BENEFIT

Business Models for Enhancing Funding
& Enabling Financing for Infrastructure in Transport

Deliverable: D 4.4 – Effects of the Crisis & Recommendations

European Commission

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Grant Agreement No.: 635973
Deliverable: D4.4: Effects of the Crisis & Recommendations

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Glossary

Within BENEFIT certain terms are used throughout. These are described here.

Collective BENEFIT database: This is the BENEFIT database consisting, at the start of the project, of seventy-five case studies of funding transport infrastructure and twenty-four country profiles. These are published data from COST Action TU1001 and the OMEGA Centre megaprojects. During the course of the project, the database will be supplemented with at least twenty-eight more cases of funding/financing infrastructure (in particular public funding/financing, which are less represented).

Funding Scheme: A funding scheme is considered to be any combination of private and public income generated by or towards the infrastructure over its life cycle. These may include any combination of user contribution (tolls, fees, fares etc.) or public contributions based on direct and indirect taxation etc. Public funding may also take on the form of availability fees, shadow tolls etc.

Financing Scheme: A Financing scheme is considered to be any combination of public and/or private financial investments required by the infrastructure over its life cycle.

Business model: The business model describes the business case of the overall investment in the project. Depending on the context, it may be narrowed, including strictly the infrastructure projects considered, or it may be widened, including other planned and commonly designed activities in order to capture other “planning gains” (and other value-added services) and even exploiting synergies across the sectors (e.g. transport, energy, ICT). The wider context of business model incorporates the notion of innovative procurement and other approaches to infrastructure delivery, now in the pilot phase.

Key Elements: Elements are groups of variable project dimensions of the same context, which influence the performance of the funding scheme and financing scheme. Elements, as noted in Figure 1.1.1 [of the proposal/contract], are the implementation environment (socio-political, micro and macroeconomic, institutional, regulatory, etc.); the transport mode (functionality; natural and contractual exclusivity, etc.); business model structure; funding scheme; financing scheme and governance and institutional arrangement (risk allocation; decision making processes; ownership rights, etc.).

Typology: A typology concerns groups of factors describing a project that contribute in demonstrating a particular behaviour. Example: Negative Private investment environment type in the implementation context typology. The group of factors leading to the demonstration of this behaviour may be: poor growth forecast, lack of enabling legal framework etc. Typologies for every element (context) will be generated during the project using the collective BENEFIT database (country profiles and case studies) as field examples and desk research. Quantitative and qualitative analysis are the analytical tools that may be used.

Decision Matching Framework: This is the Analysis and Decision Framework to be developed by the BENEFIT project. The framework will contain typologies influencing the overall performance of the investment. It will initially be developed using hypotheses of optimum matching between types, which are confirmed as Matching Principles (rules describing how optimum performance may be achieved) during the course of the project. As such, it could be used as an analysis tool (e.g. identification of “mismatches”) or decision tool (e.g. given the types of elements, which funding scheme type or project rating framework (expressed as the risk to match a specific financing scheme) or project rating enhancing framework (which types may be changed and in which direction to improve project rating) is most appropriate).

Snapshots: These describe the project case study at various points in its life cycle through the typology indicator values at the particular point in time.

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In this report, some additional terms, specific to crisis are used and they are described here:

Financial crisis: A situation in which the supply of money is outpaced by the demand for money. This means that liquidity is quickly evaporated because available money is withdrawn from banks, forcing banks either to sell other investments to make up for the shortfall or to collapse.

Global Financial Crisis (GFC): A worldwide period of economic difficulty experienced by markets and consumers. A global financial crisis is a difficult business environment to succeed in since potential consumers tend to reduce their purchases of goods and services until the economic situation improves.

Economic crisis: A situation in which the economy of a country experiences a sudden downturn brought on by a financial crisis. An economy facing an economic crisis will most likely experience a falling GDP, a drying up of liquidity and rising/falling prices due to inflation/deflation. An economic crisis can take the form of a recession or a depression. Also called real economic crisis.

Recession: Period of general economic decline, defined usually as a contraction in the GDP for six months (two consecutive quarters) or longer. Marked by high unemployment, stagnant wages, and fall in retail sales, a recession generally does not last longer than one year and is much milder than a depression. Although recessions are considered a normal part of a capitalist economy, there is no unanimity of economists on its causes.

Collapse: Sudden and dramatic slowdown in economic activity, resulting in a steep drop in prices with a consequent fall in level of employment.

Depression: Lowest point in an economic cycle characterized by (1) reduced purchasing power, (2) mass unemployment, (3) excess of supply over demand, (4) falling prices, or prices rising slower than usual, (5) falling wages, or wages rising slower than usual, and (6) general lack of confidence in the future. Also called a slump, a depression causes a drop in all economic activity. Major depressions may continue for several years, such as the great depression (1930-40) that had worldwide impact.

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List of Abbreviations

MF	:	Matching Framework
FEI	:	Financial – Economic Indicator
InI	:	Institutional Indicator
GI	:	Governance Indicator
CSI	:	Cost Saving Indicator
RSI	:	Revenue Support Indicator
RAI	:	Remuneration Attractiveness Indicator
RRI	:	Revenue Robustness Indicator
MEAI	:	Market Efficiency & Acceptability Indicator
FSI	:	Financing Scheme Indicator
FsQCA	:	Fuzzy set Qualitative Comparative Analysis
IA	:	Importance Analysis
EA	:	Econometric Analysis

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Executive Summary

The delivery of transport infrastructure is characterised by significant complexity including multiple factors that interrelate positively or negatively leading to observed performance. Multiple actors make decisions that influence the course of development and operation. Infrastructure projects are also vulnerable to external micro and macroeconomic influence, which impact performance. In addition, transport infrastructure produces short, medium and long term impacts with respect to the economy, the environment, institutions and society in general. Therefore, multiple stakeholders are involved with different and, many times, competitive interests. In this context, success or failure can only be subjective depending on the particular objectives of each stakeholder and how they are met through project performance over time. Considering the anticipated positive (and negative) impacts, the sunk nature of investments in transport infrastructure and the range of stakeholder interests, significant research has been devoted to the topic of funding and financing of infrastructure and its performance. Researchers have focused on particular aspects of the transport infrastructure delivery. However, this research only presents aspects of the problem as long as it is not considered with respect and in context with all other factors that may influence outcomes.

The BENEFIT project takes an alternative approach. It initiates by considering transport infrastructure delivery, implementation, operation and maintenance as a system (see D3.1[1]) bearing specific inputs and producing outputs (or outcomes) considered as the "performance" of the infrastructure investment. These outcomes may be project management related, transport goal related, investment related and other outcomes. The "system" includes key elements as illustrated in Figure 1. These "elements" have been studied and their key drivers have been aggregated to indicator – proxies (see D2.2[2], D2.3[3], D2.4[4], D3.1 and D4.2[5]). In this sense, the complexity of transport infrastructure funding and financing and the multiple factors involved are reduced to nine (9) indicators descriptive of the elements of the respective system: the Matching Framework as it is termed in BENEFIT.

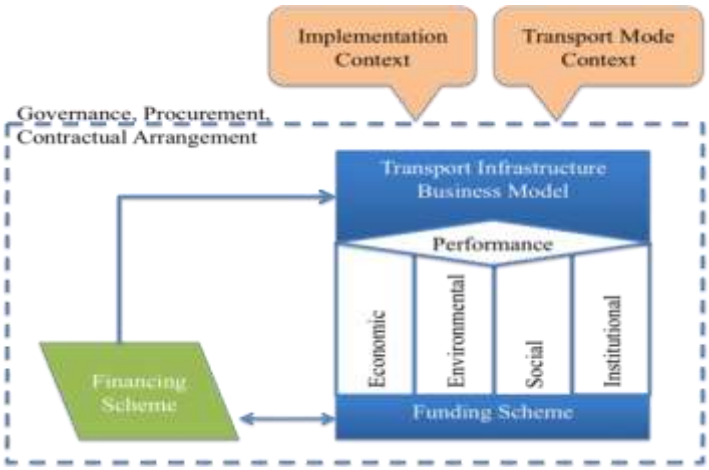

Figure 1. BENEFIT Key Elements in Transport Infrastructure Production, Operation and Maintenance

[1] BENEFIT Deliverable D3.1 Methodological Framework and Ex-post Analysis, July 2015.
[2] BENEFIT Deliverable D2.2 Funding Schemes & Business Models, April 2015.
[3] BENEFIT Deliverable D2.3 Financing Schemes Typology, March 2015.
[4] BENEFIT Deliverable D2.4 Governance Typology, March 2015.
[5] BENEFIT Deliverable D4.2 Leasons Learned – 2nd Stage Analysis, January 2016.

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The other innovative aspect of the BENEFIT approach is that, having as a starting point that different factors or combinations thereof (indicators) will influence different outcomes or combinations of outcomes it does not attempt to assess performance in terms of success or failure. Its study objective is to identify the combinations or interactions between indicators that would have a positive or negative effect on a particular outcome or a combination of outcomes. In the context of the research conducted within BENEFIT, four outcomes are being studied: Actual vs estimated Cost to completion, Actual vs estimated Time to completion, Actual vs forecasted Traffic, and Actual vs Forecasted Revenue. The first two outcomes are closely related to the construction phase of the project. The latter are connected to the operational phase of the project. Traffic is a key outcome in connection with transport goals and the justification of the public investment. Finally, Revenue describes the business case.

Finally, BENEFIT makes a key assumption: input to the system (Matching Framework) is correct. This in practical terms means that cost and time to completion, forecasted traffic and revenues estimates are considered correct involving no bias. This, however, remains an assumption to be confirmed. This assumption also implies that the feasibility study and all other assessments leading to the final project decisions were also correct.

This report approaches the impact of global financial crisis on transport infrastructure projects through several streams, starting with the qualitative assessment of projects in the BENEFIT database by mode with focus on the impact of the crisis on project outcomes, in particular cost and time to completion, and actual vs. expected traffic and revenues.

The cluster analysis, based on the change of the Macro-economic and Financial indicator (FEI) from the BENEFIT Implementation context as an indicator to identify the crisis in the countries, led to identification of three clusters regarding the impact of crisis (Figure 2).

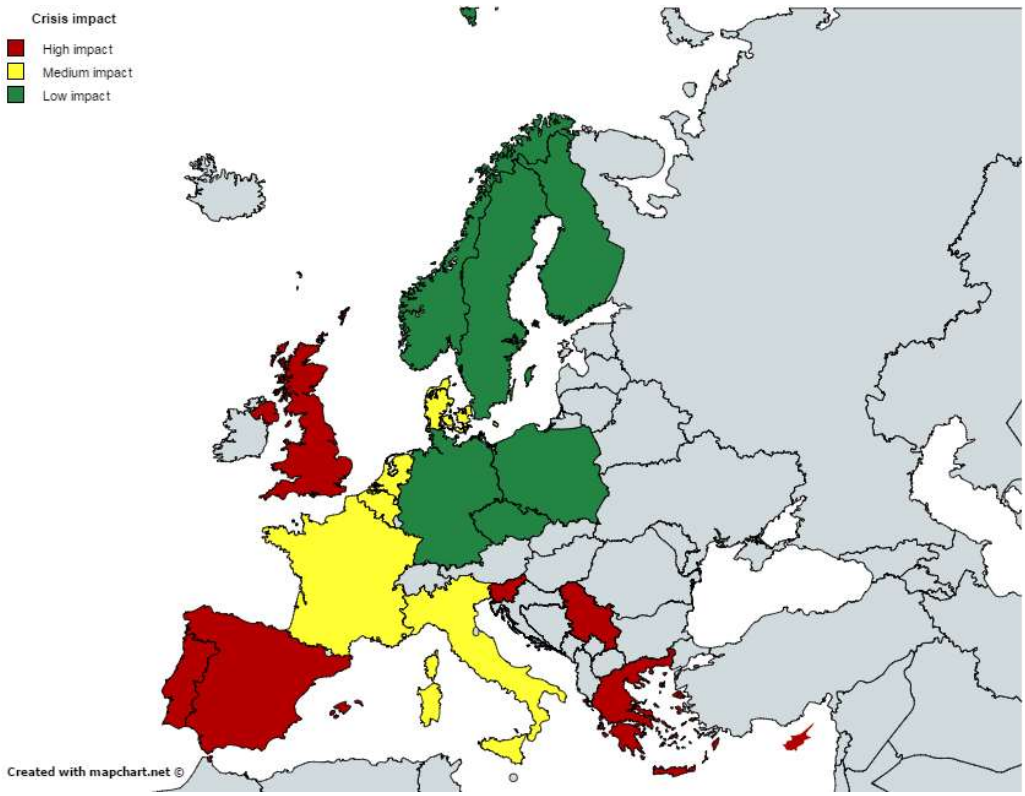

Figure 2: Distribution of countries by clusters

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The qualitative analysis of the road cases showed that most of projects in countries in which the crisis impact was low to moderate, are performing well. The consequences of global crisis may be most clearly seen in the cluster of countries with high impact of crisis that mostly includes southern European countries and UK. However, most of the UK projects are performing also in line with expectations and does not appear to be severely impacted by the crisis, stressing the importance of strong institutional context and proper project selection. In other countries in the high impact cluster most of projects faced difficulties, which may also show that poor project selection and weak institutional context may have made these countries more vulnerable to crisis. However, there are some projects that are still performing reasonably well (Athens ring road in Greece, A5 Maribor – Pince motorway in Slovenia, and M-45 in Spain).

The critical success factors that led to success of these projects include:

- Long term planning
- Top priority projects
- Realistic traffic projections
- Medium size projects
- Strong regulatory body and governmental support
- Responsible and well experienced concessionaire
- Introducing innovations (Norway, Poland, UK)

The consequences of the global financial crisis on the poorly performing projects are reflected through:

- Many projects have to be renegotiated (Portugal, Greece, UK)
- Reducing the scope of projects /significant reduction of the project size (Greece)
- An increased government participation (Greece)
- Introduction of user paid tolls (Portugal, Greece)
- Payment of claims (Greece)
- Cost underestimations (Serbia)
- Time overruns (Serbia, Greece)
- Substantial drop in AADT and revenues (Spain, Portugal, Greece)
- An imbalance of the risks shared between the public and private partner (Greece)
- GDP lower than expected (Slovenia, Portugal, Greece)
- Cash flow difficulties as a consequence of public budget restrictions (Spain, Greece, Portugal)

The impact of crisis on Urban Transport projects is even more difficult to access, since it should be analyzed on the network level, particularly in the operational phase, and most probably the impact has been larger on peripheral, supporting networks, compared to central lines. The crisis had underlined the capacity of cities and countries to support urban transport policies and projects and the importance of proper planning and design of sustainable urban transport networks taking into account realistic demand. For some projects, like Brabo 1 in Portugal, the economic crisis has had a direct impact by impacting the financial capability of private sector, which led to delays in the tendering phase.

The 2008 crisis caused a slowdown in ridership in many countries, but did not reverse the general trends of increasing ridership in urban transport since 2000. In France, Germany, and Italy, there were almost no negative trends in the increase of ridership, while in countries severely hit by crisis, like Spain and Portugal, and Central and Eastern European countries the decrease was substantial as a result of worsened economic situation. In addition to cases of reduced ridership, and consequently revenues, the secondary revenues, such as advertising, have also dropped. Finally, since these systems rely to a large extend on support from public budgets, these grants were severely affected by crisis, even in countries where there was no or was limited ridership slowdown. The crisis has also caused the increase in operating costs, such as cost of materials and taxes.

Operators of urban transport network tried to reduce operating costs, either through reducing wages and maintenance costs, or through reducing service offer. The financial crisis has also increased

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pressure on the level of investment to extend or renew metro systems. After the crisis private partners are more reluctant to invest in urban transport systems. Overall, the global financial crisis seems to have relatively small impact on financing of urban transport projects, except in countries hardly hit by crisis, where it exposed structural weaknesses.

Most of bridge and tunnels projects included in the BENEFIT database were in the operation phase in 2008 and only two projects were in the planning or construction phase.

The performance of these projects does not appear to be severely impacted by the crisis. As a result of crisis, the traffic levels mainly decreased, impacting the revenues as well. The decrease was relatively modest, thanks to the exclusivity[6] of most of the projects. However, in countries that were less hit by crisis (Scandinavian countries or Czech Republic), the traffic levels mainly recovered, except in cases where there was competing infrastructure, like in case of Herrentunnel). On the other side, it appears that decrease in traffic level that happened after 2011 (following the initial recovery of traffic after the crisis) in Germany, The Netherlands, or France, may be part of a long-term trend in road mode of transport, as a result of shift towards more sustainable transport modes. In countries that were severely hit by crisis, like in Portugal (Lusoponte bridge), the crisis caused the change in risk allocation matrix, increased public support and extension in the concession duration.

For projects that were completed after the crisis, the issues in the construction phase were mainly related to the traditional project management issues and planning, and not to the crisis. The most important success factors that led to success of bridges and tunnel projects is good planning, regarding the estimated traffic, and their exclusivity and protection from competition.

The analysis of airport cases found in the BENEFIT database confirmed the finding that small airports were hit by crisis with delay compared to large airports. However, the smaller-sized airports have an abrupt fall in traffic growth rate when the crisis hits, whereas larger airports typically keep a relatively stable traffic growth rate (although sometimes negative) throughout the crisis years. Some airports like Sa Carneiro in Portugal were able to keep traffic growth, although the growth rate has been substantially lower in 2009.

Two factors that improved the resilience of airport cases and to mitigate the impact of crisis included the growth in tourism and the growth of low-cost airline traffic. The importance of good intermodal connections was also outlined in the analysis, particularly for Modlin airport in Poland. Benefit airport cases responded to the crisis by introducing some adjustments such as offering promotions and incentives, and enforcing cost controls.

All six BENEFIT port cases are located in southern European countries, hardly hit by crisis: Portugal, Spain and Greece. However, all of them, except the port of Sines in Portugal, showed positive overall performance despite the crisis.

The major factors that contributed to success of these projects are good planning and appropriate project justification, as well as commitment and financial capability of concessionaires and link to major shipping line that allowed the traffic growth even in the case of adverse economic conditions (as in the case of Piraeus Container Terminal in Greece). In addition, the success of two projects that involve passenger traffic was related to the growth in tourism.

Funding and financing of transport infrastructure bears similarities as well as differences between transport modes. For instance, project's **exclusivity and connectivity to the transport network** are important factors in achieving targeted performance, especially in cases of capital infrastructure

[6] The term "exclusivity" is used in this report to indicate specific position of the project (or lack of competing links) in the transport network providing clear advantage in terms of travel length or travel time.

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objects as tunnels and bridges. It also affects largely its resilience to crisis. In evidence, those are the **projects of national interest, long time planned, technically mature** what made them perform in line or above expectations even in unstable environment, as during or after the global financial crisis. For this mode, projects were resilient to crisis despite of technical difficulty and large investment; unlike, for example, road projects where abovementioned project characteristic lead to many crisis-induced difficulties. Huge investment requirements in road sector may cause serious time or cost overruns, especially in road and rail projects with low levels of financial-economic and institutional conditions.

The analysis also showed importance of **good governance**, especially in times of crisis in terms of **competence** (institutional and other) of the public authorities monitoring implementation for both PPP and traditional delivery of infrastructure. In case of urban transit projects, the competence of the (local) public authorities may be critical for achieving expected performance, as it involves following closely stakeholder objectives. Good governance can be looked upon also as an expression of public authority competence and good institutions which are crucial in difficult times for number of reasons. One of those being conducting **competitive tendering** which allows choosing competent and experienced contractor or service provider, and also defining and negotiating **contracting arrangements** that can be adaptable enough for sudden and unpredictable severe changes in the projects' surrounding (e.g. to GFC).

Some modes also allow for a **wider range of value adding activities and services,** which create additional traffic and incomes. For that reason, impact of the crisis was not so significant for airport projects, and they managed to keep their expected traffic growth even during or after the crisis. That conclusion can be even expanded to road projects that exclusively serve the airports, and therefore have traffic more resistant to change. In addition, the increase in tourism helped many airport and port projects to keep traffic level increasing, although at a slower pace.

Regarding the BENEFIT Matching Framework, so-far analysis showed that there is no direct link between the indicators and change in expected outcomes as a result of crisis, but the answer lies in the combination of influences that are crisis-specific, and which lead to changes in outcomes. However, one factor was identified to have an impact on all outcomes throughout the modes, and that is **implementation context** and its **indicators financial – economic context and institutional context**. That conclusion very clearly emerged after analyzing the projects by clusters of countries, based on changes of macro-economic indicator during the crisis. However, special consideration was given to the sample of projects from UK, as UK managed to retain continuity and expected performance in almost all analyzed projects regardless of being an economy severely hit by crisis. As it came out, that resilience was a consequence of **strong legislative and governmental support**, especially in terms of implementation of PPP projects.

The report also presents the modified BENEFIT Matching Framework Typologies indicators that were result of validation performed in the stage 2 of Task 4.1. The improved indicators were recalculated for each snapshot and formed a basis for Fuzzy set Qualitative Comparative Analysis (FsQCA), Importance Analysis (IA), and Econometric Analysis (EA) that were also used to assess the impact of global crisis on transport infrastructure projects. The performance of projects has been assessed for periods before, during, and after the crisis.

Cost to completion

According to the FsQCA analysis, the high Financing scheme indicator (FSI) was a necessary condition for projects being "on cost" that were completed before the crisis, meaning that projects that were heavily subsidized by the public sector or that were purely public had more chances to be on budget than the PPPs. For solution after the crisis, the FSI is one of core conditions in both the "on cost" and "over cost" models, so it is not be possible to differentiate projects based on this indicator regarding cost performance after the crisis.

