-28,076,126	14,301,416	57,572,112	101,735,607	146,791,143	192,737,748	239,575,051

Source: Authors

A II.4 Economic analysis

From market to accounting prices

In line with the EU CBA Guidelines (2014), the social opportunity cost of the project's inputs and outputs has been considered in the economic analysis. For this purpose, market prices have been converted into accounting prices by using appropriate conversion factors.

Conversion factors are estimated for each cost item considering a conversion factor of 1 except for labour, for which the values provided in the First Interim Report for Greece were used (0.74 backward and 0.55 forward). Fiscal correction factors have been applied to the fuel component of the investment and operational costs.

Table 29. Economic conversion factors

COST CATEGORY		CONVERSION FACTORS	
		BACKWARD	FORWARD
Investment Costs	*Technical support*	*0.78*	*0.64*
	Land acquisition	*1.00*	*1.00*
	Construction	*0.87*	*0.82*
Operating costs	*Operating expenses*	*0.78*	*0.64*
	Maintenance	*0.91*	*0.86*

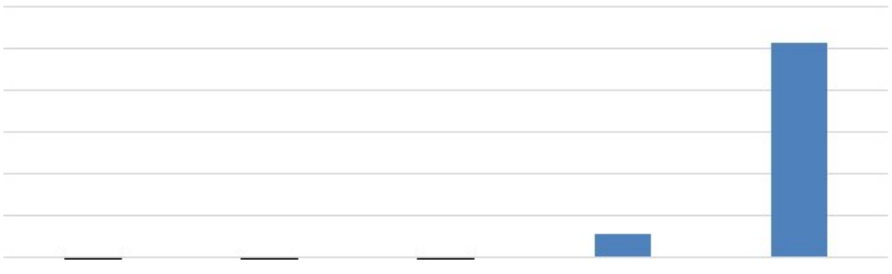
Source: Authors

Project's effects

The effects generated by the implementation of the project can be distinguished into:

- Consumers' surplus;
- Producers' surplus;
- Environmental external transport costs (noise, pollution, greenhouse gas);
- Transport safety.

Figure 21. Main socioeconomic benefits (EUR mil., discounted)



	Road safety	Greenhouse Gas Emissions	Environmental Externalities (air and noise)	Producers' surplus	Consumers' surplus
Present Value	-22,648,959	-15,625,692	-4,941,839	269,018,984	2,558,770,429

Source: Authors

The consumers' surplus is the dominant benefit in line with other investments of similar nature. Negative environmental and road safety impacts are estimated due to the additional distance travelled by the induced demand.

Consumers' surplus

Consumers' surplus includes direct benefits to the users of the crossings between Rio and Antirio. This impact is calculated taking into consideration changes in the travel time savings (compared to the do nothing scenario, the travel times for crossing the Gulf of Corinth between Rio and Antirio decreases from 45 minutes with the ferry to 5 minutes with the bridge) and in the perceived road transport costs (inclusive of fuel costs and tolls paid by users to cross the strait either by ferry or via the bridge). The calculation is performed separately for the existing demand that continues to use the ferry, the demand diverted to the bridge and the induced demand. For the latter category, the rule of half is applied.

An interesting point in economic evaluation is the assessment of the effects due to modal split and whether the rule of half shall apply also to diverted traffic or to induced traffic only.

The choice of the correct methodology relies on our understanding of the users' behaviour based on the available data and information. The bridge currently serves approximately 80% of the traffic crossing the strait of Rio-Antirio. This means that, in spite of the reported time saving per trip (40 minutes), approximately 20% of the traffic remains using the ferry. The main reason for the users' preference to the ferry is the fare: the ferry is in fact much cheaper (-40%) for most users (less than 10% of the travellers crossing the Gulf are daily commuters that could benefit of the discount programme in place on the bridge).