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The high Institutional context indicator (InI) is present in all FsQCA and all IA paths. This indicator has not been used in the EA, but solution paths for EA include Macro Financial-Economic indicator (FEI) which has been highly correlated with InI. This implies that strong institutional context with good political capacity, support and policies, good legal and regulatory framework and good public sector capacity is important for achieving "on cost" target during project construction. However, a contradictory solution has been obtained for the FsQCA "on cost" model before the crisis, which includes as core conditions high values of InI, but low values of FEI, meaning that strong institutional conditions, but poor macro-economic conditions were preconditions for projects being "on cost" before the crisis and this combination could explain 51% of projects. However, the FsQCA Model for "on cost" target after the crisis includes as core conditions both positive InI and FEI and explains 57% of cases. The low InI and FEI were also among core conditions for both solutions that could explain about 41% of cases with cost overrun after the crisis. The EA showed that marginal improvement in the FEI leads to increase of 56% of probability that project would be finished within available budget.

High Governance indicator (GI) appears for FsQCA "on cost" model before the crisis, as well as in the importance and econometric analysis. It does not appear only in the FsQCA "on cost" model after the crisis. This means that high level of efficiency and effectiveness of governance and contractual flexibility are important for achieving "on cost" target during construction. According to the EA, marginal improvement in GI raises the probability of success of the project for 15.8%.

Almost half of projects (45%) of projects being 'over cost' (and completed before crisis) can be explained by low FSI as a core condition and low Remuneration attractiveness indicator (RAI) as a peripheral condition, meaning that PPP projects and projects where remuneration scheme is less attractive to investors had more chances to be over cost before the crisis. Contrary to this, after the crisis high FSI indicator, meaning mostly publicly financed projects is considered necessary condition for cost overrun. The low RAI also appears as core condition in both "over cost" models for projects completed after the crisis.

IA and EA analysis showed that Cost savings (CSI) and Revenue support (RSI) indicators are also important for achieving the "on cost" target. The IA outlined the "Level of control" as the most relevant part of the RSI indicator that was ranked first among significant indicators for projects awarded before the crisis, but the rank was lower for projects completed before and after the crisis. The combination of high values of GI, CSI and RSI indicators appear in both IA and EA solutions, coupled with the InI in the case of IA, or FEI in the case of EA, as conditions for projects being on cost.

According to the EA, projects conducted during the economic crisis have reduced probability of finishing the project successfully on cost or below cost by 17.9%.

Time to completion

Similarly to the "cost to completion" outcome for projects completed before the crisis, the FSI indicator was necessary condition also for the outcome "on time" before the crisis.

The Governance indicator (GI) appears in almost all solutions for all three different analyses used, stressing the importance of good governance during project construction for the "on time" outcome. The combination of high GI and high FSI explains 74% of cases before the crisis and means that public projects with good contractual agreements were "on time".

InI and GI also appear in all three IA sets, i.e. projects awarded before the crisis, projects completed before the crisis, and completed after the crisis, but for projects completed before the crisis these two conditions were the only one. For projects awarded before the crisis or completed after the crisis, they are complemented with Level of control, and Remuneration attractiveness.

In addition, the financial crisis showed negative and significant impact on time performance, according to the EA, together with IRA and Revenue robustness (RRI) that appeared only in the bivariate model.

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After the crisis two core conditions for the absence of “on time” outcome were low InI and low GI. Only low InI, or low GI, as a core condition for FsQCA explains 56% of cases. In addition, low InI combined with low Transport market efficiency and acceptability indicator (MEAI) explains 46% of cases being “over time” after the crisis. Additional factors that are present in FsQCA solutions for project with cost overrun after the crisis include low FEI and low FSI, but these solutions have smaller explanatory power.

Traffic performance

For the FsQCA analysis for subset of projects “Before crisis” and for IA no solution was obtained regarding “on traffic” performance.

High InI and high RAI are core conditions, combined with high GI, that explain 64% of project being “on traffic” that were completed after the crisis.

Low InI combined with low FEI and low RAI explains 54% of projects being “below traffic” before the crisis, and 56% of cases “below traffic” can be explained by only the low InI in the simplified FsQCA. High FSI is necessary condition for “below traffic” outcome after the crisis, meaning that heavily subsidized, or public projects are underperforming after the crisis. In all three solutions the low RAI is condition for “below traffic” outcome after the crisis, together with low FEI or low GI, which explains between 37% and 51% of cases.

The EA found that significant variables explaining the traffic forecast are FEI, IRA, revenue support, RAI and Market efficiency and acceptability. However, marginal analysis showed that only FEI has strong impact, and its marginal increase would increase probability of improving outcome for 72.6%. All other indicators had much smaller influence. The parameter “crisis” did not appear to have significant influence on the traffic outcome.

Revenue performance

The high FSI was shown to be necessary condition for projects below revenues. However, this finding was not further examined, since no solution was found for the absence of revenue outcome.

High Revenue robustness was found to be a core condition for most on solutions for “on revenue” projects before the crisis. Only high RRI can explain 74% of projects with actual revenues equal or above the expectations, before the crisis, while CSI can explain 63% of cases. Other peripheral conditions include high GI and high FSI with explanatory power of 54% to 62% of cases.

High InI and high GI are core conditions for successful projects after the crisis, being able to explain 70% of cases. The other solution is based on low FEI and low GI, but able to explain only 42% of cases.

IA showed that Level of control revenue (part of Revenue scheme) indicator was significant for both, projects awarded and projects completed before the crisis. In addition, the RAI was relevant for projects awarded before the crisis, and no indicator was relevant for projects completed after the crisis.

The variables that could explain the revenue outcome in the EA are IRA, RAI, RRI, and FSI. However, the marginal analysis showed that contribution of these variables is relatively small compared to models for other outcomes.

Similarly to traffic, the parameter “crisis” did not appear to have significant influence on the revenue outcome.

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The changes in remuneration trends that are result of crisis were investigated for project in Europe and Latin America. The analysis is based on external databases provided by OECD and World Bank PPIAF. In Europe, there is clear shift towards the availability based remuneration scheme that may be the result of PPP sponsors and lender risk averseness. This may also be a result of European sovereign debt crisis that extended till 2012, especially in southern European countries. In Latin America there was increased number of projects with Government support from 2007 to 2010. However, number of these projects declined in recent years. In addition, most of projects realized since 2011 are demand based.

The report concludes with set of recommendations for improving the resilience of transport infrastructure projects to economic crisis, as a result of qualitative assessment and analysis performed on cases in the BENEFIT database.

In times of crisis, there is an evident need for more accountability in all phases of the projects. Based on the results of analyses conducted within task 4.3 and presented in this report, several recommendations are offered in relation to planning, design, construction and operation of transport infrastructure projects in the time of economic crisis.

All solution paths found that Implementation context and its indicators, institutional context (InI) and financial – macroeconomic context (FEI) have impact on all outcomes throughout the modes. This implies that strong institutional context with good political capacity, support and policies, good legal and regulatory framework and good public sector capacity is crucial for achieving targeted performance of transport infrastructure projects in case of crisis. Improvement of financial – macroeconomic context significantly increases probability of successful project performance.

The key recommendations include:

- Proper project planning and design
- Good connectivity to transport network
- Project exclusivity
- Good governance
- Contractual flexibility
- Contractor's capacity to construct
- Operator's capability to operate
- Involvement of major transport operators, and
- Diversification of revenues and across demand segment.

The BENEFIT project Matching framework and BENEFIT database provide tool and data that enabled assessment of contribution of implementation context, governance, funding and financing schemes and applied business model on project performance during the global financial crisis.

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1 Introduction

1.1 Introduction to the BENEFIT Project

BENEFIT seeks to take an innovative approach by analysing funding schemes within an inter-related system. Funding schemes are deemed to be “successful” (or not) depending on the Business Model that generates them as well as their stakeholders and policy contexts. The performance of the Business Model is affected by the implementation typology and the transport mode context – together with other contextual changes over time and space, including changes in overarching policy frameworks. It is matched successfully (or not) by a financing scheme. Relations between actors are partially described by a governance model (contracting arrangements). These are key elements in Transport Infrastructure Provision, Operation and Maintenance, as illustrated by Figure 1.1.

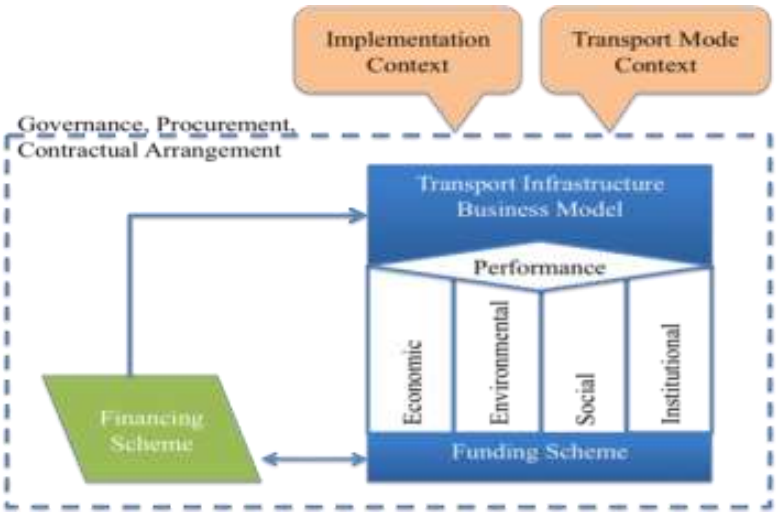

Figure 1.1: BENEFIT Key Elements in Transport Infrastructure Production, Operation and Maintenance

Success in relation to the application of a particular business model is seen here as an assessment of the appropriate matching of elements. Within BENEFIT funding and financing schemes are analysed in this respect. Describing these key elements proposed through their characteristics and attributes and clustering each of them into typologies is the basis of, first, developing a generic input/output model. Identifying best matches and their inter-relations (matching principles) leads to move from a generic model to a Decision Matching Framework that is developed to provide policy makers and providers of funding (and financing) extensive comparative information on the advantages and limitations of different funding schemes for transport infrastructure projects and improve the awareness of policy makers on the needs of projects serving an efficient and performing transport network within the Horizon 2050. Moreover, the model allows policy makers to identify changes that may be undertaken in order to improve the potential of success, such as improving the value proposition of the business model.

In developing this model, BENEFIT takes stock of project profiles known to its partners in combination with a meta-analysis of relevant EC funded research and other studies carried out with respect to funding schemes for transport (and other) infrastructure and direct contact with key stakeholder groups.

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More specifically, BENEFIT uses the published project profile descriptions of seventy-five transport infrastructure projects funded and financed by public and private resources from nineteen European and four non–European Countries covering all modes of transport. It also exploits twenty-four European country profiles with respect to contextual issues (institutions, regulations, macroeconomic and other settings) influencing funding and financing of transport infrastructure. This data has been produced within the framework of activities undertaken by the OMEGA Centre for Mega Projects in Transport and Development and the COST Action TU1001 on Public Private Partnerships in Transport: Trends and Theory. In addition, BENEFIT, through its partnership and respective experts, consolidates almost twenty years of successful European Commission research with respect to issues related to transport infrastructure and planning, assessment and pricing of transport services. In this sense the approach is supported by the tacit knowledge and insights of the BENEFIT partnership with respect to infrastructure projects in transport.

By applying the Decision Matching Framework (MF), BENEFIT undertakes:

- An ex-post analysis and assessment of alternative funding schemes (such as public, PPP and other) based on existing experiences in different transport sectors and geographical areas and their assessment with respect to economic development, value for public money, user benefits, life-cycle investment, efficiency, governance and procurement modalities, etc.; and, provides lessons learned, identification of the limitations of the various schemes and the impact of the economic and financial crisis.
- An ex-ante (forward) analysis and assessment of the potential of transport investments and the related funding schemes, including innovative procurement schemes still in a pilot phase, to contribute to economic recovery, growth and employment, in view of future infrastructure needs with a 2050 horizon for modern infrastructure, smart pricing and funding.

BENEFIT is concluded within twenty one months and bears the following stakeholder focus and policy scenarios:

- Transport infrastructure business models and their project rating: Improved value propositions lead to funding schemes with enhanced creditworthiness enabling viable financing, balancing of project financing and funding risks, increasing the value basis of stakeholders and highlighting the potential of transport investments.
- Transferability of findings with respect to lessons learned, limitations and the impact of the economic and financial crisis through the introduction of typologies for particular sets of stakeholder under different scenarios.
- Open-access case study database in a wiki format, allowing for continuous updates and providing a knowledge base serving both practitioners and researchers.

1.2 Contribution of this Report to the BENEFIT Project

The work undertaken under Task 4.3 aims to deliver against the following objectives, as stated in the BENEFIT proposal:

"*A particular aspect of the Limitations of funding and financing schemes for the delivery, operation and maintenance of infrastructure is their tolerance (resilience) to fluctuations in the financial markets and the national and global economy. Taking stock of the analysis already completed ("Lessons Learned" and "Limitations"), emphasis is placed on the types and typological settings mostly influenced by the crisis. The Matching Framework Facility guides the analysis and concerns the study of the effects of the implementation context typologies. Their change is reviewed before, during and after (emerging from) the crisis and the developments in the financing schemes caused by the economic and financial crisis. The work will include comparative analysis of resilience and robustness of different business models and respective funding schemes overall, and in the context of specific transport modes. Hence, the Matching Framework Facility guides the analysis and assessment. A qualitative assessment will be made with respect to the impact the crisis has on the future of infrastructure, especially with respect to maintenance and life-cycle investments and further so, on economic*

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recovery. Suggestions will be made as to business models and respective funding schemes, which are better positioned to sustain such changes in the changing economic environment. Findings are compared with countries/regions less influenced. The study also considers changes in the implementation context typology over time with relation to the project life-cycle. Settings capable of overriding the crisis are reported. A study including findings and recommendations is delivered."

This report approaches the impact of global financial crisis through several streams, starting with the qualitative assessment of projects in the BENEFIT database by mode with focus on the impact of the crisis on project outcomes, in particular cost and time to completion, and actual vs. expected traffic and revenues.

The report also presents the modified BENEFIT Matching Framework Typologies indicators that were result of validation performed in the stage 2 of Task 4.1. The improved indicators were recalculated for reach snapshot and formed a basis for Fuzzy set Qualitative Comparative Analysis (FsQCA), Importance Analysis (IA), and Econometric Analysis (EA) that were also used to assess the impact of global crisis on transport infrastructure projects. The performance of projects has been assessed for periods before, during, and after the crisis.

Finally the changes in remuneration trends that are result of crisis were investigated for project in Europe and Latin America. The analysis is based on external databases provided by OECD and World Bank PPIAF.

1.3 Report Structure

This section provides a guide to the contents of this report. After discussing how this deliverable fits in the wider context of the BENEFIT project, (Chapter 1), this report aims to provide the analysis of the impact of the global financial crisis on transport infrastructure projects and recommendations.

Chapter 2 presents the qualitative analysis of case studies in the BENEFIT database with respect to the impact of crisis on the performance of transport infrastructure projects. The qualitative assessment is performed by mode and lessons learned for each mode are derived.

Chapter 3 presents the revised BENEFIT Matching Framework indicators that were result of the analysis performed during Stage 2 of Task 4.1.

Chapter 4 presents the impact of changes in the implementation context indicators on the performance of transport infrastructure projects. Three clusters of countries were identified based on the change in the financial-economic indicator and the impact on the disaggregated business model, funding scheme and financing scheme indicators is assessed.

Chapters 5, 6 and 7 respectively present the findings of the Fuzzy Qualitative Comparative Analysis, the Importance Analysis and the Econometric Analysis carried out using the improved typology indicators of the Matching Framework, with focus on the impact of global financial crisis on transport infrastructure projects and analysis of pre and post-crisis performance of projects.

Chapter 8 presents trends in the remuneration schemes, as a result of crisis. The first part of analysis deals with projects in developed countries, available in the OECD database, while the second part deals with projects in developing counties, in particular in Latin America, and uses information available in the World Bank PPIAF database.

Chapter 9 concludes this report with the overall conclusions and recommendations for future implementations of transport infrastructure projects.

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2 Qualitative Analysis: The impact of crisis as presented in the BENEFIT case studies

The Global Financial Crisis (GFC) that occurred in 2007/08 was the latest of big international crises that hit the global economy. The GFC was followed by the European sovereign debt crisis that began at the end of 2009 and lasted till 2012, when the peripheral Eurozone member states of Greece, Spain, Ireland, Portugal and Cyprus were unable to repay or refinance their government debt, without the assistance of third-party financial institutions.

The impact of crisis on transport infrastructure projects depended if the projects were in construction, or operation phase, if they were located in countries less or more impacted by crisis, and also differed depending on transport mode.

The impact of crisis reflected in several different ways:

- Reduction in private sector sources of capital that caused delays in financial closures for projects
- Delays in construction caused by lack of finances
- Increase in cost of capital
- General decrease of passenger and cargo traffic, with reduction in revenues etc.

Impact of financial crisis on PPPs has been a subject of many researches. International financing institutions were leaders in this, as they also were the main promoters of the PPP concepts. In 2010, European Investment Bank (EIB) report showed that PPP market contracted in most European countries and sectors during financial crisis (Kappeler and Nemoz, 2010). Compared to 2007, PPP transaction dropped by almost 50% in 2009. International Monetary Fund (IMF) report identified a shift in preferences of financial institutions from long term loans to short term loans (Burger et all, 2009). Reviewing data from the World Bank Public-Private Infrastructure Advisory Facility (PPIAF), projects in emerging market countries were facing delays, i.e. delays in implementation, reaching financial close or even cancellation. Reasons that caused most of delays were: uncertainty regarding future demand, access to finance and the cost of financing.

A review carried out by PPIAF shows that the financial crisis significantly affected the rate of new PPP project closures in the second half of 2008 (Izaguirre, 2010). Since then investments in new PPP projects have recovered, but several transport projects have been postponed or cancelled due, *inter alia*, to difficulties in reaching financial close. Nevertheless, investment in roads in 2009 decreased by about 6 percent (to US$13.7 billion) from the 2008 peak, being the second highest level since the mid-1990s. Investments in new PPP projects in some countries such as Brazil, India, Russia and Turkey continue to recover. Financing markets have changed and some of banks have withdrawn from the market causing reduced liquidity. Projects reaching financial closure after crisis are facing lower debt-equity ratios, higher fees, shorter debt maturity, and embedded mechanisms for refinancing.

The purpose of this chapter is to provide better understanding of the cases in the BENEFIT database with respect to the impact of crisis. The assessment is based on the case narratives included in the BENEFIT wiki and the BENEFIT Cases in Transport Infrastructure e-book[7]. Information is also mined from the BENEFIT case database, where project information has been collected based on the BENEFIT data collection protocol (see BENEFIT project deliverable D2.1[8]).

The cases are analysed per mode and each team has approached the analysis on a slightly different way taking into account the number of cases in each mode and data available.

[7] BENEFIT Case Studies, ISBN 978-618-82078-1-3
[8] BENEFIT Deliverable D2.1: Updated BENEFIT Database

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2.1 Road Projects in BENEFIT

2.1.1 Qualitative analysis of road projects with respect to economic crisis

This section describes the second stage of the qualitative analysis (QA) regarding the road infrastructure cases of the BENEFIT database. The BENEFIT database consists of 31 road projects out of which for 26 projects are available snapshots (Table 2.1). Six of these projects are located in countries with low impact of crisis (Norway, Finland, Germany, and Poland), four more in countries with moderate impact (Croatia, Belgium, Italy, and The Netherlands), and remaining 20 projects are located in the countries that were severely hit by crisis (Greece, Portugal, Serbia, Slovenia, Spain, and UK). One project (Horgos-Pozega) is excluded from the analysis, since the project never reached financial close, and part of it was later realized as public project (Horgos – Novi Sad) that is included in the database. The clustering of countries due to crisis impact is based on change of macro financial-economic indicator and is presented in Section 4.

The objective of this qualitative analysis is twofold: first, to determine what may be the consequences of global crisis to road infrastructure projects, how it may affect the overall life of a project, which projects' characteristic lead to improved project resilience toward crisis, what is the influence of the location of the projects in terms of its overall success and resilience and the like, and, secondly, to explore how BENEFIT matching framework tackles the change in snapshots during (or after) the crisis, and if it was able to capture unique behaviour and to adequately address the crisis influence to the project outcomes.