In our economic assessment, we assume that the users' choice between the two alternatives is driven by a strict comparison of travel time and the ticket price, and that other considerations (such as comfort of trip and mode transfer and reliability) play a secondary role. This consideration is supported by qualitative information that confirm that users are quite price-sensitive: for instance, the ferries, to preserve a market share, have reduced (at least in real terms) their ticket prices. Also, the ferry's share slightly increased during the recession in line with the reduced average national personal income, but then this trend seems reverted with the current more positive economic environment. Finally, it shall be considered that for most if not all users, the ferry only represents a short leg of a longer trip by road transport (bus or car), and hence the segment by ferry it is evaluated as part of a longer road trip.

On this basis, we consider that the same structure of generalised costs (same VoT and perceived costs) can be used to describe how users perceive the two alternatives; in this sense, the choice between bridge and ferry as a mere choice between two itineraries of the same mode of transport, rather than a choice between different modes. Therefore, from the standpoint of consumers' surplus, the deviated traffic is in fact "existing traffic", and the whole saving applies; the rule of half is therefore applied only to induced traffic[12].

[12] As an alternative approach, we have evaluated the option to apply the RoH not only to the induced, but also to the diverted traffic. Actually, in this case, this second approach results in a higher estimate of the

The value of the total time savings has then been calculated on a basis of saved veh*hours and corresponding unit values included in the First Interim Report.[13] The impact due to the difference in the perceived costs (including the toll rates) is calculated with the same approach. It shall be noted that the price for ferry tickets is assumed to be lower in the do/something compared to the do noting case, as to face the competition of the bridge, ferry operators have started declining or at least stabilizing their fees. This is a side positive effect for the users due to the opening of the bridge, which introduced additional mode choice options for travellers.

Producers' surplus

Producers' surplus includes the additional revenue to the operators due to incremental tolls paid by the users. For the existing and diverted demand, this benefit offsets an equivalent negative impact for the consumers, while for the induced traffic the two terms do not net out, due to the application of the rule of half in the calculation of the consumers' surplus.

The calculation of the producers' surplus takes also into consideration the unperceived costs for producers of road transport (i.e. variable costs incurred by vehicle users related to tires, vehicle maintenance and so on). This last component is calculated only for the induced demand, as for the other components it is assumed that the vehicle operating costs in the two scenarios are equivalent.

In the producers' surplus, no change was considered in the cost to operate and maintain the infrastructure for ferries (access roads, piers, maritime and road traffic management and so on). The potential savings are deemed to be marginal, in consideration of the fact that the ferry service is still operated, albeit at a lower intensity.

Saving on environmental external transport costs and road safety

Negative impacts are foreseen concerning transport externalities and road safety, due to the induce demand. These impacts are estimated based on the unitary value included in the First Interim report and national statistics concerning road safety.

No impact is assumed for the demand diverted from the ferry to the bridge, as the difference in the external costs of the two modes is deemed negligible in consideration of the short length of the two alternative connections.

Project's Economic Performance

As shown in the table below, the socioeconomic indicators for the project are above the thresholds required for an investment to be deemed beneficial for society. As commented above, the benefit to users is by far the main benefit, and its magnitude alone is sufficient to justify the project.

benefit from consumers' surplus, because the comparison in not one alternative against the other, but rather the cost of the road alternative with and without the project, meaning that in the do-nothing scenario the alternative to consider is bypassing the Gulf by road. This result seems intuitively correct, as the convenience of the road alternative for users may be higher that the simply savings in time and costs (for instance, no need to transfer, no waiting times, no time spent looking for the ticket office, a much higher reliability), as qualitatively confirmed in some interviews. However, based on the considerations above and also due to some limitation in the available data on origin and destination of trips (which are required to correctly apply the RoH), not applying the RoH seems a more robust and prudent methodological choice.

[13] Values of time: EUR 9.28 for light vehicles, EUR 7.49 for bus, EUR 19.61 for heavy vehicles.