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Table 2.1: Analyzed BENEFIT road projects from the aspect of "impact of crisis" and availability of information for each

Cluster	Case study	Country	Database Entry	Narrative/ WIKI	Snapshots
Countries with low impact of crisis	E4 Helsinki-Lahti	Finland	☑	☑	☑
	E18 Muurla-Lohja	Finland	☑	☑	☑
	Bundesautobahn 20	Germany	☑		
	E18 Grimstad - Kristiansand	Norway	☑	☑	
	E39 Orkdalsvegen Public Road	Norway	☑	☑	☑
	A2 Motorway	Poland	☑	☑	☑
Countries with moderate impact of crisis	Istrian Y Motorway	Croatia	☑	☑	
	Via Zeventem	Belgium	☑	☑	☑
	BreBeMi	Italy	☑	☑	☑NC
	Combiplan Nijverdal	The Netherlands	☑	☑	☑
Countries with high impact of crisis	Athens Ring Road	Greece	☑	☑	☑
	Central Greece (E65) Motorway	Greece	☑	☑	☑
	Elefsina Korinthos Patra Pyrgos Tsakona Motorway	Greece	☑	☑	☑
	Ionia Odos Motorway	Greece	☑	☑	☑
	Moreas Motorway	Greece	☑	☑	☑
	A22 motorway	Portugal	☑	☑	☑
	A23 motorway	Portugal	☑	☑	☑
	Horgos - Pozega	Serbia	☑	☑	
	Belgrade By-pass Project, Section A	Serbia	☑	☑	☑
	E-75, Donji Neradovac - Srpska kuca	Serbia	☑	☑	☑
	E-75, Horgos-Novi Sad (2nd phase)	Serbia	☑	☑	☑
	A5 Maribor Pince motorway	Slovenia	☑	☑	☑
	Koper - Izola Expressway	Slovenia	☑	☑	☑
	C-16 Terrassa-Manresa Toll Motorway	Spain	☑	☑	☑
	Eje Aeropuerto (M-12) Motorway	Spain	☑	☑	☑
	M-45	Spain	☑	☑	☑
	Radial 2 Toll Motorway	Spain	☑	☑	☑
	A-19 Dishforth	UK	☑	☑	☑
	BNRR (M6 Toll)	UK	☑	☑	☑
	M-25 Orbital	UK	☑	☑	☑
	M-80 (Haggs)	UK	☑	☑	☑

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2.1.2 Projects in countries with low-impact of financial crisis

The cluster of countries with low impact of crisis includes Scandinavian countries (Norway, Sweden, and Finland), Germany, and Poland. The cluster is represented by six projects (Table 2.2) in the BENEFIT database, with medium to high investment size, that are either greenfield, or both greenfield and brownfield. Five of these projects are delivered as PPPs, while only Bundesautobahn 20 in Germany was delivered as public project. The PPP contract duration ranged between 15 and 25 years. However, crisis was not mentioned in any of available narratives for these projects.

The timeline for implementation of projects in the first cluster is presented in Figure 2.1. Three of these projects were in operation phase (E4 Helsinki – Lahti in Finland, Bundesautobahn 20 in Germany, and E39 Orkdalsvegen Public Road in Norway), and two were in construction phase (E18 Muurla-Lohja in Finland and E18 Grimstad – Kristiansand in Norway) during the crisis. Construction of A2 motorway in Poland commenced after the crisis.

Table 2.2: Overall characteristics of the three groups of projects

Country	Project	Type	Size	Delivery mode	PPP contract duration (years)
Finland	E4 Helsinki-Lahti	Both	High, €550-590 million	PPP	15
	E18 Muurla-Lohja	Both	High, €700 million	PPP	24
Germany	Bundesautobahn 20	Greenfield	High, > €2 billion	Public	
Norway	E18 Grimstad - Kristiansand	Both	Medium €350 million	PPP	25
	E39 Orkdalsvegen Public Road	Both	Medium, €150 million	PPP	25
Poland	A2 Motorway	Greenfield	High, €1.3 billion	PPP	25

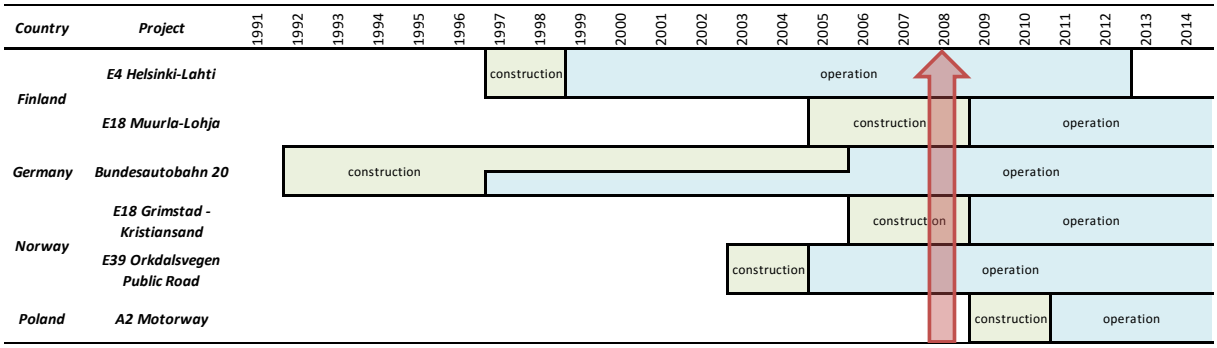

Figure 2.1: The timeline of road projects in the countries with low impact of crisis

The **E4 Helsinki – Lahti** motorway in Finland was conceived in 1997 as the first PPP project in Finland, and 15-year concession contract finished in 2012. The Project was delivered earlier and was in other respects (e.g. service level, safety) regarded as good, e.g. general level of project's perceived success was high. The revenue scheme was based on shadow tolls based on vehicle kilometres travelled, and project total budgetary costs for the Road Administration were higher than estimated as actual traffic volumes exceeded projected. Critical success factors were above all, good general governance, administration in place and responsible concessionaire.

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The **E18 Muurla-Lohja** motorway in Finland is part of the international East-West connection, but it also improves connection from Turku to Helsinki. It was the second PPP project in Finland. The project was conceived in 2004-2005, the construction phase lasted till 2009. The concession contract ends in 2029. The revenue scheme is based on availability payments. So far, the road has been serving the road users well without any major interruptions or defects in construction or maintenance.

The **Bundesautogahn 20** in Germany (Autobahn 20, BAB 20 or A 20 for short) is one of a programme of German Unity Transport Projects built following reunification to link the old and new Federal states together, and also forms part of the EU Trans-European Road Network. It is colloquially known as Ostseeautobahn, due to its geographic location near the Baltic Sea coastline. It was designed to be opened in stages, with construction starting in 1992, the first section opening in 1997 and the official opening ceremony in December 2005. The final cost of the project was 15% higher than estimated cost. The traffic in 2006 was about 75% of the estimated traffic.

The **E18 Grimstad – Kristiansand** link in Norway is extremely important as it brings together almost 1.7 million of people, and connects 14 cities. The project was conceived in 2002/2003, signed in 2006, and opened to traffic in 2009. The road was built in 38 months with no time and cost overruns. Concession contract entitled the winning company of being paid an annual compensation during the minimum 25 year operating period. The project is in its fourth year of the 25 years period. Judging from delivery, current operation and maintenance standard, the project is highly successful in delivering services to the road users. Actual traffic is in line with the forecast.

The **E39 Orkdalsvegen Public Road** in Norway road was considered as a road of high national political priority. The Project was conceived in 2001, and had reached financial close in 2003. The operation contract is valid for 25 years from completion of construction and was opened in 2005 with no time and cost overruns. Actual traffic is in line with forecast. The project is highly successful in fulfilling all the projections, and has several specific success factors. For instance, the procurement process, project phase and operational phase have been carried out by both contractual parties according to the initial plans. This has created a stable environment for the long term perspective of operating the road. Secondly, by introducing a lighter colour in the road surface, the need for energy to lighten the road has been reduced. The contractor has implemented LED lighting along the road and in the tunnels, which has reduced the energy consumption significantly.

The **A2 motorway** in Poland is a crucial part of the TEN-T corridor II (North Sea – Baltic) and part of West-East European route E-30, extending from the southern Irish port of Cork in the west to the Russian city of Omsk in the east. The project commenced in 1995, and the contract was signed in 1997. However, the financial close and commencement of works were in 2009, and in 2011 the motorway was opened to traffic, with 5-year delay compared to the original timeframe due to regulatory changes and long lasting negotiations, but 6 months before the planned time. Key success factors of this project were good communication and management, adequate and timely changes in laws, and reorganizations of public bodies (i.e. Ministry), changes in attitude to PPP by different political parties and social acceptance. The project included very wide environmental protection program. The project can be regarded as successful one, since the actual traffic has exceeded forecast.

The impact of the global financial crisis in these countries was minimal, and all projects that were analysed showed very strong resilience to crisis. The governmental support varied from high to low, depending on the projects, but the legal bodies were in general very capable of introducing and regulating PPP contracts, through laws and legislations.

For instance, PPPs in Norway received rather moderate/low political support by federal/state government, and rather moderate increase in support during the construction period; no PPP law was in place when the projects were conceived, and those projects were looked upon as experimental: to gauge how PPP would work in terms of efficient delivery of services to the public. Project E39 was

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actually Norway's first-ever public private partnership project. The parliament approved its financing and passed a proposition concerning it, as one of three PPP projects in Norway.

Furthermore, the project A2 in Poland experienced also low governmental support during the commencement and very moderate increase in political support during the project life. Legal framework for PPP in Poland is specified by the Law on public private partnership in 2008, but even before that time, the Act of toll motorways was introduced in 1994 and Public Procurement Law ("PPL") from 2004, which all gave regulatory frame for applying PPP as financial model.

Regarding project E4 in Finland, there was no strategic policy document outlining an explicit policy strategy on PPPs, but there was strong governmental support to PPP, and increase in political support in some extent during the project life.

Institutional indicator values ranged between 0.81 and 0.86 for Finland and Norway and from 0.61 to 0.69 for Poland. Values of other indicators, from the snapshots, are provided in the Table 2.3.

Table 2.3: Snapshots for road projects in countries with low impact of crisis

Case Study	Snapshot	FEI[1]	GI[2]	Business model		Funding Scheme			FSI[8]
				CSI[3]	RSI[4]	RAI[5]	RRI[6]	MEAI[7]	
E4 Helsinki-Lahti	1997, award	0.627	0.688	0.489	0.145	1.0	1.0	0.222	0.679
	1998, inn.	0.627	0.875	0.489	0.145	1.0	1.0	0.167	
	1999	0.637	0.750	0.489	0.145	0.333	1.0	0.222	
	2001	0.637	0.750	0.467	0.097	0.333	0.947	0.222	
	2008	0.792	0.750	0.467	0.097	0.333	1.0	0.222	
	2012	0.766	0.750	0.467	0.097	0.333	1.0	0.222	
E18 Muurla-Lohja	2005, award	0.753	0.688	0.467	0.121	0.667	1.0	0.167	0.773
	2008, inn.	0.792	0.750	0.467			1.0	0.222	
	2008, f.c.	0.792	0.750	0.133			0.967	0.222	
	2009	0.758	0.750	0.133			0.824	0.222	
E39 Orkdalsvegen Public Road	2003, award	0.738	0.563	0.722	0.200	0.333	0.667	0.833	0.719
	2005, inn.	0.808		0.556					
	2014	0.842		0.667					
A2 Motorway	2008, award	0.630	0.688	0.510	0.222	1.0	0.444	NA	0.752
	2009	0.600		0.719	0.216				
	2011, inn.	0.608		0.719	0.216				

Notes:
[1]Financial-Economic indicator
[2]Governance indicator
[3]Cost Saving indicator
[4]Revenue Support indicator
[5]Remuneration Attractiveness indicator
[6]Revenue Robustness indicator
[7]Market Efficiency & Acceptability indicator
[8]Financing Scheme indicator

The projects in this cluster include two tolled roads (A2 motorway in Poland, an E-39 road in Norway). However, remuneration of concessionaire for Norwegian project is based on availability payment, as for E18 project in Finland. For E4 project in Finland the remuneration is based on shadow tolls.

It can be also concluded that projects in this cluster were very reasonably planned since the actual traffic was in line with forecasts (Table 2.4). Even more, population density, level of industrialization and economic activities were higher than expected. Also, income per capita of the region and GDP are in line or higher than expectations, while unemployment rate, in most cases was lower than predicted. Exception is Poland where GDP was in line with expectations, but income per capita was lower than expected and unemployment rate was higher than expectations (app. 16%). In Norway, unemployment was also higher than expected, but it was anyhow lower than 3%.

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Table 2.4: Outcome for road projects in countries with low impact of crisis

Case Study	Snapshot	BENEFIT Outcome								
		COST	TIME	Traffic	Revenue	Transport Goals	Economic	Social	Environ.	Institut.
E4 Helsinki-Lahti	1998, inn.	0	1	0	0	0	0	0	0	0
	1999	0	1	0	0	0	0	0	0	0
	2001	0	0	1	0	0	0	0	0	0
	2008	0	0	0	1	0	0	0	0	0
	2012	0	0	1	1	0	0	0	0	0
E18 Muurla-Lohja	2008, inn.	0	1	0	0	0	0	0	0	0
	2008, f.c.	0	0	1	1	0	0	0	0	0
	2009	0	0	0	0	0	0	0	0	0
E39 Orkdalsvegen Public Road	2005, inn.	0	0	0	0	0	0	0	0	0
	2014	0	0	1	1	1	1	1	1	0
A2 Motorway	2009	0	0	0	0	0	0	0	0	0
	2011, inn.	0	1	1	1	0	0	0	0	0

All projects were considered as highly successful, and have 100% return of investment, traffic in line or above expected, and do not show any influence of global crisis to their overall performance.

2.1.3 Projects in countries with moderate impact of economic crisis

Four road projects in countries that were moderately hit by crisis include medium to high investment size projects in four different countries that are both greenfield and brownfield projects, as well as their mix, as presented in Table 2.5. Three of these projects are PPPs with contract duration between 20 and 30 years. Two projects were integrated with railway projects (Via Zeventem and Combiplan Nijverdal).

The first phase of only one of these projects was in operation (Istrian Y motorway in Croatia) before the crisis; Via Zeventem in Belgium was under construction, while projects in Italy and the Netherlands started with construction after the crisis (Figure 2.2).

Table 2.5: Overall characteristics of road projects in countries moderately hit by crisis

Country	Project	Type	Size	Delivery mode	PPP contract duration (years)
Belgium	Via Zeventem	Both	Medium €220 million	PPP	30
Croatia	Istrian Y Motorway	Both	High, €1.15-1.2 billion	PPP	28
Italy	BreBeMi	Greenfield	High, €2.2 billion	PPP	20
The Netherlands	Combiplan Nijverdal	Brownfield	Medium €316 million	Public	

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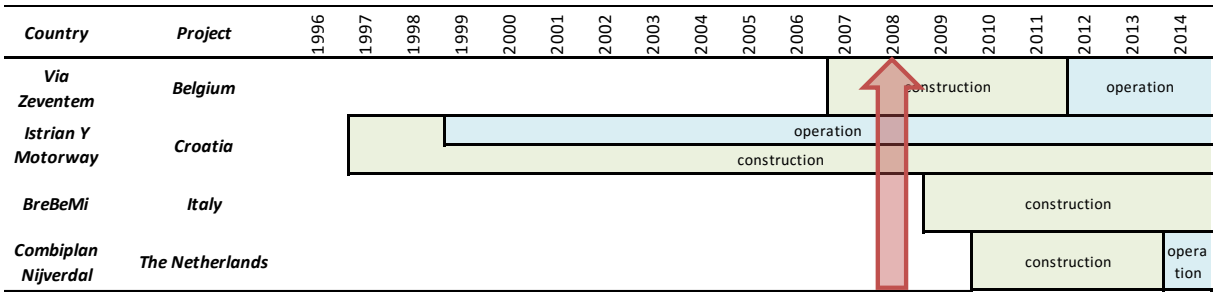

Figure 2.2: The timeline of road projects in the countries with moderate impact of crisis

The main purpose of **Via Zeventem project** was to improve access and reduce congestion north of Brussels Zeventem airport. From construction management perspective, the project was delivered on time and almost to budget, with minimum disturbance to local environment. However, the traffic has been distorted by the impact of the crisis, since both passenger and cargo traffic at the Zeventem airport dropped sharply as a result of crisis, but has recovered in the meantime.

The **Istrian Y motorway** connects the Istrian Peninsula, one of main touristic regions in Croatia, to the A8 and A9 international motorways, i.e. to continental Croatia and central Europe to the north, and Slovenia and Italy to the west. The construction was carried out in phases, where the second phase, that included completion to full motorway and second tube of Ucka tunnel was conditioned with Annual Average Daily Traffic (AADT) of 10000 vehicles per day (vpd) or summer AADT of 16000 vpd. The widening of motorway has been mostly completed (except two viaducts and the second tube of tunnel Ucka) and traffic growth was higher than anticipated, especially for passenger cars, indicating that the impact of crisis was very limited for this project.

The **BreBeMi** motorway was expected to decongest the existing road and motorway network along the corridor Milan - Bergamo - Brescia. The financial crisis came immediately after the commitment signed with the lenders (both the pool of commercial banks and the Cassa Deposito e Prestiti) and resulted in the need to define, along with the Mandated Lead Arrangers, a new financing structure that would allow maintaining adequate financial indicators and bankability even in adverse market conditions. Moreover, despite the crisis, the Italian Government decided to continue with all the priority projects included in the three-year General Transport Plan, considering these projects, and especially those developed with a PPP model, considering them as drivers for economic development.

The **Combiplan Nijevrdal** included both motorway and railway line across the city of Nijevrdal, including the tunnel, with the main objective to remove congestion. The project experienced cost overrun between 5 and 10% and delay, primarily due to scope change and introduction of new regulations for tunnels. However, there is no reference to crisis; the GDP growth rate increased and unemployment rate dropped in the region after the contract signing.

Table 2.6 provides snapshots available for three road project in medium impact cluster countries. The only indicators that changed were financial-economic indicator that decreased in all three cases during the crisis, and cost-savings and revenue support indicators.

The change in the cost savings indicator for Via Zeventem project was result of different formulation of indicator for construction and operation phases, while the increase in revenue support indicator was result of increased capability to manage traffic demand. Despite the decrease in the airport traffic during the crisis, this project is considered to perform in line with expectation, according to the outcomes, presented in Table 2.7.

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Table 2.6: Snapshots for road projects in medium impact cluster

Case Study	Snapshot	FEI[1]	GI[2]	Business model		Funding Scheme			FSI[8]
				CSI[3]	RSI[4]	RAI[5]	RRI[6]	MEAI[7]	
Via Zeventem	2006, award 2014	0.690 0.600	0.688	0.515 0.449	0.206 0.216	0.667	0.000	0.000	0.740
BreBeMI	2009, beg.works 2014	0.492 0.450	NA	NA	0.142	0.333	0.667	0.444	0.735
Combiplan Nijverdal	2006, award 2007 2013, inaugur. 2014	0.760 0.775 0.660 0.650	0.479 0.375	0.148 0.137 0.245 0.313	0.202	1.000 0.833	0.000	NA	1.000

Notes:
[1]Financial-Economic indicator
[2]Governance indicator
[3]Cost Saving indicator
[4]Revenue Support indicator
[5]Remuneration Attractiveness indicator
[6]Revenue Robustness indicator
[7]Market Efficiency & Acceptability indicator
[8]Financing Scheme indicator

Table 2.7: Outcome for road projects in medium impact cluster

Case Study	Snapshot	BENEFIT Outcome								
		COST	TIME	Traffic	Revenue	Transport Goals	Economic	Social	Environ.	Institut.
Via Zeventem	2014	1	1	0	0	0	0	0	0	0
BreBeMI	2014	-1	-1	-1	0	0	NA	NA	NA	NA
Combiplan Nijverdal	2007 2013, in. 2014	0 -1 NA	0 -1 NA	0 -1 NA	0 0 NA	0 0 NA	0 0 NA	0 0 NA	0 0 NA	0 0 NA

For BreBeMI project the only indicator that changed between snapshots is the macro financial-economic indicator, and cost savings indicators are not available, so it is not possible to assess if negative project outcomes are reflected in the changes of cost saving indicator. The increased public sector support was needed for this project as a direct result of crisis.

The initial decrease in the cost-saving indicator for Combiplan Nijevrdal project was result of decreased capability to monitor construction, resulting from technical difficulties in the project. The cost savings indicator at the end of construction phase indicates improved capability to monitor construction. However, the general negative outcome of the project at the end of the construction phase is not related to the impact of crisis.

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2.1.4 Projects in countries with high-impact of economic crisis

The group of projects in the countries highly impacted by crisis include five projects in Greece, two in Portugal and Slovenia, three projects in Serbia, and four in Spain and UK, as presented in Table 2.8.

Table 2.8: Overall characteristics of road projects in countries severely hit by crisis

Country	Project name	Type	Size	Delivery mode	PPP contract duration (years)
Greece	Moreas Motorway	Both	High, €904 million	PPP	30
	Ionia Odos Motorway	Both	High, €1019 million	PPP	30
	Elefsina Korinthos Patra Pyrgos Tsakona	Both	High, €967 million	PPP	30
	Central Greece (E65) Motorway	Both	High, €1060 million	PPP	30
	Attiki Odos (Athens Ring Road)	Greenfield	High, €1300 million	PPP	25
Portugal	A22 motorway	Both	Low, €216 million	PPP	30
	A23 motorway	Greenfield	Medium, €654 million	PPP	30
Serbia	Belgrade By-pass Project, Section A	Greenfield	Low, €68 million	Public	
	E-75, Donji Neradovac - Srpska kuca	Brownfield	Low, €22 million	Public	
	E-75, Horgos-Novi Sad (2nd phase)	Both	Low, €146 million	Public	
Slovenia	A5 Maribor Pince motorway	Both	Medium, € 640 million	Public	
	Koper - Izola Expressway	Both	Low, €164 million	Public	
Spain	C-16 Terrasa Manresa toll motorway	Greenfield	Low, €233 million	PPP	50
	Eje Aeropuerto (M-12) Motorway	Greenfield	Medium, €475 million	PPP	25
	M-45	Greenfield	Medium, €750 million	PPP	25 + 4 to 15 years extension
	Radial 2 Toll Motorway	Greenfield	Medium, €900 million	PPP	25 + 15 years extension
UK	A-19 Dishforth to Tyne Tunnel	Brownfield	Low, £29.4 million	PPP	30
	M-25 Motorway London Orbital	Brownfield	High, £900 million	PPP	30
	M80 Haggs	Both	Medium, £320 million	PPP	30
	The BNRR (M6 Tollroad)	Greenfield	High, £485 million	PPP	30

All analysed projects in Greece, Portugal, Spain and UK are delivered as PPPs, while projects in Slovenia and Serbia are public. The investment size ranged from low for all projects in Serbia, to low to medium for projects in Portugal, Slovenia, and Spain, and low to high for UK projects. All projects in Greece belong to high investment size. The PPP contract duration was 30 years for all projects in

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Greece (except Attiki Odos for which contract duration is 25 years), Portugal, and UK. For projects in Spain contract duration ranges from 25 to 50 years and for two out of four projects project duration has been extended as a result of renegotiations.