The project has also an unusually high level of residual value: this is due to the very long residual life of the bridge (85 years after the end of the time horizon) as well as the high net flows that are generated by the investment, which are used to calculate the residual potential benefits after 2039.

Table 30. Economic performance indicators of the project

INDICATOR	VALUE
CAPEX	-1,277,585,421
OPEX	-283,380,346
CONSUMERS' SURPLUS	2,558,770,429
PRODUCERS' SURPLUS	269,018,984
EXTERNALITIES AND SAFETY	-43,216,490
RESIDUAL VALUE	961,637,774
ENPV (EUR)	**2,185,244,931**
B/C	**2.400**
EIRR (%)	**6.87**

Source: Authors

It is worth noting that the results are especially positive in terms of total project net impact (ENPV) and as a ratio to the investment (B/C). When comparing these indicators to the results of other project, it shall be taken into consideration that these indicators are calculated on discounted cash flows and that a comparatively low social discount rate was adopted in the assessment of this project compared to the ones applicable in other regions of Europe. In this respect, the EIRR also shows a very positive result, that may be compared to other projects in a more straightforward way.

The results of the economic analysis are presented in the following table.

Table 31. Economic return of the project (EUR)

EUR 2017	NPV2017	TOTAL	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	*2009*
CAPEX																		
Technical support	5,524,938	4,376,410	86,438	687,673	712,920	632,678	307,530	998,788	221,246	157,441	168,846	132,400	135,325	84,618	50,508	0	0	0
Land acquisition	106,681,468	86,071,799	0	0	0	0	50,716,068	5,199,896	16,013,929	202,566	55,881	1,559,748	528,240	9,010,735	486,868	993,010	37,178	637352.4624
Construction	1,165,379,015	948,764,551	0	0	11,830,644	155,789,102	44,759,191	162,742,299	69,732,148	177,349,031	134,987,046	119,988,871	71,501,656	84,564	0	0	0	0
TOTAL	1,277,585,421	1,039,212,759	86,438	687,673	12,543,564	156,421,779	95,782,789	168,940,983	85,967,323	177,709,037	135,211,773	121,681,018	72,165,222	9,179,916	537,377	993,010	37,178	637352.4624
OPEX																		
Operating expenses	235,066,604	275,445,679	0	0	0	0	0	0	0	0	0	0	0	10,344,032	10,757,258	9,813,196	9,720,147	11120644.27
Ordinary annual maintenance for the new section	48,313,742	61,633,821	0	0	0	0	0	0	0	0	0	0	0	268,145	700,469	678,193	1,447,904	1538273.274
TOTAL	283,380,346	337,079,499	0	0	0	0	0	0	0	0	0	0	0	10,612,177	11,457,726	10,491,389	11,168,051	12658917.54
DIRECT BENEFITS																		
Consumers' Surplus	2,558,770,429	3,276,142,656	0	0	0	0	0	0	0	0	0	0	33,724,154	80,983,847	91,682,975	101,357,208	106,673,272	96598200.05
Producers' Surplus	269,018,984	332,355,322	0	0	0	0	0	0	0	0	0	0	3,383,149	13,923,463	10,529,851	10,365,554	10,251,110	12758383.34
TOTAL	2,827,789,414	3,608,497,978	0	0	0	0	0	0	0	0	0	0	37,107,302	94,907,309	102,212,825	111,722,762	116,924,382	109356583.4
EXTERNALITIES AND SAFETY																		
Environmental pollution	4,455,000	5,534,111	0	0	0	0	0	0	0	0	0	0	50,773	168,043	171,108	183,982	184,963	207449.5497
Noise	486,838	604,762	0	0	0	0	0	0	0	0	0	0	5,548	18,364	18,699	20,105	20,213	22669.89408
GHG emissions	15,625,692	20,319,030	0	0	0	0	0	0	0	0	0	0	133,890	442,118	434,146	457,310	461,558	534990.8682
Road safety	22,648,959	28,135,091	0	0	0	0	0	0	0	0	0	0	258,127	854,321	869,903	935,352	940,339	1054661.271
TOTAL	43,216,490	54,592,994	0	0	0	0	0	0	0	0	0	0	448,339	1,482,847	1,493,855	1,596,749	1,607,072	1819771.583
RESIDUAL VALUE	961,637,774	2,212,455,357	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET CASH FLOWS	2,185,244,931	4,390,068,082	-86,438	-687,673	-12,543,564	-156,421,779	-95,782,789	-168,940,983	-85,967,323	-177,709,037	-135,211,773	-121,681,018	-35,506,258	73,632,370	88,723,867	98,641,614	104,112,082	94,240,542

Source: Authors

EUR 2017	NPV2017	TOTAL	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CAPEX																		
Technical support	5,524,938	4,376,410	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Land acquisition	106,681,468	86,071,799	630,328	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	1,165,379,015	948,764,551	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1,277,585,421	1,039,212,759	630,328	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OPEX																		
Operating expenses	235,066,604	275,445,679	10,530,749	9,279,833	8,886,929	9,143,903	9,160,693	8,405,946	8,393,799	8,606,520	7,367,170	6,461,446	6,805,362	6,589,042	7,049,649	6,575,128	6,912,403	7,624,938
Ordinary annual maintenance for the new section	48,313,742	61,633,821	1,824,578	1,488,726	1,347,660	1,329,460	1,548,635	1,368,407	1,905,217	2,158,838	2,790,278	1,710,255	2,025,738	1,694,213	2,278,320	1,604,215	2,035,471	2,981,549
TOTAL	283,380,346	337,079,499	12,355,327	10,768,559	10,234,589	10,473,363	10,709,329	9,774,353	10,299,016	10,765,358	10,157,449	8,171,701	8,831,100	8,283,254	9,327,969	8,179,343	8,947,874	10,606,487
DIRECT BENEFITS																		
Consumers' Surplus	2,558,770,429	3,276,142,656	88,610,087	72,504,102	60,524,316	57,008,811	56,798,680	58,125,185	64,547,002	69,431,054	73,187,325	75,932,547	78,790,795	81,516,444	83,158,237	85,765,614	88,420,851	91,119,004
Producers' Surplus	269,018,984	332,355,322	10,897,665	8,809,060	6,328,712	5,658,556	4,952,903	5,257,548	6,608,455	8,171,497	8,614,281	8,732,559	8,800,124	8,871,279	8,914,748	9,020,675	9,138,466	9,262,294
TOTAL	2,827,789,414	3,608,497,978	99,507,753	81,313,163	66,853,028	62,667,367	61,751,583	63,382,732	71,155,457	77,602,551	81,801,606	84,665,107	87,590,919	90,387,723	92,072,984	94,786,288	97,559,317	100,381,298
EXTERNALITIES AND SAFETY																		
Environmental pollution	4,455,000	5,534,111	178,716	148,156	115,179	104,176	102,047	101,454	113,785	128,678	135,739	138,513	140,711	142,855	144,151	146,630	149,265	151,985
Noise	486,838	604,762	19,530	16,190	12,587	11,384	11,152	11,087	12,434	14,062	14,833	15,137	15,377	15,611	15,753	16,024	16,312	16,609
GHG emissions	15,625,692	20,319,030	480,173	440,457	372,247	353,795	354,772	362,352	416,304	478,381	508,920	526,035	540,710	555,726	570,266	587,294	605,065	623,310
Road safety	22,648,959	28,135,091	908,580	753,217	585,563	529,624	518,803	515,789	578,475	654,189	690,090	704,194	715,366	726,266	732,854	745,456	758,853	772,685
TOTAL	43,216,490	54,592,994	1,586,999	1,358,020	1,085,576	998,979	986,774	990,682	1,120,999	1,275,309	1,349,582	1,383,878	1,412,163	1,440,458	1,463,023	1,495,404	1,529,495	1,564,590
RESIDUAL VALUE	961,637,774	2,212,455,357	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET CASH FLOWS	2,185,244,931	4,390,068,082	84,935,099	69,186,584	55,532,863	51,195,025	50,055,481	52,617,697	59,735,442	65,561,885	70,294,575	75,109,528	77,347,655	80,664,011	81,281,993	85,111,542	87,081,948	88,210,222