The time frame for project implementation is presented in Figure 2.3. All projects in Portugal and Spain, two out of four UK projects and Attiki Odos in Greece were in the operation phase before the crisis. All remaining Greek projects were under construction, as well as two projects in Slovenia. The remaining two UK projects and all projects in Serbia were commenced just after the crisis.

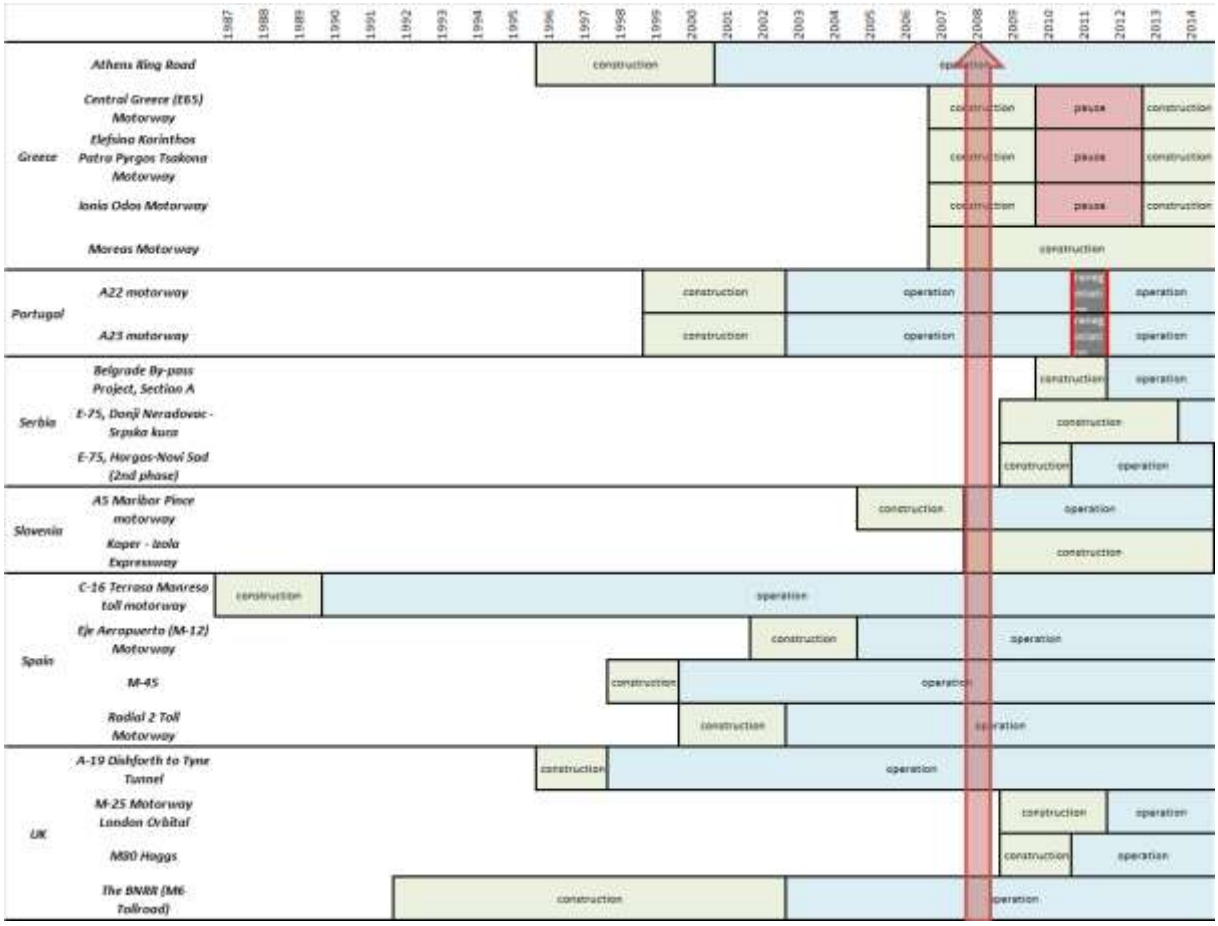

Figure 2.3: Projects Timeline for high impact cluster relative to crisis

The impact of crisis was particularly significant in **Greece**. Out of five analysed Greek projects, four were conceived right before the financial crisis, and for three out of four the construction was stopped from 2010 to 2013 and all projects were subjected to lengthy renegotiations. Only the Attiki Odos (Athens Ring Road) project was in its operation phase, when the crisis occurred. As mentioned before, all five projects required major investment and each was having budget close to 1 billion euros.

The **Attiki Odos (Athens Ring Road)** was one of the biggest co-financed road projects in Europe, worth €1.3 billion. The Project was conceived in 1960, award year was 1995, financial close was reached in 2000, and the road was opened to traffic in 2004, without time or cost overruns. There was one re-negotiation that took place one year after the contract award. This had to do with design changes requested by the State. From the start of operation and until 2011, the actual traffic was

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higher than the predicted. However, for the first time in 2012, this has changed and the actual traffic was lower than predicted one. Ever since, due to the economic crisis, the AADT has dropped.

However, in spite of the crisis, the project has been rated as highly successful. Critical Success Factors are:

1. The project was planned since the 1960s. When it was initiated it was a long needed infrastructure to provide alternative route
2. The motorway is practically the exclusive access to the Athens Airport.
3. The motorway is of high quality.

The pioneer construction, the care for the environment, the high-level operation and the pioneer technologies used, in combination with the human factor, are sectors of the project which received international acknowledgements and awards, and the project was the backbone of the transportation network during the execution of the Athens Olympic Games in 2004.

Due to the Greek and Eurozone financial crisis, three projects (**Central Greece Motorway E-65, Elefsina Korinthos Patra Pyrgos Tsakona, and Ionia Odods Motorway**) had seen a steep decrease in motorway traffic and, as a result, the Lenders have imposed a draw stop and construction ceased in 2010. All stakeholders including the Greek State, the Shareholders and the Lenders had since then entered renegotiation discussions in order to restructure the project's financing and restart construction works. As of 12 April 2013, the government and the SPV have reached an agreement on basic renegotiated terms. For all the three projects, these terms included an increased government participation in the project's funding, a significant reduction of the project size – the construction of certain sections of the project is postponed - and the payment of claims to the Construction Joint Venture. For example, Greece Ionia Odos Motorway project in 2007 included the Elefsina-Patra section (182 km) and the Patra – Tsakona section (184km). Following re-negotiation due to the crisis (2010 -2014), the scope was reduced to include only the Elefsina-Patra section (182 km).

The significant delays due to the project suspension and contract renegotiations, as well as the new toll charges during the economic crisis period, have lowered the perceived success of the projects.

The **Moreas Motorway** was commenced prior to 1998, tender was announced in 2005, contract was awarded in 2007, and financial close was reached in 2008. The expected completion of works was at the end of 2015. The project had cost overrun of 10% and was delayed for 2.5 years due to slow payments on behalf of the State (financial crisis) and archaeological findings.

The Project so far went through 3 renegotiations. The economic crisis has had a severe impact on traffic and has impacted the success of the project. The EIB in 2013 stopped payments based on the reasoning that the financial model was not valid anymore due to the drop in traffic and requested that the Greek State foresee an additional 200 million Euros in capital support. Other pending claims on the part of the concessioner amount to 100 million Euros while the Greek State is also making demands against the concessioner. According to the concessioner, traffic has dropped by 40% since 2009. The concessioner reports that losses due to reduced traffic amount to 500 million Euros, but the EIB estimate is 200 million. There is an on-going discussion for a loss of 250-350 million Euros since 2009. Cost recovery - tolls, the primary source of income was severely impeded by the economic crisis due to the increase in fuel prices, the reduction in private car use and ownership.

However, the project managed to continue construction during the economic crisis, and therefore has been considered as highly successful. Transport success factors were related to the fact that

- The motorway was very needed to allow very important connection
- The new road is safe and allows for comfortable driving in total contrast to the previous connection.

Table 2.9 presents the change of indicators through available snapshots for Greek projects in the BENEFIT database. The sharp decrease in cost saving indicator reflects the pause in construction of

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three projects (Ionia Odos, Central Greece Motorway, and Elefsina Korinthos Patra Pyrgos Tsakona motorway). The slight changes in the revenue support indicator were result of different level of satisfaction for the brownfield sections of the projects. In addition, the Funding Scheme Market Efficiency indicator decreased indicating the lower public acceptability of funding scheme. The change in financing indicator should indicate increased government support in funding of these projects.

Table 2.9: Snapshots for Greek road projects

Case Study	Snapshot	FEI[1]	GI[2]	Business model		Funding Scheme			FSI[8]
				CSI[3]	RSI[4]	RAI[5]	RRI[6]	MEAI[7]	
Moreas Motorway	2007, award 2013,fin.pause	0.558 0.308	0.750	0.561 0.750	0.301	0.400	0.679	0.667 0.611	0.765 0.816
Ionia Odos Motorway	2007, award 2010, pause 2013,re-start	0.558 0.458 0.308	0.750	0.506 -0.011 0.226	0.269 0.255 0.247	0.433	0.667	0.444 0.111 0.111	0.554 0.554 0.622
Elefsina Korinthos Patra Pyrgos Tsakona	2007, award 2010, pause 2013,re-start	0.558 0.458 0.308	0.625	0.514 -0.021 -0.021	0.255 0.244 0.222	0.400	0.667	0.500 0.444 0.444	0.796 0.796 0.644
Central Greece (E65) Motorway	2007, award 2010, pause 2013,re-start	0.558 0.458 0.308	0.625 0.625 0.750	0.510 0.314 0.237	0.173 0.173 0.186	0.333	0.667	0.667 0.389 0.389	0.913 0.913 0.938
Attiki Odos (Athens Ring Road)	1999, award 2001,in.1.sec. 2004,compl. 2009 2014	0.543 0.543 0.587 0.500 0.358	0.688	0.230 0.313 0.313 0.427 0.427	0.224 0.224 0.229 0.229 0.224	0.333	0.667	0.389 0.500 0.500 0.500 0.500	0.561

Notes: [1]Financial-Economic indicator
[2]Governance indicator
[3]Cost Saving indicator
[4]Revenue Support indicator
[5]Remuneration Attractiveness indicator
[6]Revenue Robustness indicator
[7]Market Efficiency & Acceptability indicator
[8]Financing Scheme indicator

The Greek financial crisis and associated recession have had an increased impact on the project's revenues, indicating that there was an imbalance of the risks shared between the public and private sector; this is coupled with the inability to make accurate traffic forecasts, as the current traffic trends are showing a decrease exceeding 50% of the initial traffic envisaged. Therefore the projects outcomes are mostly negative, as presented in **Error! Reference source not found.**

Two projects in **Portugal** include **A22 motorway**, going longitudinally in the Algarve region, on the south of the country, and **A23 motorway** that provides fastest link between Lisbon and Spain border. The A22 included maintenance and operation of 91.5 km brownfield section, and construction of 35.6 km long greenfield section, while the A23 was greenfield project. The revenue scheme for both projects was initially based on shadow tolls.

The traffic on the A22 motorway was above before the crisis up to 20% higher than expected. The traffic dropped in 2008, but was still above expectations, and that is partly due to touristic nature of the region and many trips that were generated by tourism. Contrary to A22, the traffic on A23 was since inception lower than expected, and since introduction of tolls in December 2011 a significant drop in traffic has been witnessed on both motorways.

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Table 2.10: Outcome for Greek road projects

Case Study	Snapshot	BENEFIT Outcome								
		COST	TIME	Traffic	Revenue	Transport Goals	Economic	Social	Environ.	Institut.
Moreas Motorway	2013,fin.pause	-1	-1	-1	-1	0	1	0	0	0
Ionia Odos Motorway	2010, pause	-1	-1	-2	-1	0	0	0	0	0
	2013,re-start	-1	-1	-2	0	0	0	0	0	0
Elefsina Korinthos Patra Pyrgos Tsakona	2010, pause	-1	-1	-2	-1	0	0	0	0	0
	2013,re-start	-1	-1	-2	0	-1	0	0	0	0
Central Greece (E65) Motorway	2010, pause	-1	-1	-2	-1	0	0	0	0	0
	2013,re-start	-1	-1	-2	0	-1	0	0	0	0
Attiki Odos (Athens Ring Road)	2001,in.1.sec.	0	0	1	1	1	1	1	1	1
	2004,compl.	0	0	1	1	1	1	1	1	1
	2009	0	0	1	1	1	1	1	1	1
	2014	0	0	-1	0	1	1	1	1	1

The government law was issued in Portugal in 2004 stating that the shadow toll roads should charge real tolls. However, it was only when the financial crisis began that the renegotiation process was actually started. The reasons for the renegotiation processes were the economic crisis, restructuring of public debt and the option to retrieve some revenue from the previously shadow tolled roads. At the time of the renegotiation, the public partner was weakened by the financial crisis and the demands of the IMF/ECB/EC bailout agreement, which meant that it was easy for the private partner and the banks to take the opportunity to improve their business, press all pending requests for financial rebalancing, and eliminate traffic risk. Despite the overall reduction of risk, the private partners kept their initial return on investment. Furthermore, the public partner was not able to defend public interest going into renegotiations by not taking account the added costs to the tax-payers from traffic redirection to un-tolled roads paid for by the national road agency, and the substantial loss of socio-economic benefits such as travel time savings, and increased road safety.

For *Estradas de Portugal, a*ctual traffic and revenues were 200% below the forecast. The funding scheme failed during the economic crisis due to the non-availability of state subventions, leading to the need of introducing tolls in previously un-tolled infrastructure, which caused major traffic reductions and inefficiencies. The revision of the concession contract was partly caused and partly aimed to correct the imbalances caused by the economic crisis and the biased traffic forecasts.

The substantial decrease in traffic was due to three main factors:

- The direct effects of loss of purchase power of the economic crisis
- The need to raise tolls in previously free infrastructure which caused very significant reductions in traffic
- The opening of new pieces of infrastructure which included highly optimistic base traffic forecasts

Table 2.11 presents the indicators in available snapshots for Portuguese road projects. The sharp drop in cost savings indicator is result of reduced capability to operate project. The changes in revenue support indicator resulted from different risk allocation as a result of renegotiation process. The Remuneration Scheme and Revenue Robustness indicators increased for both projects after renegotiations, indicating reduced risk for private partner. However, it is interesting to note that introduction of real tolls that resulted in severe decrease in traffic in not reflected in the Funding Scheme Market Efficiency indicator which should indicate the reduced level of public acceptability.

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Table 2.11: Snapshots for Portuguese road projects

Case Study	Snapshot	FEI[1]	GI[2]	Business model		Funding Scheme			FSI[8]
				CSI[3]	RSI[4]	RAI[5]	RRI[6]	MEAI[7]	
A22 motorway	2000, award	0.540	0.625	0.464	0.188	0.383	0.095	0.111	0.779
	2011,bef.ren.	0.517	0.625	0.598	0.188	0.383	0.095		
	2013	0.442	0.813	0	0.267	0.667	0.283		
A23 motorway	1999, award	0.540	0.625	0.318	0.200	0.383	0.095	0.111	0.779
	2011,bef.ren.	0.517	0.625	0.489	0.200	0.383	0.095		
	2013	0.442	0.813	0	0.222	0.667	0.283		

Notes: [1]Financial-Economic indicator
[2]Governance indicator
[3]Cost Saving indicator
[4]Revenue Support indicator
[5]Remuneration Attractiveness indicator
[6]Revenue Robustness indicator
[7]Market Efficiency & Acceptability indicator
[8]Financing Scheme indicator

The outcomes of the projects, presented in Table 2.12, mainly reflect the negative traffic outcome since 2011 and introduction of tolls, which resulted in the decrease in revenues.

Table 2.12: Outcome for Portuguese road projects

Case Study	Snapshot	BENEFIT Outcome								
		COST	TIME	Traffic	Revenue	Transport Goals	Economic	Social	Environ.	Institut.
A22 motorway	2011, bef.ren.	0	0	1	1	1	1	1	1	1
	2013	0	0	-2	-1	-2	-2	-2	-2	-1
A23 motorway	2011, bef.ren.	0	0	-1	-1	-1	-1	-1	-1	-1
	2013	0	0	-2	-1	-2	-2	-2	-2	-1

All three public cases in **Serbia** that commenced after the crisis are part of the north-south corridor going through Serbia, and connecting the northern border with Hungary to southern border with Former Yugoslav Republic of Macedonia (FYROM).

The **E-75 Horgos – Novi Sad motorway**, was previously part of the failed concession project Horgos – Pozega and connects the Hungarian border with city of Novi Sad. The project was entirely financed by Serbian public budget and included the completion of second carriageway of the existing motorway. However, the financing of project was delayed due to restriction of state budget, and that ultimately led to bankruptcy of one contractor. The cost was higher than anticipated, although reasonable. The road is tolled, and the traffic is generally decreasing in recent years.

The **Belgrade-Bypass project** was conceived back in 1990 as a greenfield project with the objective to relieve congestion on the motorway going through Belgrade. However, due to crisis in former Yugoslavia, it commenced only in 2010. The project was financed by EIB and EBRD loans. The feasibility study showed that the demand elasticity on sections A and B is high. In other words, traffic is very sensitive to price and cost changes. Therefore, while the potential of introducing tolls on the Belgrade by-pass was preliminary considered, tolls were finally not applied and the use of section is free for users. The design traffic on the bypass has been severely overestimated, assuming more than

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40000 vpd and the actual traffic is far below. However, all truck traffic uses the bypass, and transport goals have been mostly achieved.

The **E-75 Donji Neradovac – Srpska kuca** section is located in the south, close to border with FYROM. The construction of this section was financed by the Republic of Serbia with the financial support of the Government of Greece within the framework of the Hellenic Plan for Economic Reconstruction of the Balkans (HiPERB). Estimated cost was about 40 million euro, but contracted price was almost half of the estimated, app. 20 million euro. This was result of severe competition of local and foreign contractors in the market in the post-crisis environment. The road is supposed to be tolled once the whole project is completed.

All projects in Serbia suffered from delays due to problems with delayed financing and unrealistically low offers (Horgos – Novi Sad, Donji Neradovac – Srpska kuca), expropriation (Belgrade Bypass), and many technical issues resulting from problems in design.

The forecasted growth of GDP for Serbia in the feasibility study was 6% for the period 2006-2011 and 3.5% for 2012-2025. However, the average growth of Serbian GDP in the period from 2006-2014 was 1.38%. GNI per capita is lower than expected, while unemployment rate is higher than expected.

Table 2.13 presents the indicators for Serbian road projects. The Governance indicator is relatively low, compared to other countries. The cost savings indicator is low, indicating the extended impact of the crisis and the limited capability of both investor and contractors. Table 2.14 provides the outcomes of Serbian road projects.

Table 2.13: Snapshots for Serbian road projects

Case Study	Snapshot	FEI[1]	GI[2]	Business model		Funding Scheme			FSI[8]
				CSI[3]	RSI[4]	RAI[5]	RRI[6]	MEAI[7]	
Belgrade By-pass Project, Section A	2010, award 2012,inn. 2014	0.483 0.467 0.417	0.313	-0.031 -0.031 0.222	0.211	1.0	0.203	0.111	0.85
E-75, Donji Neradovac - Srpska kuca	2009, award 2014	0.550 0.417	0.188	0.089 0	0.193	1.0	0.667	0.111	1.0
E-75, Horgos-Novi Sad (2nd phase)	2009, award 2011, inn. 2014	0.483 0.517 0.417	0.188	-0.053 -0.030 0.222	0.257	1.0	0.667	0.278	1.0

Notes:
[1]Financial-Economic indicator
[2]Governance indicator
[3]Cost Saving indicator
[4]Revenue Support indicator
[5]Remuneration Attractiveness indicator
[6]Revenue Robustness indicator
[7]Market Efficiency & Acceptability indicator
[8]Financing Scheme indicator

Two public projects in **Slovenia** include the **Maribor – Pince motorway** that connects city of Maribor to Hungarian border, and is part of the corridor connecting Eastern European countries to South-West Europe, and **Koper – Izola Expressway** that is supposed to improve connection between Koper and Isola and access to touristic destination on Istrian peninsula from the Western Europe. Both projects are financed by state budget. The toll in Slovenia is collected through vignettes for passenger cars, while trucks have to pay regular tolls.

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The Maribor – Pince motorway was constructed between 2005 and 2008 and was opened to traffic in 2008. The traffic was above the estimate, resulting from serious need after the inclusion of Eastern European countries (Hungary, Slovakia, Romania) in the EU, despite the crisis, and with about 20% of traffic being commercial, truck traffic.

Table 2.14: Outcome for Serbian road projects

Case Study	Snapshot	BENEFIT Outcome								
		COST	TIME	Traffic	Revenue	Transport Goals	Economic	Social	Environ.	Institut.
Belgrade By-pass Project, Section A	2012, inn. 2014	0 0	-1 -1	-2 -2	-2 -2	0 0	0 0	0 0	0 0	0 0
E-75, Donji Neradovac - Srpska kuca	2014	-1	-1	0	0	0	0	0	0	0
E-75, Horgos-Novi Sad (2nd phase)	2011, inn. 2014	-1 -1	-1 -1	-1 -1	0 0	0 0	0 0	0 0	0 0	0 0

At the time when project *Koper - Izola Expressway* was conceived, Slovenia had higher GDP than expected. Unfortunately the economic crisis, started in 2008, changed the situation, leading to having GDP lower than expected during the project realization. That possibly led to problems during project implementation that caused delay of the project and resulted in the bankruptcy of two contractors. However, the project is considered reasonably successful according to all other outcomes.