Source: Authors

EUR 2017	NPV2017	TOTAL	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
CAPEX																
Technical support	5,524,938	4,376,410	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Land acquisition	106,681,468	86,071,799	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	1,165,379,015	948,764,551	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1,277,585,421	1,039,212,759	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OPEX																
Operating expenses	235,066,604	275,445,679	6,849,778	6,849,778	6,849,778	6,849,778	6,849,778	6,849,778	6,849,778	6,849,778	6,849,778	6,849,778	6,849,778	6,849,778	6,849,778	6,849,778
Ordinary annual maintenance for the new section	48,313,742	61,633,821	1,922,278	1,922,308	1,922,158	1,921,818	1,921,964	1,921,879	1,922,210	1,922,273	1,922,068	1,922,201	1,922,035	1,922,154	1,921,949	1,921,982
TOTAL	283,380,346	337,079,499	8,772,056	8,772,086	8,771,936	8,771,596	8,771,742	8,771,657	8,771,988	8,772,052	8,771,846	8,771,979	8,771,813	8,771,932	8,771,727	8,771,760
DIRECT BENEFITS																
Consumers' Surplus	2,558,770,429	3,276,142,656	93,856,966	96,632,999	99,446,145	102,295,823	105,181,609	108,103,128	111,060,016	114,051,903	117,078,420	120,139,195	123,233,856	126,362,034	129,523,365	132,717,486
Producers' Surplus	269,018,984	332,355,322	9,388,813	9,516,395	9,644,362	9,772,479	9,900,687	10,028,974	10,157,332	10,285,743	10,414,181	10,542,611	10,671,001	10,799,315	10,927,518	11,055,577
TOTAL	2,827,789,414	3,608,497,978	103,245,780	106,149,395	109,090,507	112,068,302	115,082,296	118,132,103	121,217,348	124,337,647	127,492,601	130,681,806	133,904,857	137,161,349	140,450,883	143,773,063
EXTERNALITIES AND SAFETY																
Environmental pollution	4,455,000	5,534,111	154,751	157,540	160,346	163,166	166,000	168,847	171,710	174,587	177,480	180,388	183,311	186,250	189,204	192,173
Noise	486,838	604,762	16,911	17,216	17,522	17,831	18,140	18,451	18,764	19,079	19,395	19,713	20,032	20,353	20,676	21,000
GHG emissions	15,625,692	20,319,030	641,869	660,661	679,653	698,835	718,207	723,014	727,817	732,619	737,420	742,221	747,022	751,823	756,624	761,425
Road safety	22,648,959	28,135,091	786,743	800,925	815,191	829,527	843,933	858,411	872,963	887,592	902,298	917,081	931,943	946,883	961,900	976,996
TOTAL	43,216,490	54,592,994	1,600,273	1,636,342	1,672,712	1,709,359	1,746,279	1,768,723	1,791,255	1,813,877	1,836,593	1,859,403	1,882,308	1,905,308	1,928,404	1,951,594
RESIDUAL VALUE	961,637,774	2,212,455,357	0	0	0	0	0	0	0	0	0	0	0	0	0	2,212,455,357
NET CASH FLOWS	2,185,244,931	4,390,068,082	92,873,450	95,740,966	98,645,859	101,587,347	104,564,275	107,591,723	110,654,106	113,751,718	116,884,163	120,050,425	123,250,736	126,484,109	129,750,752	2,345,505,066

Source: Authors

A II.5 Sensitivity analysis

A sensitivity analysis has been carried out on the key variables in order to determine whether they are critical or not. The procedure requires to make them vary one at a time by a +/-1%, and then to assess the corresponding change in the Economic NVP and IRR. A variable is referred to as "critical" if the corresponding variation in the economic output is greater than 1% in absolute value.

A number of different variables have been tested as part of the sensitivity analysis performed as part of this ex-post assessment. As a result of the sensitivity tests (see table below), two critical variables have been identified: *demand for light vehicles* and *ferry travel time.*

Table 32. Results of the sensitivity analysis

INDEPENDENT VARIABLE	VARIATION (in %) of the economic NPV due to a ± 1% variation	CRITICALITY JUDGEMENT *
Demand for light vehicles	6.85%	Critical
Travel time ferry	1.76%	Critical
Demand for heavy vehicles bridge	0.50%	Not critical
Travel time bridge	0.20%	Not critical
Vehicle operating costs km	0.12%	Not critical
Vehicle operating costs	0.09%	Not critical
OPEX	0.09%	Not critical

Very critical: ΔNPV > +5%; Critical: ΔNPV > +1%; Not critical: ΔNPV < +1%.

A II.6 RISK ASSESSMENT

The risk assessment has been conducted on the two critical variables with the highest results coming out from the sensitivity analysis: *demand for light vehicles* and *ferry travel time.* For the sake of simplicity, it was assumed that the probability distribution of each of these variables is triangular, the value with the highest probability being the reference one – that is, the "base value" adopted for carrying out the CBA – and the lower and upper bounds being the "pessimistic" and "optimistic" values defined in the scenario analysis.

The analyses have been elaborated using the Monte Carlo simulation technique with 1,000 random repetitions. In brief, at each iteration a value from the distribution of each of the independent variables is randomly extracted. The extracted values are then adopted for computing purposes of the ENVP and IRR. Finally, the 1,000 estimated values of ENPV and IRR are used to approximate the probability distribution of the two indicators.

The risk assessment shows that the expected value of the ENPV is equal to EUR 2,356.4 million (higher than the reference case), and that the expected value of the ERR is 6.96% (against a reference case of 6.87%). The probability that the ENPV will become negative and that the ERR will be lower than the SDR adopted in the analysis is nil. Furthermore, there is a less than 50% probability that the two indicators assume a lower value than in the reference case (49% for both ENPV and ERR). Hence, the CBA outputs appear to be robust to future possible variations in the key variables. Overall, the risk analysis shows that the project has a negligible risk level.

Figure 22. Results of the risk analysis for ENPV (left-hand side) and ERR (right-hand side)

CBA Reference value	
2,185,244,931	

Estimated parameters of the distribution	
Mean	2,356,433,561
Median	2,197,419,611
Standard deviation	699,823,559
Minimum	1,161,542,778
Maximum	5,383,415,248