Table 2.15 presents the indicators for Slovenian road projects. For Maribor Pince motorway the Cost Saving indicator is relatively low. However, that didn't prevent the project to be highly successful, as presented in Table 2.16.

Table 2.15: Snapshots for Slovenian road projects

Case Study	Snapshot	FEI[1]	GI[2]	Business model		Funding Scheme			FSI[8]
				CSI[3]	RSI[4]	RAI[5]	RRI[6]	MEAI[7]	
A5 Maribor Pince motorway	2005, award 2008,inn. 2014	0.595 0.683 0.433	0.563	0.097 -0.007 0	0.151	1.0	1.0	0.444	1.0
Koper - Izola Expressway	2008, award 2014 2015,inn.	0.683 0.433 0.433	0.500	0.196 0.279 0.279	0.152	1.0	1.0	0.444	1.0

Notes:
[1]Financial-Economic indicator
[2]Governance indicator
[3]Cost Saving indicator
[4]Revenue Support indicator
[5]Remuneration Attractiveness indicator
[6]Revenue Robustness indicator
[7]Market Efficiency & Acceptability indicator
[8]Financing Scheme indicator

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Table 2.16: Outcome for Slovenian road projects

Case Study	Snapshot	BENEFIT Outcome								
		COST	TIME	Traffic	Revenue	Transport Goals	Economic	Social	Environ.	Institut.
A5 Maribor Pince motorway	2008, inn.	1	-1	1	1	0	0	0	1	0
	2014	1	0	1	1	1	0	1	1	0
Koper - Izola Expressway	2014	1	-1	0	0	0	0	0	0	0
	2015,inn	1	-1	0	0	0	0	1	1	0

The case studies in **Spain** include four PPP projects that were all in the operational phase when crisis started.

The **C-16 motorway** is integrated with the E9 from Orléans to Barcelona. The motorway connects two important urban areas in northern Spain and is interconnected with principal roadways. The initial contract duration was 35 years, but it was extended to 50 years as a result of renegotiations caused by traffic and revenues lower than expected back in 1990s, which was result of optimism bias regarding traffic and underestimation of construction duration in the offer. The adjustment reflected the Government's concerns with respect to traffic levels, the economic recession and the financial health of concessionaire AUTEMA, which was affected by interest rates in the national market and the fluctuation of the exchange rate for foreign debt. In 1999, the Regional Government introduced a 50% discount for regular users and in 2004 established the mandatory linkage of tolls not only to inflation, but also to a correction factor depending on traffic levels. The introduction of discounts to tolls led to lawsuit with concessionaire. Currently, the motorway serves more than 20000 vpd.

The **M-12 Eje Aeropuerto motorway** provides an alternative access to the Barajas airport. The project was conceived as a typical BOT project with user tolls, and commercial risk totally transferred to private partner. There was a two-year ramp up period in the traffic forecast, but this was insufficient to capture the initial build-up of traffic and its decline since the economic downturn. The traffic was increasing prior to 2007 to more than 20000 vpd, but decreases since then. The traffic on tolled section was even lower, about 7000 vpd and decreasing. Since operations started, traffic performance has been poor, well below the forecast, and users' reluctance to pay tolls has been evident, especially for taxis which were supposed to be the main users. On November 2013, the concessionaire and its parent company jointly petitioned for voluntary insolvency proceeding to be initiated, which was later accepted.

The **M-45 toll road** project is semi-ring motorway, located in the outer urban area of Madrid, connecting motorways to Barcelona and Estramadura. The project was implemented through three concession contracts in order to reduce the construction risk. The final cost of the project was well above the estimated cost. The M-45 was the first project in Spain based on shadow tolls. Since the beginning traffic has been above forecast, and in one section concession revenues are near the maximum possible. The average traffic level is around 70,000 vpd, varying by section between 50-100,000 vehicles per day, and reaching 140,000 vpd at some points during peaks. In general, traffic has steadily increased since operations started, with the exception of the M-50 loop opened during the period 2003-2005, and the arrival of the economic downturn after 2007. However, this negative impact was not as strong as it was for other Spanish roads, as there were no direct tolls for use of the road. However, since 2012, the direct tolls had to be introduced due to high maintenance costs as well as due to economic problems of the regional government. Traffic in 2012 fell at all counting points by between 2.6-7.9%, except for Km 25.75 in which there was a traffic drop by 15.8%. Recently, M-45 traffic levels have been recovering much better than those on other roads, and payments due to the concessionaires are at maximum levels.

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The **Radial 2** motorway is an alternative toll road to the existing N-II National Highway in the north east area of Madrid. The project was awarded in 2000 to a consortium led by Spanish construction firms ACS and Acciona Group. The initial construction budget was EUR 500M. However due to additional payments related to land acquisition, the investment amount is still increasing and is projected to be near EUR 900M. The concession duration was originally till 2024, but was extended to 2039 to partially compensate concessionaire for the additional works and other cost overruns in the price of land acquisition. The R-2 opened to traffic in 2002. Since operations started traffic performance has been lower than projected and users' reluctance to pay tolls has been evident. There was a ramp up period in the forecast, but this has been insufficient to capture the initial build-up of traffic and its decline since the economic downturn. Traffic gradually escalated to an average of 11,034 vehicles per day in 2007. Due to the economic crisis, traffic in 2012 fell to 5,928 vehicles per day, a 24% drop from previous year. In 2013, there was another considerable decrease by 23% to 4,588 vehicles per day. In 2013, the concessionaire and its parent companies asked for voluntary insolvency proceedings to be initiated, that were ultimately accepted.

Table 2.17 provides the indicators for four Spanish projects. Most of indicators are constant throughout the life of projects. Even the change in the Cost Saving indicator occurred before the crisis, and is not able to indicate the changed circumstances due to crisis. In addition, three projects that have quite different performance, i.e. M-12 Eje Aeropuerto and R-2 Toll Motorway with poor performance regarding traffic (

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Table 2.18), and M-45 that was quite successful, have almost identical Cost Saving and Revenue Support indicators. The M-45 project is based on shadow tolls, compared to the other two projects based on direct tolling, and that is reflected in the Remuneration Scheme indicator. The Revenue Robustness and Market Efficiency indicators are much lower for M-45 project compared to all other cases. All projects in Spain are non-exclusive.

Table 2.17: Snapshots for road projects in Spain

Case Study	Snapshot	FEI[1]	GI[2]	Business model		Funding Scheme			FSI[8]
				CSI[3]	RSI[4]	RAI[5]	RRI[6]	MEAI[7]	
C-16 Terrasa Manresa toll motorway	1987, award	0.637	0.563	0.511	0.201	0.333	0.667	0.667	0.406
	1990, inn.	0.637		0.133					0.300
	2015	0.467		0.200					0.300
Eje Aeropuerto (M-12) Motorway	2002, award	0.617	0.500	0.541	0.040	0.333	0.667	0.444	0.640
	2005, inn.	0.678		0.541					0.640
	2008	0.700		0.311					0.640
	2012	0.508		0.311					0.670
	2014	0.467		0.311					0.698
M-45	1998, award	0.637	0.563	0.533	0.089	0.667	0.063	0.167	0.703
	2000, inn.	0.637		0.583					
	2008	0.700		0.333					
	2012	0.508		0.333					
	2014	0.467		0.333					
Radial 2 Toll Motorway	2000, award	0.637	0.500	0.244	0.089	0.333	0.667	0.444	0.640
	2003, inn.	0.638		0.244					0.640
	2008	0.700		0.333					0.640
	2012	0.508		0.333					0.669
	2014	0.467		0.333					0.698

Notes:
[1]Financial-Economic indicator
[2]Governance indicator
[3]Cost Saving indicator
[4]Revenue Support indicator
[5]Remuneration Attractiveness indicator
[6]Revenue Robustness indicator
[7]Market Efficiency & Acceptability indicator
[8]Financing Scheme indicator

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Table 2.18: Outcome for road projects in Spain

Case Study	Snapshot	BENEFIT Outcome								
		COST	TIME	Traffic	Revenue	Transport Goals	Economic	Social	Environ.	Institut.
C-16 Terrasa Manresa toll motorway	1990, inn.	-1	0	-1	0	-1	0	0	0	0
	2015	-1	0	-1	0	-1	0	0	0	0
Eje Aeropuerto (M-12) Motorway	2005, inn.	-1	-1	-1	0	0	0	0	0	0
	2008	-1	-1	-1	-1	0	0	0	0	0
	2012	-1	-1	-2	-1	0	0	0	0	0
	2015	-1	-1	-2	0	0	0	0	0	0
M-45	2000, inn.	-1	0	1	1	0	0	0	0	0
	2008	-1	0	1	1	0	0	0	0	0
	2012	-1	0	0	0	0	0	0	0	0
	2014	-1	0	1	1	0	0	0	0	0
Radial 2 Toll Motorway	2003, inn.	-1	-1	-1	0	0	0	0	0	0
	2008	-1	-1	-1	-1	0	0	0	0	0
	2012	-2	-1	-2	-1	0	0	0	0	0
	2014	-2	-1	-2	0	0	0	0	0	0

All four cases from the **UK** included in the BENEFIT database are PPP projects with contract duration of 30 years, that range from low to high investment size that are either greenfield, brownfield, or both. The projects were initially conceived from 1980 to 2008, and in time of crises were in various stages, as shown in Figure 2.3. Motorway A-19 was in the 10th year of operation, motorway BNRR was in the 5th year of operation, while motorways M-25 and M80 were in the planning and tendering stages of project. In this case, the commonly argued statement that "during the crisis size of PPP projects tend to be lower" cannot be applied, as M-25, initiated just after the crisis, was a construction project that required major investment (£900 million).

The **A-19 Dishforth to Tyne Tunnel** in North East England was part of the first group of PFI projects as fully privately financed, brownfield project, with relatively low investment size. The project was constructed between 1996 and 1998 with no delays. Concession contract was worth around £330 million over a 30-year period, while the initial construction of capital works was valued at £29.4 million. The revenues in the first 12 years of operation had fluctuated significantly. Revenues were highest in the period 1998 to 2001, followed by a massive reduction in revenue to 2003. Since then, there has been a recovery but not to the level of pre 2001 values. Costs of £ 29.4 million compared to revenue of £136 million (1996 to 2006) can be considered as a high value return for private sector. This project was estimated as highly successful project, especially in terms of profit to a concessionaire. This project was conceived long before world economic crisis, and consequently there is no evidence of any effect of the later on the overall project success, or any performance indicators.

The **M25 motorway** or London Orbital motorway forms a 125-mile orbital route some 20 miles from the centre of London that almost encircles Greater London. In 2009, the Agency signed a 30-year private finance contract that involves construction works of around 40 miles of M-25 motorway plus 125 miles of connecting roads. Project was completed in 2012 in time and within the budget. In 2013 project was extended, and full completion was expected in 2015. The nominal contract value over the 30-year contract period is £6.2 billion. The overall value cost was estimated to be of £3.4 billion, from which construction cost comprise of £900 million. The project was completed on time and within budget. However, there are some criticisms about the initial delays from project inception (in 2000) to contract signing (in 2009) that exposed the project to the 2008 financial crisis, resulting in further delays and higher financing costs. These costs were attributed to changes of design standards generating impact on investment costs. Finally, actual traffic and revenues are in line with forecast, while network usage has increased after the project implementation. The general level of the project's perceived success is high, particularly with regard to reduction in congestion and improvements in safety standards. In addition, travel cost and reliability improvements are fully in line with or have exceeded expectations.

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This **M80 Haggs** section belongs to one of the most heavily used roads in Scotland. The contract was signed in 2009 and had foreseen the construction works of around 20 km of road. Operations started in 2011. Project was completed in time and within budget. Through the interviews it was seen as highly successful project. The timing of this project is very significant as it was during a period of extreme financial turbulence due to national and international economic downturn. This upgrade to the Scottish network for this section was being formulated from the 1970`s which highlights the fact that the road was a significant element of the economic and political importance to the regional and national network.

The **M6 Toll** (also known as the Birmingham Northern Relief Road) opened in 2003 as the UK's first tolled motorway. The M6 Toll was a test-bed for reducing the direct cost to government of operating and maintaining infrastructure which could be better and more efficiently managed by the private sector. The project was conceived in 1980, but Concession contract was signed in 1992, financial close was in 2000, the road was open for traffic in 2003, and refinanced in 2006, having construction budget of £485 million total. The project experienced cost overruns (16%) due to construction issues (changes of design standards) and landscape maintenance. The "5 year post opening" report acknowledged that in 2007 traffic had reduced in the last two years (Traffic was -10% Revenue was -7%), and data suggests that economic recession is likely to be an important factor. However, the traffic on the M6 Toll had declined in 2007, before the economic downturn was actually recognized. The capacity of this road is designed at 70,000 vehicles a day of which approximately half of capacity is used. This all indicates that the current usage of the toll road is less than anticipated due to the direct competition of the free-to-use M6.

Out of four projects in the UK, only one (M-25 Motorway London Orbital) had a delay, and only one project (BNRR - M6 Toll road) has actual traffic below forecast and was labelled as project with "low level of success" because it has experienced early contract termination and renegotiations. The other three projects are perceived as highly successful. They are delivered in time, within budget and have adequately satisfied all planned transport and other project goals.

The main driver for the public agency in UK to choose PPP as type of financing was ensuring value for money, in all the analysed projects. The government authorities, at the time of implementing the PPP option, were carrying out a review of the assets in public ownership and privatizing large swathes of these asset groups such as utilities. It was therefore a test bed for the process of reducing the direct cost to the government of operating and maintaining infrastructure which, maybe can be better and more efficiently managed by the private sector.

All UK projects had strong political support by the government and of majority of political parties in Parliament. The support for the project even raze higher during the construction phase. Strategies and legal acts were well established, even prior to commencement of the project, i.e.:

- Shadow tolls act 1996
- Policy strategic document about PPP was available 5 years before contract award for all projects.

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2.1.5 This was also confirmed through "governance" indicator, within the snapshots, which took high values, from 0.688 to 0.813 (Out of four projects in the UK, only one (M-25 Motorway London Orbital) had a delay, and only one project (BNRR - M6 Toll road) has actual traffic below forecast and was labelled as project with "low level of success" because it has experienced early contract termination and renegotiations. The other three projects are perceived as highly successful. They are delivered in time, within budget and have adequately satisfied all planned transport and other project goals (Conclusions based on the road cases

The qualitative analysis of the road cases showed that most of projects in countries in which the crisis impact was low to moderate, are performing well. The consequences of global crisis may be most clearly seen in the cluster of countries with high impact of crisis that mostly includes southern European countries and UK. However, most of the UK projects are performing also in line with expectations and does not appear to be severely impacted by the crisis, stressing the importance of strong institutional context and proper project selection. In other countries in the high impact cluster most of projects faced difficulties, which may also show that poor project selection and weak institutional context may have made these countries more vulnerable to crisis. However, there are some projects that are still performing reasonably well (Athens ring road in Greece, A5 Maribor – Pince motorway in Slovenia, and M-45 in Spain).

Table 2.21 presents the average values of indicators for road projects by clusters, and for High impact cluster by countries.

Table 2.21: The average values of indicators by clusters and countries

Cluster	Country	FEI[1]	GI[2]	Business model		Funding Scheme			FSI[8]
				CSI[3]	RSI[4]	RAI[5]	RRI[6]	MEAI[7]	
LOW		0.713	0.703	0.498	0.154	0.625	0.817	0.355	0.724
MEDIUM		0.635	0.558	0.301	0.189	0.639	0.167	0.222	0.869
HIGH									
	Greece	0.461	0.692	0.330	0.230	0.371	0.668	0.448	0.695
	Portugal	0.500	0.688	0.312	0.211	0.478	0.158	0.111	0.779
	Serbia	0.469	0.235	0.049	0.224	1.000	0.493	0.174	0.944
	Slovenia	0.543	0.532	0.141	0.152	1.000	1.000	0.444	1.000
	Spain	0.589	0.528	0.359	0.094	0.426	0.499	0.404	0.616
	UK	0.627	0.737	0.577	0.122	0.550	0.292	0.266	0.525

Notes: [1]Financial-Economic indicator
[2]Governance indicator
[3]Cost Saving indicator
[4]Revenue Support indicator
[5]Remuneration Attractiveness indicator
[6]Revenue Robustness indicator
[7]Market Efficiency & Acceptability indicator
[8]Financing Scheme indicator

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Table 2.19).

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The revenues are generated through direct tolling (M6 Toll road), shadow tolls (A19) and availability payments (M80 and M25).

2.1.6 Out of four projects in the UK, only one (M-25 Motorway London Orbital) project (BNRR - M6 Toll road) has actual traffic below forecast and was level of success" because it has experienced early contract termination three projects are perceived as highly successful. They are delivered in adequately satisfied all planned transport and other project goals (Conclusions based on the road cases

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	Slovenia	0.543	0.532	0.141	0.152	1.000	1.000	0.444	1.000
	Spain	0.589	0.528	0.359	0.094	0.426	0.499	0.404	0.616
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Notes: [1]Financial-Economic indicator
[2]Governance indicator
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[5]Remuneration Attractiveness indicator
[6]Revenue Robustness indicator
[7]Market Efficiency & Acceptability indicator
[8]Financing Scheme indicator

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Table 2.19: Snapshots for road projects in UK

Case Study	Snapshot	FEI[1]	GI[2]	Business model		Funding Scheme			FSI[8]
				CSI[3]	RSI[4]	RAI[5]	RRI[6]	MEAI[7]	

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A-19 Dishforth to Tyne Tunnel	1996, award 1998, inn. 2014	0.635 0.635 0.600	0.688	0.411 0.411 0.667	0.075	0.667	0.063	0.167	0.525
M-25 Motorway London Orbital	2009, award 2012, inn. 2014	0.625 0.600 0.600	0.688 0.688 0.750	0.656 0.656 0.967	0.270	0.667	0.121	0.167	0.668
M80 Haggs	2009, award 2011, inn. 2014	0.625 0.617 0.600	0.688	0.353 0.564 0.867	0.148	0.667	0.063	0.167	0.529
The BNRR (M6 Tollroad)	1992, award 2003, inn. 2008 2012 2014	0.635 0.665 0.742 0.600 0.600	0.813	0.522 0.172 0.611 0.611 0.611	0.045	0.347 0.347 0.333 0.333 0.333	0.673 0.673 0.667 0.667 0.667	0.444	0.640 0.640 0.300 0.300 0.300

Notes: [1]Financial-Economic indicator
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[7]Market Efficiency & Acceptability indicator
[8]Financing Scheme indicator

Table 2.20: Outcome for road projects in UK

Case Study	Snapshot	BENEFIT Outcome								
		COST	TIME	Traffic	Revenue	Transport Goals	Economic	Social	Environ.	Institut.
A-19 Dishforth to Tyne Tunnel	1998, inn. 2014	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
M-25 Motorway London Orbital	2012, inn. 2014	0 0	-1 -1	0 0	0 0	0 0	0 0	0 0	0 0	0 0
M80 Haggs	2011, inn. 2014	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
The BNRR (M6 Tollroad)	2003, inn. 2008 2012 2014	0 0 0 0	0 0 0 0	-1 -1 -1 -1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0

The review of the road cases showed that most of projects in countries in which the crisis impact was low to moderate, are performing well. The consequences of global crisis may be most clearly seen in the cluster of countries with high impact of crisis that mostly includes southern European countries and UK. However, most of the UK projects are performing also in line with expectations and does not appear to be severely impacted by the crisis, stressing the importance of strong institutional context and proper project selection. In other countries in the high impact cluster most of projects faced difficulties, which may also show that poor project selection and weak institutional context may have made these countries more vulnerable to crisis. However, there are some projects that are still performing reasonably well (Athens ring road in Greece, A5 Maribor – Pince motorway in Slovenia, and M-45 in Spain).

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It can be also concluded that projects were very reasonably planned since the actual traffic was in line with forecasts. Even more, population density, level of industrialization and economic activities were all higher than expected, in all projects. Also, per capita income level of the region and GDP are in line or higher than expectations while unemployment rate, in most cases was lower than predicted. This all lead to overall success of projects, considering also that actual revenues were in line with forecast.

In this case, this resilience to global crisis, although UK was considered as a country where the crisis had hit its economy hard, may be explained by strong governmental support, experienced contractors and adequate project planning.

2.1.7 Conclusions based on the road cases

The qualitative analysis of the road cases showed that most of projects in countries in which the crisis impact was low to moderate, are performing well. The consequences of global crisis may be most clearly seen in the cluster of countries with high impact of crisis that mostly includes southern European countries and UK. However, most of the UK projects are performing also in line with expectations and does not appear to be severely impacted by the crisis, stressing the importance of strong institutional context and proper project selection. In other countries in the high impact cluster most of projects faced difficulties, which may also show that poor project selection and weak institutional context may have made these countries more vulnerable to crisis. However, there are some projects that are still performing reasonably well (Athens ring road in Greece, A5 Maribor – Pince motorway in Slovenia, and M-45 in Spain).

Table 2.21 presents the average values of indicators for road projects by clusters, and for High impact cluster by countries.

Table 2.21: The average values of indicators by clusters and countries

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	Spain	0.589	0.528	0.359	0.094	0.426	0.499	0.404	0.616
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[5]Remuneration Attractiveness indicator
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[8]Financing Scheme indicator

The critical success factors that led to success of these projects include:

- Long term planning
- Top priority projects
- Realistic traffic projections
- Medium size projects

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- Strong regulatory body and governmental support
- Responsible and well experienced concessionaire
- Introducing innovations (Norway, Poland, UK)

The consequences of the global financial crisis on the poorly performing projects are reflected through the fact that many projects have entered renegotiations (e.g. projects in Greece, Portugal, UK), which in most cases involved reducing the scope of projects and significant reduction of the project size in terms of investment as well as an increase in government participation in funding scheme (e.g. projects in Greece) and introduction of user paid tolls or increase in toll prices (e.g. in Portugal). Consequently, the distribution of risks shared between public and private partner has been substantially changed (e.g. projects in Greece).

Due to increased competition on the market, some contractors were offering lower than estimated prices, that was among factors that ultimately led to cost (e.g. projects in Serbia) and time overruns (e.g. projects in Serbia and Greece).

The crisis has caused also a substantial drop in AADT and revenues for projects in Spain, Portugal, and Greece. The GDP lower than expected may have also contributed to the decrease in traffic (e.g. Slovenia, Portugal, Greece). In addition, many concessionaires faced with cash flow difficulties as a consequence of public budget restrictions (e.g. projects in Spain, Greece, and Portugal).

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2.2 Urban Transit Projects in BENEFIT

2.2.1 Introduction

What have been the impacts of the economic crisis on financing schemes for urban transport projects? We will try to answer this question via a literature review and a qualitative analysis of cases available in the BENEFIT database. Whenever it is possible, we will also question the ability of the *Matching Framework Facility* to take into account these impacts in the variations of main indicators between *snapshots*. In introduction, some preliminary thoughts and questions are necessary.

When using the general term of “economic crisis”, we are in reality referring to two successive crises:

- The "economic" crisis of 2008, which was a situational crisis, mainly affecting the private sector. This crisis, though sudden and unexpected, was not especially different from previous crises in its intensity or in its consequences: rising unemployment, mainly in the industrial sector, and a sharp contraction of the GDP. By causing a rise of unemployment, this first crisis may have had an impact on urban transport ridership, especially for home-work commuting and business trips.
- The "sovereign debt" crisis which appeared in various European countries between 2010 and 2012 is a structural public crisis. By challenging States' debt capacity, this crisis has had an impact on local authorities' resources, through all tax sensitive to economic activity and through amounts of allocations from central government to local authorities.

Public transport, particularly in its ability to develop new infrastructures, was probably more sensitive to the 2010/2012 sovereign debt crisis than to the 2008 crisis. This assumption needs, however, to be verified from the literature review and case studies.

Another assumption also has to be checked: urban public transport might also differentiate itself from other means of transport by being less correlated with economic growth. Public transport projects (unlike road projects) carry only passengers and not goods. Accordingly, this mobility should be less fluctuating and less vulnerable to changes in economic activity.

Finally, in a context of economic crisis in both the public and the private sectors, wondering which of these two actors is better placed to take risks related to the financing of projects is interesting.

2.2.2 Literature review

The literature review mainly focused on articles written just after the 2008 economic crisis. Accordingly, these articles provide an analysis of the initial effects of the crisis. However, articles performing the same analysis after the "sovereign debt" crisis and throughout the whole of Europe are hardly ever found. It will therefore be more difficult to analyze the impact of the most recent crisis.

2.2.2.1 The 2008 economic crisis had an overall impact on the use of public transport

The academic literature reviewed on the subject was, as soon as 2009, asking what impact the economic crisis might have on public transport ridership. Different articles put forward two seemingly contradictory assumptions (Abrantes, 2009):

- The economic crisis leads to a decrease in economic activity which is responsible for mobility demand. It is therefore likely that the decline in economic activity has caused **a decline in public transport ridership**;

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- The economic crisis leads to job instability and uncertainty about job security. It is therefore likely that it has slowed down household car ownership and contributed to their **shifting towards collective means of transport**. A study conducted in 2002 (Dargay and Hanly) on bus transport in the UK between 1986 and 1997 sought to identify the impact of household income on the use of public transport by isolating the other parameters. This study had brought to light a negative correlation between these two parameters: a decline in revenue might therefore lead to an increase in the number of bus trips. If this negative elasticity coefficient was observed in the recent crisis, this crisis could then be seen as an opportunity to switch a part of the motorized population over to public transport (Abrantes, 2009).

While these arguments lead to conflicting conclusions, the reality seems to lie in a combination of these two approaches, which varies depending on the country examined. In a statistical report from 2014, International Association of Public Transport (UITP, 2014) highlights the fact that, for the period 2000/2012, analysis of the increase in the number of trips a year by bus, tram and metro in 28 European countries follows three stages:

- A first stage from 2000 to 2005 where the increase was steady in relation to the increase in the number of people living in urban areas;
- A second stage from 2005 where acceleration was quicker than urban growth, reaching a peak in 2008, which proves the attractiveness of public transport networks in this period;
- After this peak in 2008, the economic crisis matched with a decline between 2008 and 2009, but the dynamics picked up in 2010 at a pace over the period 2010/2012 slower than the pace over the period 2005/2008 (UITP, 2014).

By causing a reduction in economic activity, increasing unemployment, decreasing personal mobility and generating a drop in demand for public transit trips, the 2008 economic crisis broke the **dynamics of increased ridership** that had been observed since 2000 (UITP, 2014).

At European level, this break seems to be a temporary one, insofar as in “developed cities” transport demand increased by 1.5% between 1995 and 2001 and by 1.6% between 2001 and 2012 (UITP, 2015). So while the crisis caused a slowdown in ridership, it did not reverse the trends.

This statement seems, however, to require some qualification because it aggregates very different realities. So when an quotation from the proceedings of the UITP Congress in Vienna in July 2009 pointed out that "*in [Public transport networks] where there is strong elasticity in terms of fuel prices and, more broadly, the cost of an individual journey, buses and trams have maintained their recent ridership levels or even recorded impressive ridership growth, but only if they have recently modernized their service offer"* (Segretain,2009), another UITP analysis, also conducted in July 2009, underlines the fact that: *“Given the link to their economies it is unsurprising that many Metro systems are starting to show signs of falling ridership”* (UITP, 2009a).

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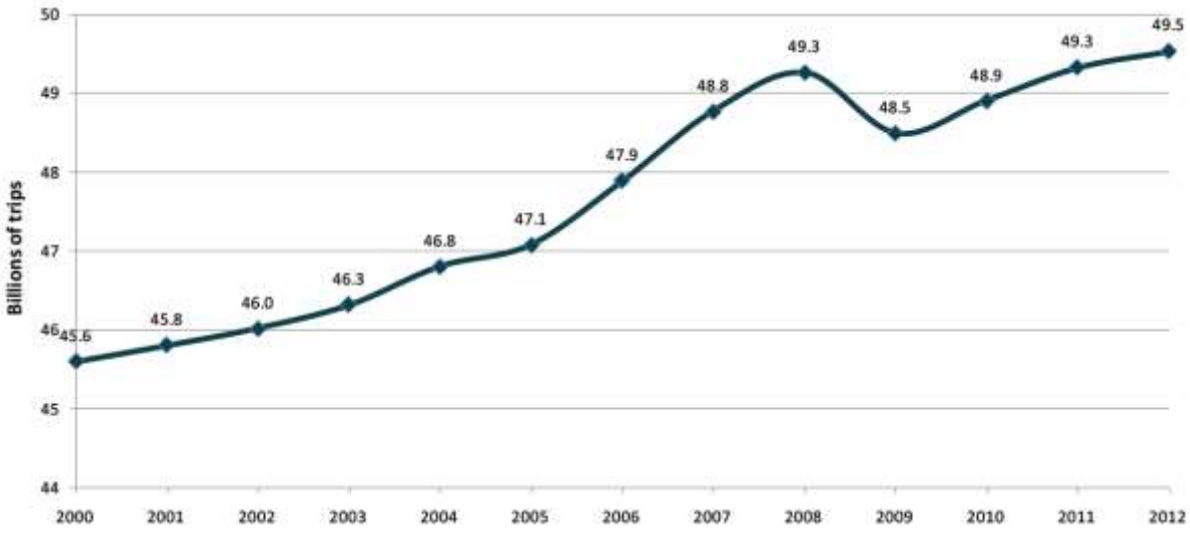

Figure 2.4: Local public transport journeys by bus, tram and metro in the EU, 2000 to 2012
Source: UITP, 2014

2.2.2.2 The effects of the crisis on urban transport exist but they are complex to analyze

So an analysis of population growth in comparison with the increasing demand for public transport over the period 2001/2012 (a period encompassing the economic crisis of 2008), in various large cities, highlights great differences, even among European cities (UITP, 2015). It is observed that cities like London, even though they have suffered from the economic crisis (Figure 2.5), are experiencing an increase in ridership that is much higher than its population growth. On the contrary, Madrid and Athens are below the curve.

So, the relationship between economic crisis and public transport ridership is more complex and must be analyzed at least on a state-by-state basis.

In several countries in Western Europe, despite the 2008 crisis, the use of public transport has not declined. For example, in France, ridership on urban networks, mainly driven by large-scale networks, continued to increase during the 2008 crisis, but this positive development was severely slowed down, and, when recovery began, the increase continued but at a slower rate (Cerema, 2015). Ridership declined only on the RATP and the Transilien networks. Urban networks in the provinces and TER (local rail services) increased between 2008 and 2009 (by 1.2% and 2.5% respectively).

In Germany and Italy, the impact of the crisis on public transport demand in 2008-2009 was relatively limited. In Germany, ridership has even increased. This increase was, however, at a slower rate than before the crisis. In Italy, the Milan network, for example, showed an increase of 1.2% over the first 9 months of 2009, compared to the same period in 2008 (UITP, 2009b). However the trend seems to have reversed since ridership on Italian public transport networks declined between 2009 and 2010 by 0.2%.

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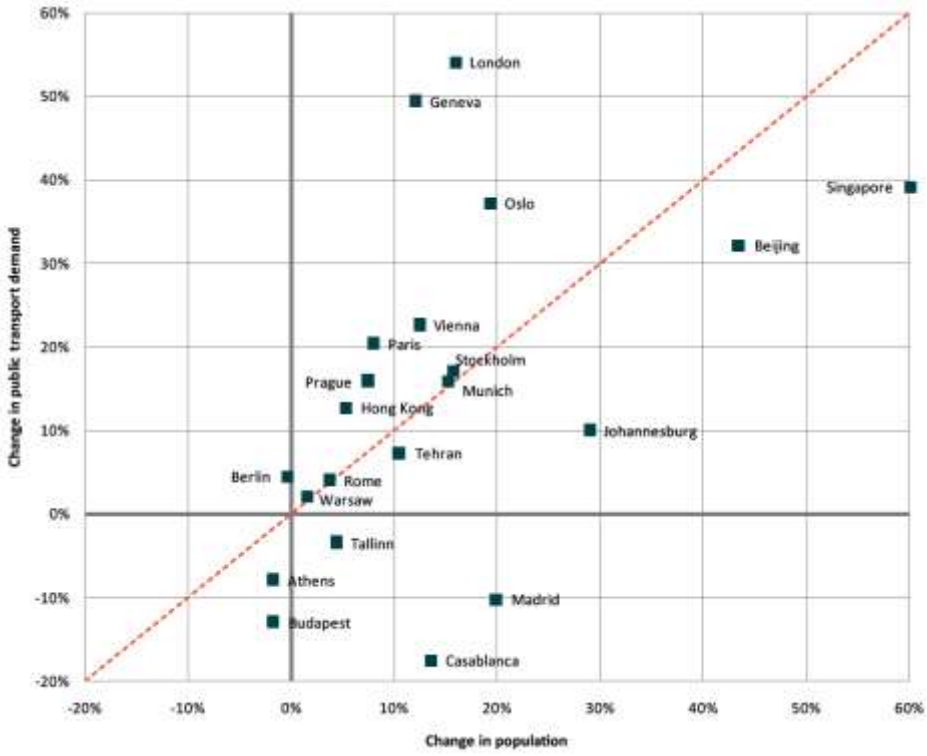

Figure 2.5: Change in public transport demand
Source: UITP, 2015

Table 2.22: Change in the use of public transport as a percentage (Source: PTI, 2012)

Country	Period		
	2008-2009	2009-2010	2000-2010
Germany	+0.1	+0.8	+9.3
United Kingdom	-1.3	+0.4	+9.3
France	-0.2	+1.4	+24.3
United States	-3.2	-0.8	+10.1
Spain	-3.8	-0.8	+10.1
Italy	+0.8	-0.2	+8.3

Conversely, in the UK, the decline in public transport ridership seems to have started as early as 2008/2009 (-1.3%). So in the London public transport system, Transport for London (TfL) faced a sharp decline in ridership in the underground (-6%) between 2008 and 2009 (UITP, 2009b). This ridership, like that found more generally in the UK, returned to its pre-crisis level as of 2010 (PTI, 2012). So while the crisis hit public transport ridership very early on in the UK, this impact will ultimately be very limited over time.

On the contrary, countries such as Spain or Portugal were very strongly affected by the crisis, with a 10% reduction in the use of urban/intercity lines and long distance travel. In Spain, the drop in ridership after the 2008-2009 crisis was significant (-5.6% between 2007 and 2010) (PTI, 2012).

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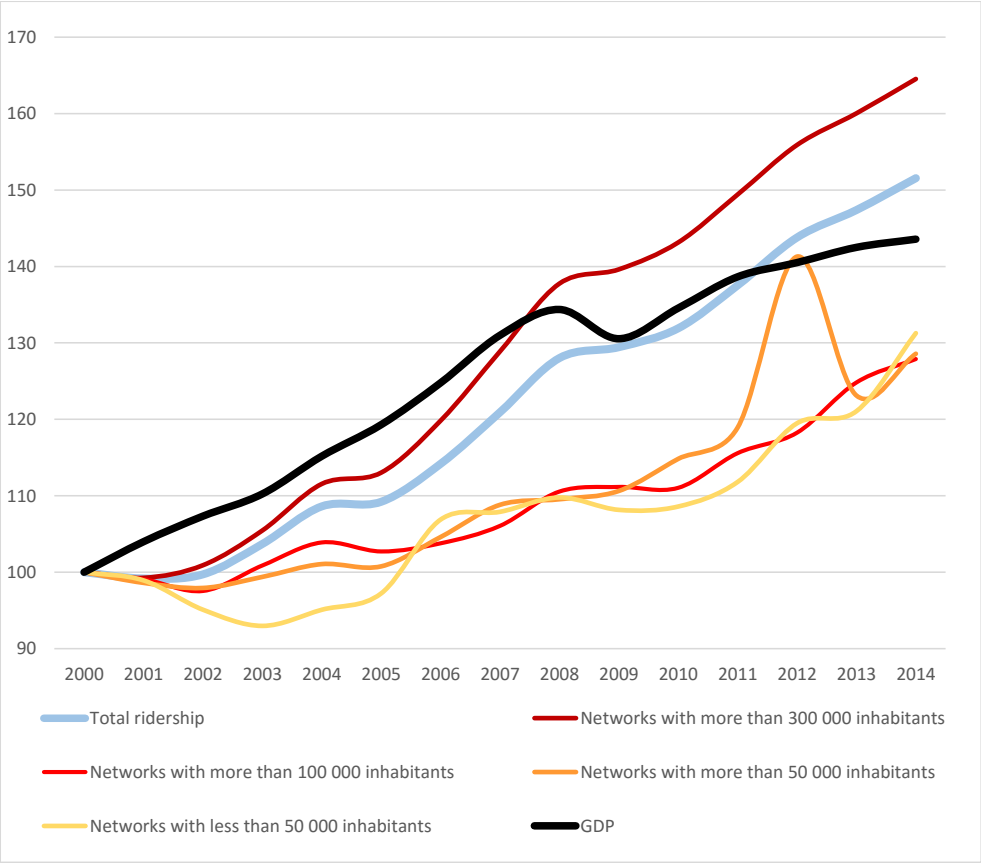

Figure 2.6: Growth (in index points) of annual ridership on French public transport networks and of the GDP
Source: Annual urban public transport survey by Cerema-DGITM-GART-UTP.

Similarly, in Central and Eastern Europe, **ridership has declined due to rising unemployment** (UITP, 2009b).

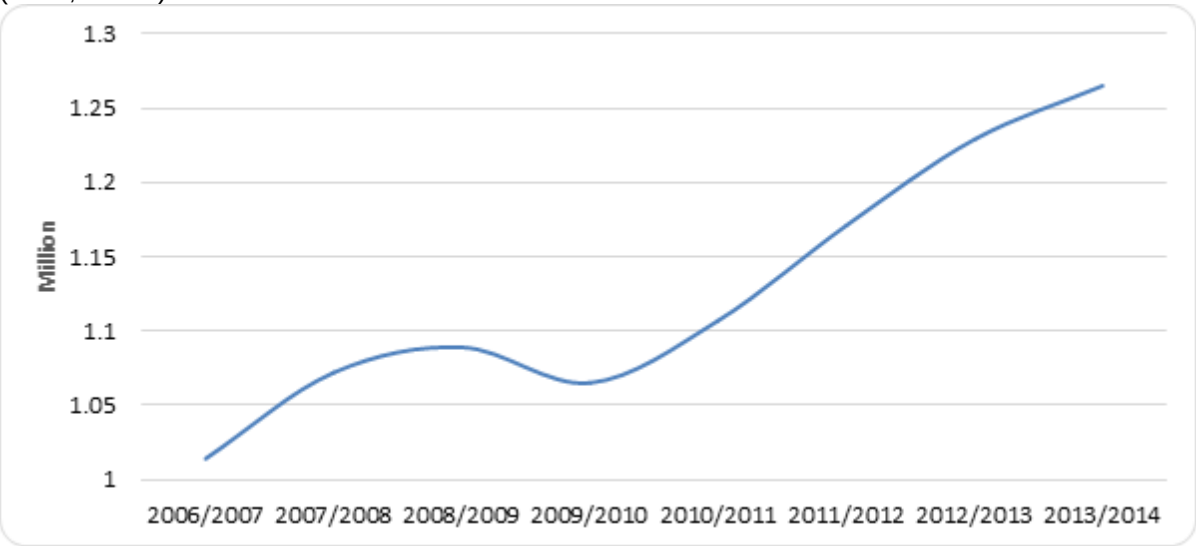

Figure 2.7: Passenger journeys in the London Underground
Source: TfL, Annual Report and Statement of Accounts

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2.2.2.3 The effects of the crisis on the financial resources of networks

The impact of the economic crisis on the use of public transport, although it varied from one European country to another, has necessarily had an impact on fare revenues from the networks concerned.

The impact of the economic crisis on networks' financial resources does not seem to be limited to only a decrease in fare revenues, reflecting a decline in ridership. So, as UITP points out, in a crisis, transport authorities might reduce their obligations, particularly about fare systems. These political changes may increase the risk on the revenue taken by operators. Political reluctance to raise fares in times of economic difficulty is indeed frequent. So, commercial revenues of public transport networks can be affected by the absence of changes in pricing policies.

Conversely, the decline in ridership (and in revenue) may be due to fares that are perceived by users as “too high”. For some underground railways where a fare change was scheduled, the fall in inflation resulted, in real terms, in a higher fare increase than expected (UITP, 2009a).

In addition to fare revenues directly related to the use of urban transport services, **secondary revenue** related to economic activity, such as advertising, has often also dropped (UITP, 2009a).

However, the importance of commercial revenues and concerns about their decline must be seen in perspective. Actually, these revenues often cover only 30-50% of the operating costs of urban transport systems. Additional resources are necessary to ensure the economic balance of operating these services. These additional resources may also be affected by the crisis.

So even in the case of networks where ridership has not been too severely affected by the 2008 economic crisis (with unchanged fare revenue), it is necessary to be cautious because other financing sources may dry up (Segretain, 2009).

In France, for example, **state grants will fall** by €11 billion in the coming years. Revenue from the “Versement Transport”, a tax based on payroll used to finance urban public transport, has already been directly affected by the economic crisis (Transport Public, 2014).
In Thessaloniki, the financial crisis has caused **a reduction in state subsidies** which has generated a sharp decline in available income (UITP, 2011).

In Spain, revenue from urban development has fallen sharply (UITP, 2009b).

Finally, the impact of the crisis on financing networks has also been identified in the literature review through the **increase in operating costs**. This increase may be related to changes in the price of raw materials, as is the case in Greece where the economic crisis has had the effect of increasing fuel prices by 50% (UITP, 2011). Networks may also experience a change in their taxation, as was the case in France where, since 1 January 2014, the reduced VAT rate (applied to public transport tickets) rose from 7.5% to 10%. Urban transport networks that have refused to pass this increase on to users have seen their revenue directly impacted.

In Greece, the increase in direct taxes or VAT (+ 30%) has also led to a sharp increase in the operating costs of urban transport networks.

Finally, the literature review mentions the impact of the crisis on the financial fragility of private partners responsible for operating. So Transport for London was faced with additional costs related to the collapse of Metronet.

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2.2.2.4 To cope with their declining financial resources, some networks are seeking to reduce their operating costs

Faced with this decline of their financial resources, two types of strategies adopted by urban networks had been identified via the literature review:

- Reduction of operating costs with an unchanged offer: UITP points out, for example, that, in the case of metro networks, the determination **to contain or reduce operating costs** by pressure on wages, maintenance costs and operating costs is clearly stated (UITP, 2009a).
- Reduction of transport offer.

In the case of the Thessaloniki network, to cope with the crisis, the organizing authority decided to redesign the public transport network and improve services in order **to reduce operating costs** by:

- Reducing the number of overtime hours made by employees;
- Reducing shareholder remuneration;
- Limiting the effort to improve the quality of service.

In addition to these modifications, **fares have been increased** (UITP, 2011).

In France, for the first time in nearly twenty years, a decrease in the service offer has been observed in the first half of 2015, which is the inevitable consequence of declining revenues (UTP, 2015). Reducing the service offer is analyzed in the literature review as a last-chance option: in fact the risk is to lose market share for public transport, these market shares will be difficult to recapture later (Segretain, 2009).