Estimated probabilities	
Pr. ENPV ≤ base value	0.493
Pr. ENPV ≤ 0	0.000

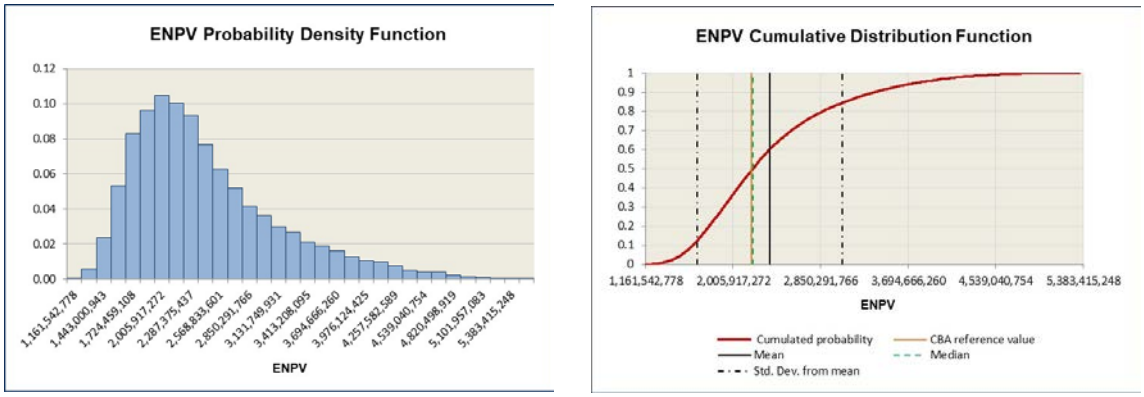
CBA Reference value	
6.87%	

Estimated parameters of the distribution	
Mean	6.96%
Median	6.88%
Standard deviation	0.66%
Minimum	5.36%
Maximum	9.13%

Estimated probabilities	
Pr. ERR ≤ base value	0.489
Pr. ERR ≤ Social discount rate	0.000

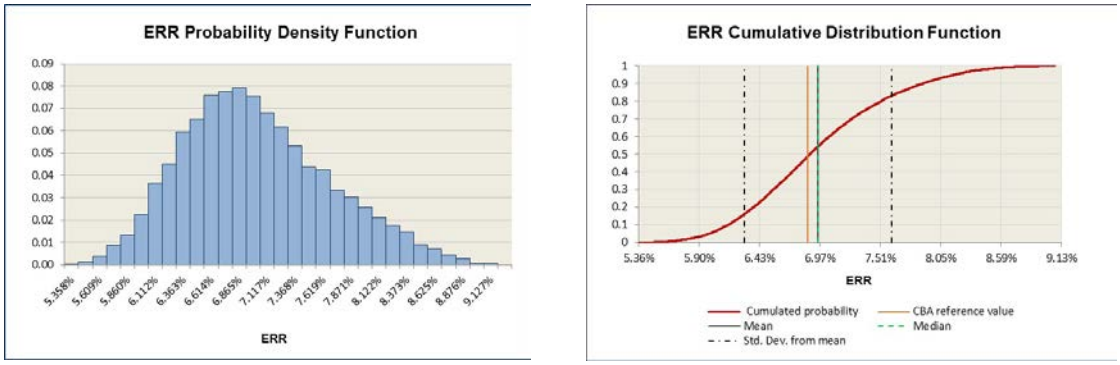
Source: Authors

Figure 23. Probabilistic distribution of the Economic Net Present Value (EUR)



Source: Authors

Figure 24. Probabilistic distribution of the Economic Internal Rate of Return



Source: Authors

ANNEX III. LIST OF INTERVIEWEES

The following table provides details on the stakeholders that have been interviewed as part of the ex-post assessment. The stakeholders have been identified based on the authors referenced in the documents included in the application dossier provided by the European Commission. The institutions approached through these referenced contacts have been consulted in order to confirm the most appropriate and relevant persons to be involved in this ex-post analysis. Additional stakeholders have been identified on the basis of the review of articles and Web Sites, which have been consulted as part of this evaluation. Particularly considering the limited availability of quantitative and qualitative data and information on the wider benefits generated by the project on the economy and society, but assuming a high potential of this investment in this regard, also based on existing literature, interviews have concentrated on these elements.

NAME	POSITION	AFFILIATION	DATE
George Kalogirou	Deputy Finance & Administration Manager	GEFYRA, SA (Operator)	10.10.2017/13.12.2017
Zoi Papasiopi	Head of Managing Authority OP «Transport Infrastructure, Environment & Sustainable Development»	MINISTRY OF ECONOMY AND DEVELOPMENT Special Secretariat for ERDG & CF funded sectoral OPs	14-15.12.2017
Sotirios Basioukas	Director	Ministry of Infrastructure, Transport and Networks, Directorate-General for Transport Infrastructure - Operating, maintenance and operating infrastructure with a concession agreement	06.10.2017
Stratigoula Houliara	Director Department of Operations	Ministry of Infrastructure, Transport and Networks, Directorate-General for Transport Infrastructure - Operating, maintenance and operating infrastructure with a concession agreement	06.10.2017
Kalliopi Dragoulogona	Civil Servant	Ministry of Infrastructure, Transport and Networks, Directorate-General for Transport Infrastructure - Operating, maintenance and operating infrastructure with a concession agreement	12.12.2017
Athanasios Bellas	Chairman-Managing Director	Observatory of Road Networks in Western Greece & Peloponnese	15.12.2017
Vasilios Aivalis	President	Technical Chamber of (Western Greece)	by phone and e-mail
Platonas Marlafekas	President	Commercial & Industrial Chamber (Western Greece)	by phone and e-mail
Christos Mastogiorgos	Advisor to Counselor Grigoris Alexopoulos	Region of Western Greece	by phone
Nikos Karapanos	Mayor	Messologi Municipality	by phone
Athanasios Papathanasis	Vice-chairman of the panhellene pharmaceutical	Ex-Mayor of Naupactus Municipality	by phone

NAME	POSITION	AFFILIATION	DATE
	association		
Christos Douvris	Private Business/Owner	Delta Car	by phone
Tryfon Pachys	Contact Advisor	Private Sector	by phone and e-mail
Paraskevas Gerasimopoulos	General Manager	Travel Agent-10 buses	11.10.2017
Mr. Kostas Pitsiolas	Owner	AGRINO, SA - PISTIOLAS, SA	by phone and e-mail
Mr. George Gouvitsas	Airport Chief (master)	Araxos Airport	by phone and e-mail
Mr. Theodore Galanis	Deputy Airport Chief (master)	Aktion Airport	by phone and e-mail
Mr. Antonios Lioudakis	Owner	LIOUDAKIS BROS - TRANSPORT, LTD	by phone and e-mail
Mr. George Papanastasiou	Mayor	Agrinio municipality	by phone and e-mail
Mr. Athanasios M. Panagopoulos	Mayor	Aigialia municipality	by phone and e-mail
Mr. Nabil Yosef Morand	Mayor	Andraviva & Kyllini municipality	by phone and e-mail
Mr. Christos Christodoulopoulos	Mayor	Hlida municipality	by phone and e-mail
Mr. George Lagouras	Mayor	Kalavryta municipality	by phone and e-mail
Mr. Panagiotis Loukopoulos	Mayor	Naupactus municipality	by phone and e-mail
Mr. Kostas Peletidis	Mayor	Patras municipality	by phone and e-mail
Mr. Gavrilis Liatsis	Mayor	Pyrgos municipality	by phone and e-mail
Mr. George Roros	President	Commercial and Importing Association of Patras	by phone and e-mail
Mr. Konstantinos Nikoloutsos	President	Chamber of Ileia	by phone and e-mail
Mr. Panagiotis Tsichritzis	President	Chamber of Etoloakarnania	by phone and e-mail
Mr. Fotis Smirnis	Technical Director	Port Authority of Patras	by phone and e-mail
Mr. Christos Kostakopoulos	President	Etoloakarnania Hotel Association	by phone and e-mail
Mr. Dimitrios Diamantopoulos	President	Achaia Hotel Association	by phone and e-mail
Mr. Antonios Mavropoulos	President	Hotels Association of Western Ilia	by phone and e-mail
Mr. Gerasimos Zacharopoulos	President	Hotels Association of Pyrgos	by phone and e-mail
Mr. Petros Mantas	President	Association of Installed Enterprises in the Industrial Area of Patras	by phone and e-mail
Mr. George Kapsiampetis	President & Managing Director	KTEL Etoloakarnanias, SA	by phone and e-mail
Mr. Andreas Manolopoulos	President	KTEL Achaias, SA	by phone and e-mail
Mr. Byron Kabarakys	Programme Manager - EU policies / Desk Officer / Senior specialist for transport matrix interaction	European Commission, DG REGIO	by phone

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