In France, this reduced offer mainly concerned secondary public transport lines. Conversely, in Spain, the crisis may have impacted central lines (Metro Report international, 2013):

- In Madrid, in April 2012, the junction Pinto - San Martin de la Vega, built in 2002 to serve a recreational park and whose ridership was very limited (200 passengers per day) was **closed**;
- The tramway between Velez Malage and Torre de Mar in Andalusia (4.7 km), commissioned in October 2006, was **closed** after 5 years of operation;
- The Jaen tramway, built in May 2011, has proved to be not viable. In July 2013, the regional government refused to take responsibility for it. By late 2013, it had **still not been commissioned.**
- Work on line 2 of the Alicante tramway was completed in late 2010. In the absence of financing to ensure its operation and maintenance, **a move to a public-private partnership (PPP) was attempted, but failed**. The line is operated today by the government.

2.2.2.5 In response to the crisis, some networks have decided to postpone their investments or stop their work

The financial crisis has increased pressure on the level of investment to extend or renew metro systems:

- In London, as investment financing is partly based on revenue from traffic, the public transport extension programme has been **partly postponed**. Maintaining the Crossrail project made necessary to reprogram other projects (UITP, 2009b).

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- In Berlin, the choice was made to renovate the rolling stock rather than replace it and the automation of signalling was abandoned (UITP, 2009a).
- In Spain, all metro projects in Madrid have been cancelled or postponed, except for the extension of Line 9, for one station, from Mirasierra to Costa Brava (2 years late, opening planned for 2015). Work on the suburban line C5 between Mostoles and Navalcarnero, which began in 2008, was stopped in 2010 for lack of funds (€150 million spent).
- On the Barcelona metro, considerable delays have been accumulated in the construction of Line 9 (46 km, a diametrical, driverless line). Two sections have been opened in the north. Other segments have been built to the south but there is **no prospect** for completion of the entire line.
- In France, the investment capacity of local authorities has fallen by 23%. Public Transport Authorities **delay, phase or abandon** their major investment projects. Problems also appear for maintenance investments such as the renewal of bus fleets (Transport Public, 2014).

2.2.2.6 After the crisis, private partners seem more reluctant to invest in urban transport

Private investors today are reluctant to commit to transport projects for which the **return on investment (ROI) is not clear** (Segretain, 2009).

Due to the long period of amortization for these kinds of public transport projects, it is conceivable that in times of economic crisis, private entities would focus more on projects with shorter ROI times (Abrantes, 2009).

Moreover, in times of crisis, private partners have **more difficulty in obtaining loans.** So for the Brabo tram project, the company De Lijn had to postpone a PPP planned for a period of 30 years because banks were reluctant to commit for such a long period in such an unpredictable financial environment. As a result, this 30-year PPP had to be reduced to 10 years. Because of this uncertainty, the government agreed to grant a state guarantee for the loan (UITP, 2009b).

2.2.3 Qualitative analysis of some cases from the BENEFIT database

2.2.3.1 Usable cases

Figure 2.8 shows the key periods of the timeline of a transport project (period for offer call/tender/contract award - construction period - operating period) for 16 urban transport study cases in the BENEFIT database.

Figure 2.8 shows the limits of the BENEFIT database for analyzing the impacts of the recent economic crisis on the financing of transport projects. In fact:

- Almost all of the projects in the database were designed before the crisis. If they can provide information about how to adapt an existing project to the crisis, to analyze the development of urban transport projects in times of crisis is not possible;
- Among the projects designed before the crisis, 10 projects were wholly or partially constructed before the crisis, in particular before 2010/2012 period afterwards states' funding capacity have been greatly challenged;

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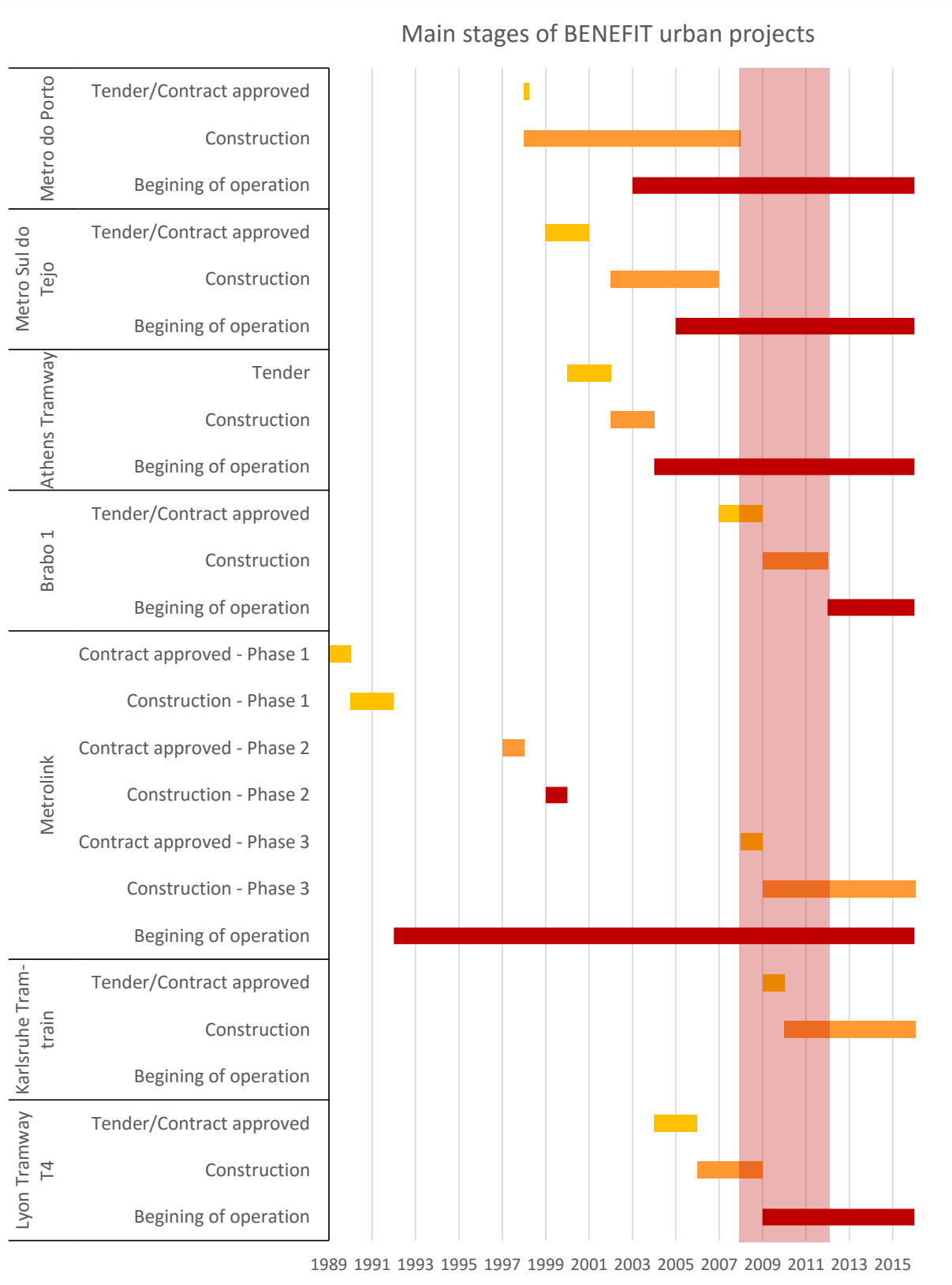

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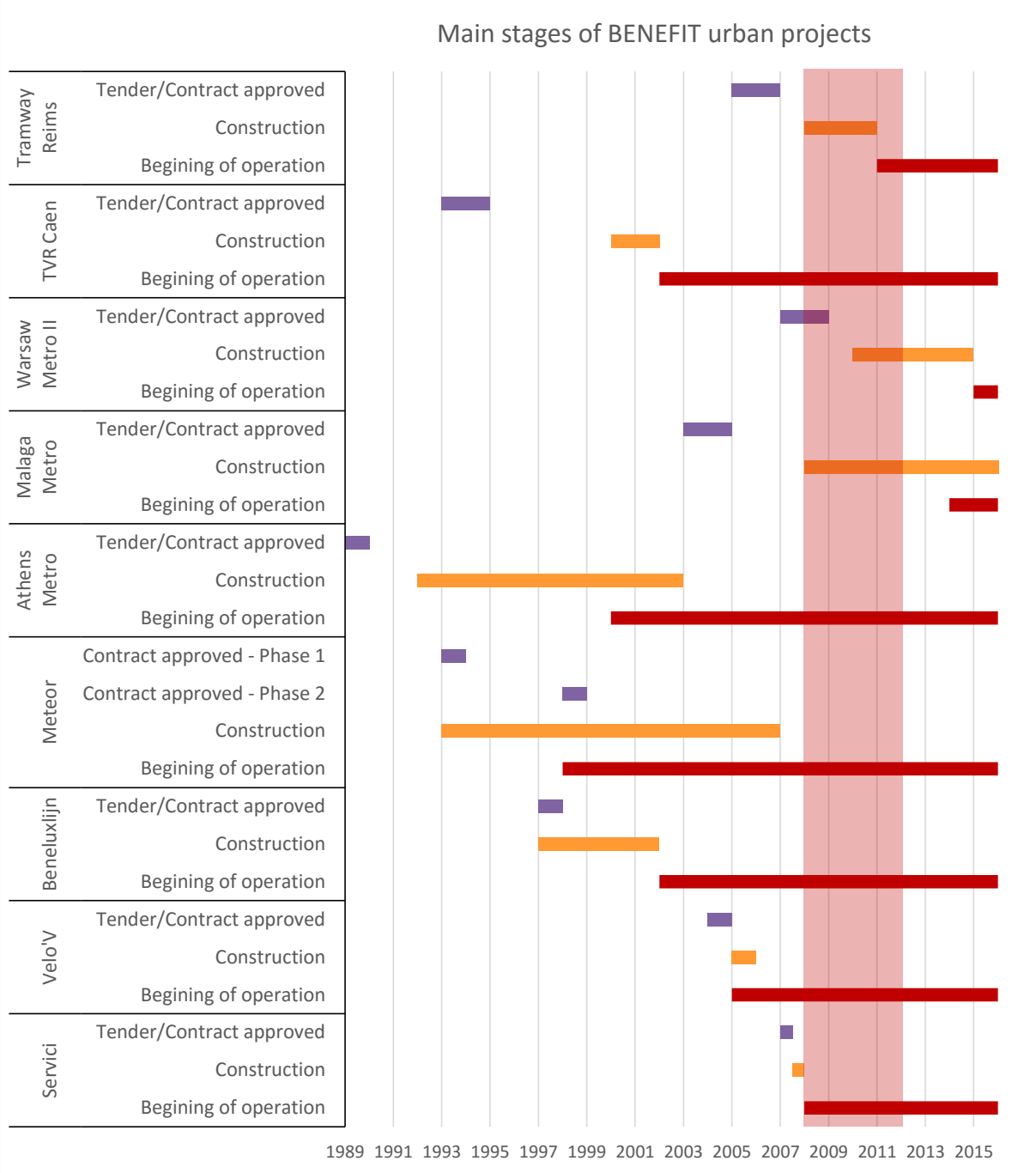

Figure 2.8: Main stages of BENEFIT Urban Transport projects

- Among the projects constructed before the crisis, some of them were in operation well before 2008. A change in commercial revenue or in ridership is not necessarily caused by the crisis even if it occurred simultaneously. The ability of the transport network to remain attractive may indeed have an important role.

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From the available data (including the narratives), we will nevertheless try to analyze the impacts of the economic crisis on urban transport projects according to whether the crisis occurred during:

- the design of the project;
- the tender and/or the contract signature;
- the construction of the transport system;
- the operation of the transport system.

For each of these steps, we will try to point out the possible impacts of the economic crisis on the transport projects which could have been taken into consideration in the quantitative approach developed through the Matching framework.

2.2.3.2 What happens if the crisis occurred during the design phase?

In the transport database, no projects have been actually "designed" during the crisis. As the gestation period for large-scale public transport projects exceeds a decade, projects designed between 2008 and 2012 are not yet in service. So, the exercise has to be only theoretical.

It seems that the economic crisis may have two types of impact at the design stage of projects:

- An impact on the forecast of ridership;
- An impact in terms of gestation slowing down (or, conversely, speeding up).

Impact in terms of forecast transport project use:

A key element of the design of transport infrastructure projects is the estimation of its future ridership. The size of the project (capacity, mode, etc.) and finally the cost per km of infrastructure are based on this estimation. These forecasts therefore are crucial to determine the business model of the project, especially if fare revenues are expected to play a main role in this model.

But the literature review summarized above does not bring to light a simple and unequivocal link between economic crisis and urban transport ridership. The 2008 economic crisis may, by slowing down economic activity, have caused a reduction in transport demand. Conversely, in some countries, the crisis has had an impact on household car ownership; it could be the cause of a modal shift from the car to public transport, which is more affordable financially.

In all cases, the economic crisis has increased the uncertainty surrounding ridership forecasting. In this, it may have had an impact during the design of projects. This impact should however be viewed with caution: a main part of the projects analyzed in the BENEFIT database, which were designed before the crisis, are characterized by poor ridership forecasts. For example, out of 9 projects studied in the first stage of qualitative analysis:

- 6 projects have overestimated rate of use objectives (Porto metro, Sul do Tejo metro, Athens tramway, Reims and Caen tramways, Málaga metro);
- 3 projects have rate of use targets in line with expectations (Brabo 1, Lyon T4 tramway and Manchester Metrolink).

A similar analysis, conducted by Cerema in 2015, on 14 French tram/metro projects had also pointed to the approximate nature of ridership forecasts. However in the second study, the observed trend was rather to underestimate ridership.

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Impact in terms of slowing down / speeding up project design in times of economic crisis:

The so-called "sovereign debt" economic crisis which appeared, depending on the country, between 2010 and 2012 has led to a contraction of financial resources of countries and local authorities, a scarcity of public subsidies, and therefore to a reduction in resources expected to complete commercial revenue.

This contraction of public authority financing capacity has necessarily impacted public transport whose profitability is highly dependent on this public subsidy, especially at construction stage. The crisis may have delayed projects or caused them to be postponed.

For example, the extension of the Jubilee Line has been impacted by the former economic crisis (1991). For this project, £480M were expected from different private stakeholders (the main landlords of properties located along the route of the extension). £400M had to be paid, in several instalments, by the developer Olympia & York. In 1991, a sharp recession in the industrial field led to the collapse of this company which was unable to fulfil its commitment. As a consequence, the construction of the project has been postponed pending a new financial scheme which had to include a significant participation of private stakeholders.

Insofar as the database contains only completed or partially completed projects, it does not make it possible to examine abandoned projects. Neither does the recent nature of the economic crisis provide us with any projects for which the design may have been "slowed down" by the crisis (the Jubilee Line project is an exception as it refers to the former economic crisis). It should however be noticed that design phase is often developed very independently from seeking funding. So, projects such as the extension of the Jubilee Line experienced a particularly long maturation phase before the financing plan was agreed upon and the project could begin.

The economic crisis could therefore turn out to be problematic when moving from design to contracting and construction.

Conversely, it is not impossible that in some cases the crisis led to a certain acceleration of project gestation by creating a kind of urgency to commit to investment spending to boost economic growth before the sector became too depressed. Investment programmes were launched "hastily", resulting in inadequate preparation phases for the transport projects.

The BENEFIT database, and in particular the narratives, highlight a number of cases where project design visibly suffered from obvious lack of a priori assessment (Malaga, Karlsruhe, Warsaw, etc.), leading either to high additional costs related to unforeseen events during the construction phase or to completely inadequate ridership forecasts.

If crisis by itself does not lead to ill-conceived projects, in a context of crisis, these projects experienced great difficulties because there was no longer any capacity for absorbing the mistakes made during the design phase.

A qualitative analysis of the effects of the economic crisis, when it occurs during design, would therefore lead one to identify the following consequences for further development of the projects:

- difficulties during tenders, because of the insufficient design of the project;
- difficulties during construction, due to the underestimation of construction costs;
- difficulties during operation, due to overestimation of ridership.

The BENEFIT project is based on the assumption that the projects analyzed have been sufficiently examined upstream and if there is any discrepancy between prediction and reality, this discrepancy can be explained after the project design phase. So the impact of a crisis occurring during the design phase cannot be studied using snapshots.

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2.2.3.3 What happens in the crisis occurred during the tender and/or during the contract award phase?

The question here is whether the eruption of the economic crisis has any effect on tenders. The crisis may intensify or, on the contrary, weaken the competition. Few indicators in the database are likely to reflect this phenomenon. It may however be interesting to study, for each of these projects, potential changes in:

- the number of bidders during the tendering phase;
- the duration of the contracting phase.

The change in the number of candidates may reveal how aggressive the negotiation is in order to obtain the contract. Two scenarios seem possible:

- As the crisis is making construction contracts rarer, it could lead to an increased competition among bidders. While this competition may, to a certain extent, be beneficial to public contracting authorities, it may also lead private players to take greater risks in order to win the bid. In this view, they might make offers to public contracting authorities that they probably will not be able to implement (unrealistic offers). Their strategy is based on the hope of later renegotiations;
- The crisis may also lead to a high risk aversion for private players who, given the climate of uncertainty, refuse to submit an offer.

Of the 16 cases in the BENEFIT database, only 4 have negotiation/contracting phases occurring simultaneously with the outbreak of the economic crisis: Metrolink Phase 3, the Brabo 1 project, the second Warsaw metro line and the Karlsruhe tram-train project.

For Phase 3 of the **Metrolink** project, tender phase took place in May 2008. Little information is available in the narrative, which suggests that contracting did not face major difficulties. The duration of the tender phase appears to have been similar to the average duration of tender phase for the three other phases of the project (18 months). The number of bidders who responded to the tender for Phase 3A (5 candidates) is the same number of candidates who had been allowed to submit a bid for the Phase 1 (12 candidates had then expressed interest) and is close to the number of bidders who submitted an offer for the Phase 2 (4 candidates).

Very few indicators vary between snapshots S5 (crisis start - 2008) and S6 (crisis peak - 2012) for the Metrolink project, which seems to confirm the limited impact of the economic crisis on this project. However, insofar as the project is phased, it remains difficult to interpret the possible impacts of the economic crisis on its roll-out.

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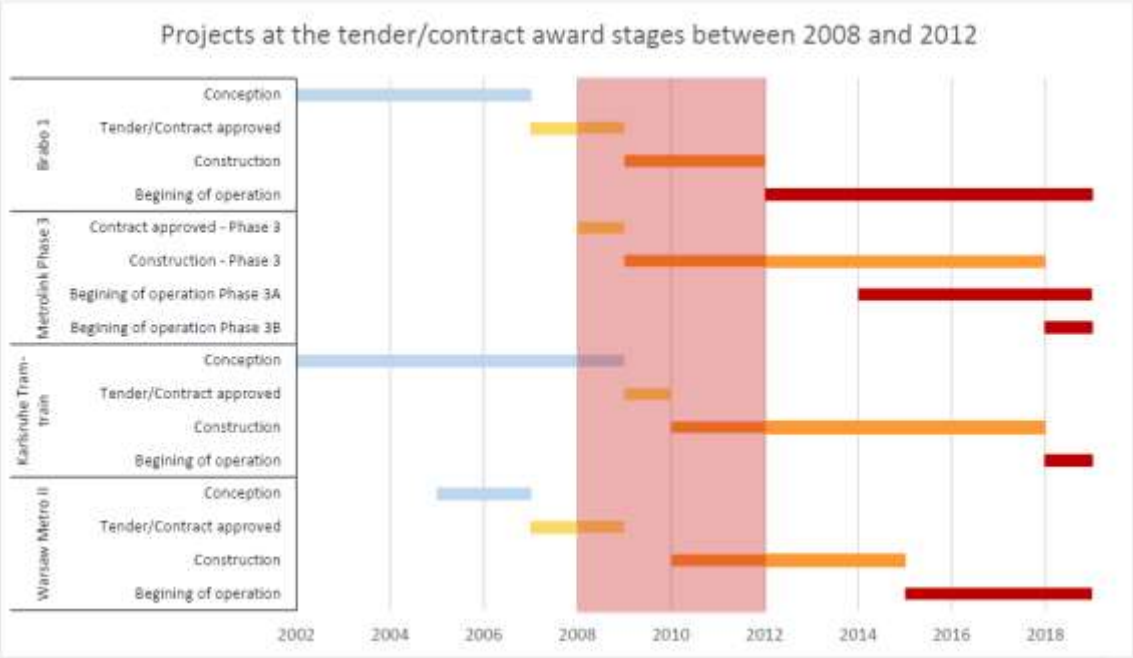

Figure 2.9: Projects at the tender/contract award stages between 2008 and 2012

In the case of **the second Warsaw metro line**, two successive tenders were necessary. The first, in 2008, took the form of a competitive dialogue but the offers submitted were judged too expensive by the contracting authority who declared the call for tender void. It seems, however, that the economic crisis is not the main reason for this situation. The first call for tender imposed a very restrictive time frame in which it was required to commission the line to match with the European Football Championship, which may have led to a sharp rise in construction costs. The second call for tender, held a year later, was won by a Turkish contractor with an offer lower by €350 million than the offer made by the same bidder in 2008.

In the case of the **Brabo tramway**, three bidders submitted an offer for the tender organized between July 2007 and spring 2009. The long duration of this call for tender (26 months) was due to the inability of the bidders to find the necessary financial partners to draw up their final bid. The closing date of the call for tender had to be postponed. The impact of the economic crisis is very visible here: by impacting the financing capacity of the private sector, it led to delays.

Finally, as part of the call for tender held in 2009 for the **Karlsruhe tramway**, the consultation documents were sent to five consortia. Because this was a "public" project, the duration of the contracting phase is more difficult to assess.

The BENEFIT database cases analyzed do not therefore make it possible to note an increase or a reduction of the number of candidates submitting a bid in times of economic crisis. However, in the case of the Brabo 1 project, it can be seen that the economic crisis has had a direct impact on the duration of the contracting phase.

The BENEFIT database contains information on the number of candidates at each stage of the negotiations or on the duration of the negotiation phase. These indicators, however, are not included in the calculation of the Matching framework indicators. So while a "global" delay in the project is taken into account, in different projects this delay is an aggregate of highly disparate elements. A project such as Brabo will be considered as having been commissioned on time (despite a contracting phase

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that was longer than expected) while a project like the Karlsruhe Tram-train, which did not encounter any difficulty in the tendering phase, will probably pick up delays due to difficulties encountered during the construction phase.

However this may be, the economic crisis brings to light a "risk aversion" that weighs on the tendering and negotiation phase: growth is no longer there to absorb errors (deliberate or otherwise) that might be made at this stage by the candidates.

In all cases, the conduct of a call for tender and the effect of competition in times of economic crisis may have consequences on the choices made by the contracting authorities. These choices may eventually have an impact on the progress of projects:

- difficulties during construction, because of the choice of "bad" builders,
- difficulties during operation, because of the choice of "bad" operators.

As we have seen, the crisis may impact the conduct of tendering by making it more difficult for private consortia to obtain loans from banks when they are completing funding applications. It is therefore probable that this crisis may have the effect of delaying the launch of projects. But at least for projects financed as PPPs, financial closure being necessary to launch the construction, there may be a delay (as in Brabo or Reims) but, once construction has begun there will probably be no more reason for further delays to occur for financial reasons (in fact, there will be delays - and extra costs - but these will be linked to the existence of technical hazards).

The situation will be obviously different for public projects, where there is no need to have the entire budget available to start the project. In the best of cases, a project conceived as a whole can be phased (such as the T4 tramway project in Lyon and Meteor in Paris). In the worst of cases, construction of the project cannot be completed for lack of funding, and the project will be abandoned or its commissioning indefinitely postponed. .

2.2.3.4 What happens in the crisis occurred during the construction phase?

The BENEFIT database contains 7 projects for which the construction phase took place, partly or in full, during the period when the economic crisis broke out: Metrolink Phase 3, Sul do Tejo Metro, Tram T4 in Lyon, Reims Tramway, Metro de Malaga, Karlsruhe tram-train and the Warsaw Metro.

It might be expected that the economic crisis, leading to an increase to the cost of raw materials, automatically causes an explosion in the construction cost of urban transport infrastructure. Analysis of the cases in the BENEFIT database quite rarely brings out this point, while the literature review above refers to it at least for difficulties caused during the operation phases.

Of the seven projects examined, 3 seem to have construction costs close to those estimated (Metrolink Phase 3, Reims Tramway and Phase 1 of the Lyon T4 Tramway):

- For the first phase of the **LyonT4 tramway**, built in 2008-2009, the economic crisis does not appear to have had any significant impact. This phase encountered no extra cost and no significant delay. The project was fully financed by the public authorities, and the outbreak of the 2008 economic crisis seems not to have impacted the capacity of the various public players to finance. If the project had to be completed in two phases, the choice was made before the economic crisis. This crisis did not challenge completion of the second phase commissioned in 2013.

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- The 2008 crisis occurred during the construction phase of the **Reims tramway**, the 2012 crisis during its operational phase. Construction was however completed without any significant additional cost or delays.

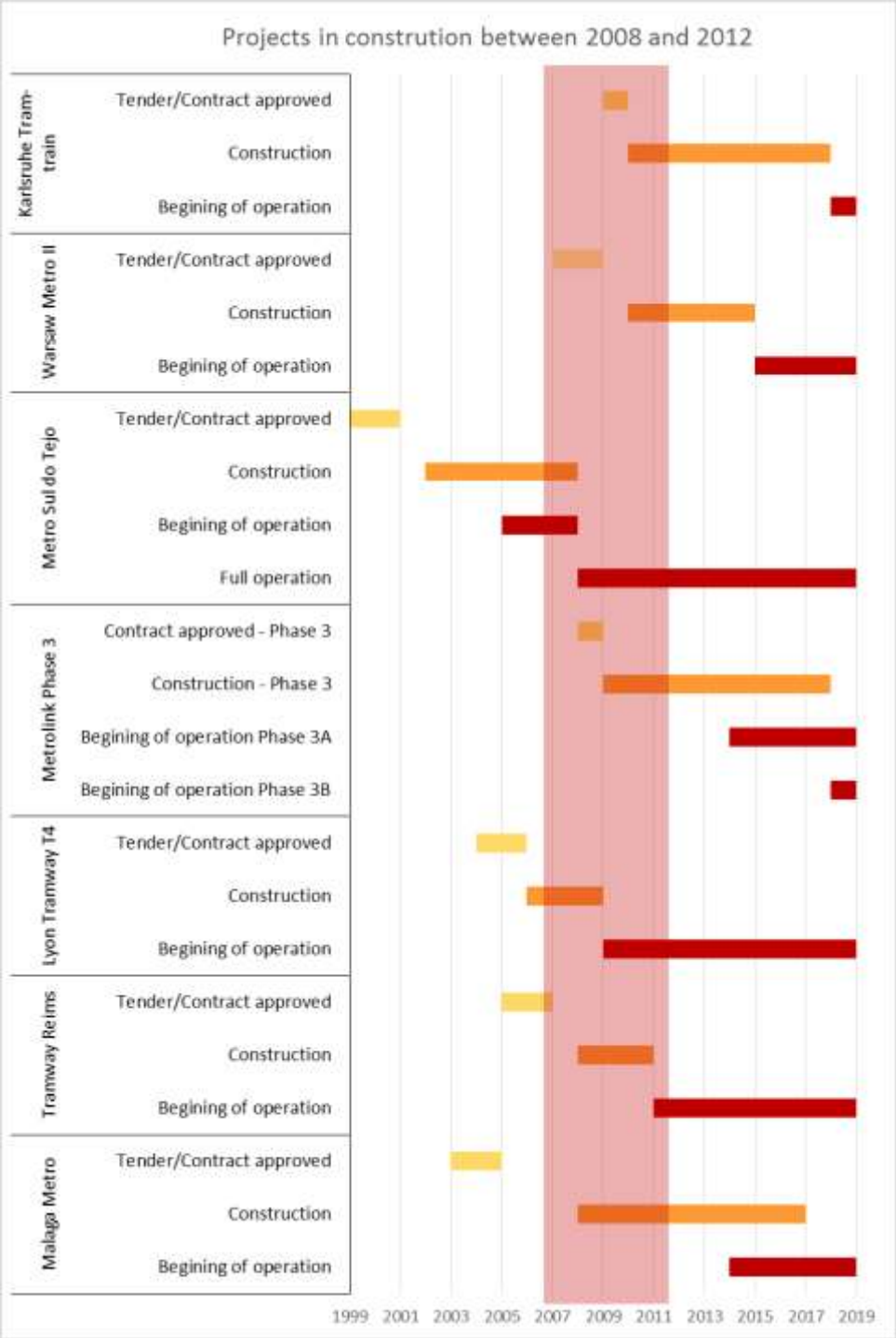

Figure 2.10: Projects in construction phase between 2008 and 2012

The other 4 projects had to cope with cost overruns, these overruns being particularly significant in the case of Karlsruhe tram-train and Málaga Metro.

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- The construction phase of the Málaga Metro took place from 2004 to 2014. The move from snapshot S1 (2004) to snapshot S2 (2014) reveals cost overruns (from €403 to € 600 million) and projected deadlines exceeded, but nothing indicates that these are due to the crisis. In contrast, financing of the project encountered serious difficulties and the pressure on public finances caused by the crisis may explain the fact that public authorities were unable to buy the assets of the investment company instead of an American pension fund.
- The construction phase of the **Karlsruhe tram-train** is planned for the period 2010/2018. So it started in the crisis period. The project faces a very substantial rise in construction costs: the estimated cost of €589 million in 2009 had to be revised to €897 million in 2014. This additional cost is related to poor project planning and difficulties with civil engineering work. The construction company chosen (Alpine Bau Deutschland AG) was declared insolvent in 2013, which may have delayed the project. This event is, however, difficult to integrate in different snapshots, since for a public project it is the "Capability to construct" of the contracting authority (here "KASIG") which is analyzed. In our case, this capability is rated 2 (medium capacity - national level) in 2009 and in 2014;
- During its construction phase, **the Málaga Metro** experienced an overrun of its projected cost from €403 million to €600 million. This increase is not really due to the economic crisis but to lack of upstream evaluation, poor planning of the work and the addition of additional work. This increase is absorbed by the public authorities in the form of both grants and debt. The crisis did not therefore prevent the contracting authority from completing project financing.

In general, it appears that the additional costs and delays in the construction phase of the projects identified in the BENEFIT database are due rather to technical difficulties. To the extent that these difficulties seem quite unrelated to the direct capability of the builder, they are probably caused by the relationship between the public contracting authority and its builder, snapshots hardly ever integrate this relationship. Ultimately, the most important indicator for tracking these issues during the construction phase is the Financing Indicator. It shows changes in the financing plan but manages only with some difficulty to take into account the difficulties arising from these changes. It appears that for snapshots between design and commissioning:

- it does not vary in the case of the Warsaw Metro (1);
- it decreases very slightly in the case of the Karlsruhe tram-train (from 0.971 to 0.946);
- it increases in the case of the Malaga metro (from 0.689 to 0.785).

These variations, which scarcely reflect reality, can be explained by the way that the indicator is built to characterize a financing scheme at a given time (high in the case of substantial public financing; low in the case of private financing) and not its level of consistency with the proposed financing scheme.

Finally, even for those with very high additional construction costs, the projects are brought to completion and put into operation. However, one may still question whether it is possible to finance the operation phase of such projects, when their construction phase has drawn to such an extent on the available resources. The Spanish examples presented earlier in the literature review show that in many cases projects were not commissioned or were stopped after a few months or years. No such case is however recorded in the database.

2.2.3.5 What happens in a crisis during operation?

As shown by the literature review, the economic crisis may have negative impacts on the financing of the operation phase of urban transport systems insofar as it often results in loss of revenue due to declining ridership or a fare freeze. Secondary revenues from advertising may also be affected by the crisis. This reduction in revenue (from traffic or secondary sources) results in an increase in the operating deficit and the subsidy to be paid by the public contracting authority to ensure the economic

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balance of the service. The local authority will have major difficulty in ensuring the level of subsidy to which it has committed because some of its revenue will also be sensitive to economic activity.

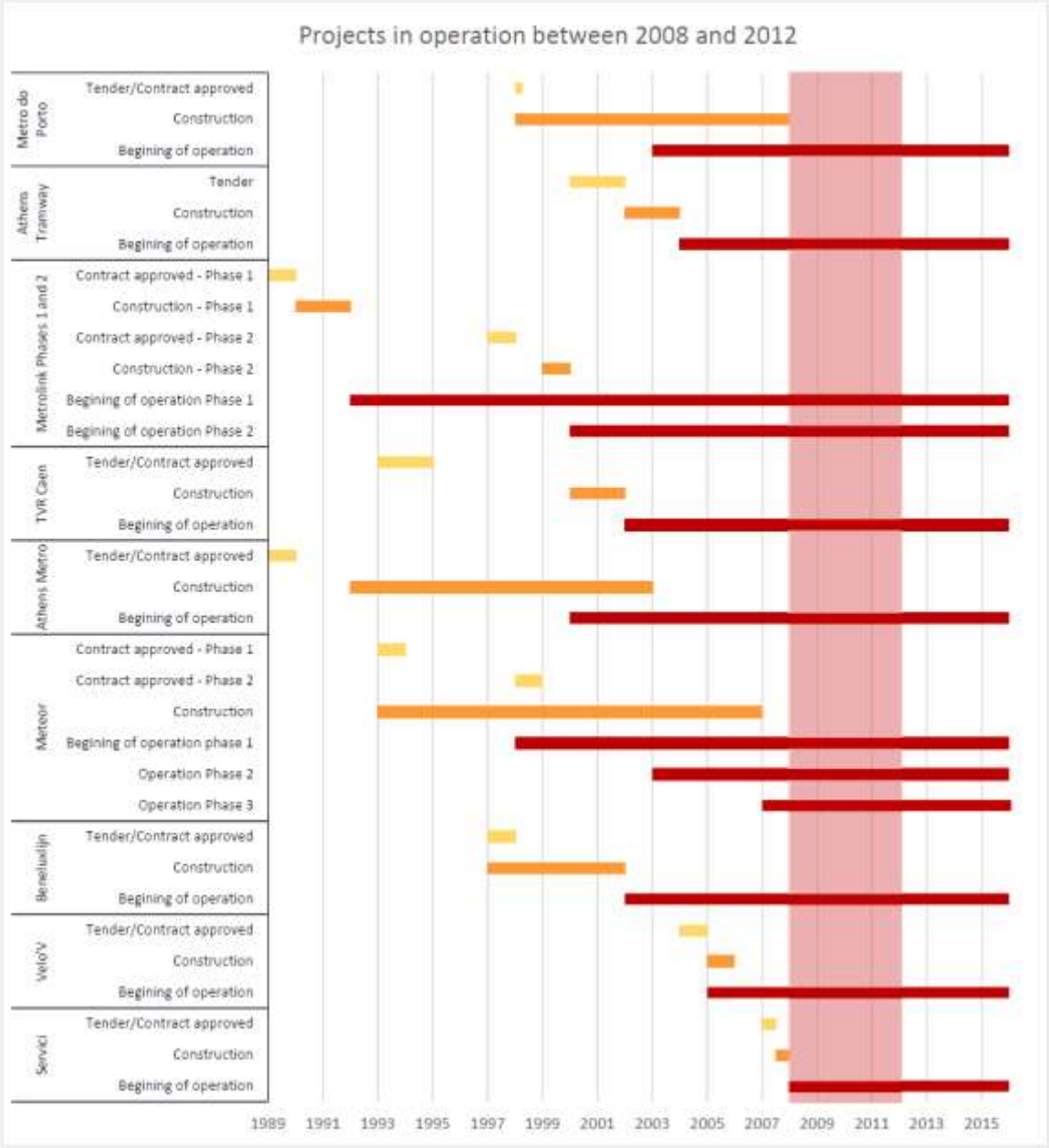

Figure 2.11: Projects in operation phase between 2008 and 2012

Nine projects examined have commissioning dates prior to the economic crisis while being sufficiently close to it. In fact, it is not possible to examine the impact of the crisis on the scale of a transport line, when the latter has been integrated for a very long period into a constantly changing network (as in the case of the London network with commissioning of the extension of the Jubilee Line dating from late 1999).

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As shown by the literature review, the first impact of the economic crisis on our projects must be examined in terms of ridership. In most cases the projects examined have lower than expected ridership, but this can also be said for projects commissioning at times not directly related to the crisis. However, it can be seen that a project like **Metrolink** (limited here to its phases 1 and 2) which hitherto had been little affected by the economic crisis, saw its attendance drop slightly during the crisis. This drop was however followed by little impact as ridership resumed very quickly.

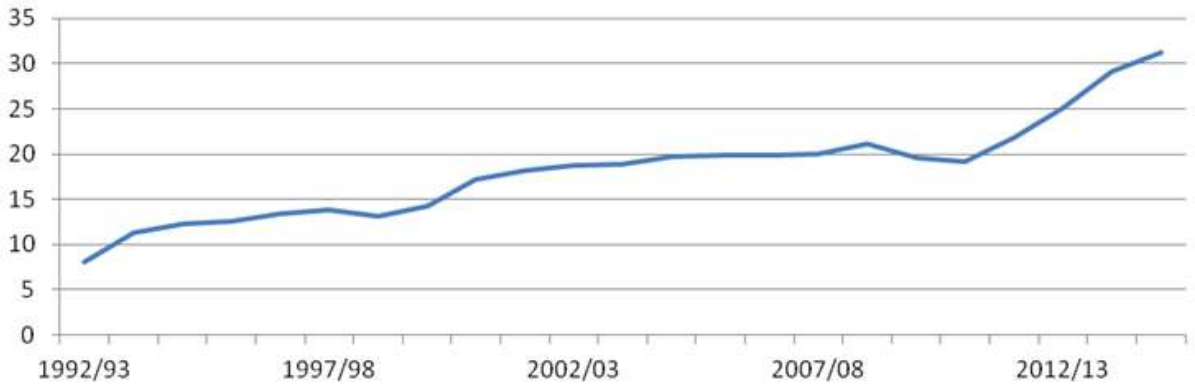

Figure 2.12: Number of annual journeys in Metrolink (in millions)
Source: Department for Transport statistics, UK, Light Rail Statistics, <http://www.dft.gov.uk/statistics/series/light-and-rail-and-tram/>, accessed in April 2016.

The third phase of the Paris **Météor** project was commissioned in 2007. The 2008 economic crisis did not cause any significant decrease in ridership.

In the case of **Sul do Tejo Metro**, inaugurated in 2008, the level of ridership is below forecasts from 2008 to 2011. While this drop cannot be directly attributed to the crisis, it was compensated by the public authorities whose subsidy level rose from the planned level of 0% to 26% of the project cost. This variation deteriorated the revenue scheme of this project, which moved from 0.556 to 0.491.

The drop in ridership on urban transport networks in times of crisis is one thing, but it should not obscure the fact that financing for operating the services is often compromised firstly by the poor quality of forecasts, as was the case for the Porto metro, the Sul do Tejo metro, the Reims tramway, etc. So in the case of the **Reims tramway**, poor ridership forecasts very quickly made the public transport network unsustainable financially for the operator. While the crisis is certainly not the cause of this phenomenon, it may have limited the ability of the organizing authority to fund the deficit. The local authority, being financially limited, refused to review the operating subsidy paid to the operator and turned towards a strategy of increased fares and a reduced supply strategy mainly concerning additional bus lines.

In the case of the **Athens tramway**, the average fare planned at commissioning was €0.41. In reality, the fare applied when the line was opened was €0.75. This too high fare led to reduced ridership, especially as it did not provide the expected level of availability. The crisis then impacted the level of ridership. Advertising revenues compensated for a time but quickly collapsed, also because of the crisis. The strategy was then to integrate the tram into the network managed by Stasy which allowed a sharp drop in operating costs.

The question of the relationship between advertising and pricing is also present in the case of bike sharing projects. **Vélo'V** and **Sevici** had to increase their rates. For Vélo'V, this increase is related to the need to meet the operating costs due to higher usage than expected. For Sevici, the rate increase is a result of the economic crisis which has resulted in lower advertising revenues and the need to renegotiate the contract in 2013.

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2.2.4 Conclusion

As a preamble to this conclusion, we have to question the relevance of analyzing the effects of the economic crisis on urban transport lines such as metros and trams while in urban transport it is the network effect that predominates, particularly in the operational phase. It is also likely that the effects of the economic crisis are not generally supported by the central lines (metros and trams). On the contrary, drastic reductions in supply are more commonly applied to additional networks or lines (buses). The network – and not the line – is probably the right scale to analyze the effects of the crisis on urban transport projects.

With this proviso, the literature review and the qualitative analysis of case studies from the BENEFIT database show that the crisis only underlines the limits of the capacity of cities and countries to support urban transport policies and projects. In Spain for example, the crisis has highlighted a tendency to invest in urban transport beyond the actual travel demand. The sustained investment programme implemented in the country until 2008-2009 has clearly created overcapacity. The Barcelona and Madrid metros saw the length of their lines double in fifteen years from 1995 to 2011. Suburban network projects have appeared in twelve cities and conurbations. Fourteen new tram projects were begun between 1994 and 2011. The arrival of the crisis and the drying-up of financing at national level have started to lead to questions about the ability of cities to continue to finance the construction and operation of new public transport lines (the Seville tramway and the light metro in Málaga). The decline in public transport ridership in Spain after the crisis (-7.7% from 2011 to 2012, -4% to -5% forecast for 2012-2013) has highlighted the oversizing of recent infrastructures and shown the fragility of the "bubble" economy characteristic of Spain over the last twenty years (Metro Report International, 2013).

What the qualitative analysis and the literature review also show is the distinction that needs to be made in terms of impact between the projects affected by the crisis during their construction phase and those affected during their operational phase. At the time of construction, the impact of the crisis on the project is felt rather through the existence of additional costs or delays in commissioning. At the time of operation, the impact of the crisis is to be analyzed through the project's ability to maintain its business model and thereby to achieve its revenue and ridership objectives. At all events, it must be noted that, with or without the economic crisis, public transport remains in most cases loss-making.

The case studies in the BENEFIT database that have been analyzed qualitatively refer to projects usually supported by cities or local governments but also subject to control or a strong support from the states. In a context of economic crisis, the most expensive projects are usually quickly abandoned because their excessive visibility could jeopardize state support for other operations. But it also happens that the projects in question are considered as symbols by states, which then prefer to maintain them, even to the extent of abandoning smaller projects (the English government will be keeping Crossrail despite the adverse economic conditions).

In the end, the economic crisis seems to have had relatively little impact on financing for urban transport infrastructure, if we set aside the case of countries where the crisis has only highlighted major structural weaknesses, going far beyond the transport field. In other countries, the crisis appears rather as an opportunity to restore the link between the economic growth of cities and the development of urban public transport infrastructure. UITP reminds us that the development of metro systems throughout the world had certainly resulted in a higher level of debt, but that this was justified by an expected growth in long-term revenue (UITP, 2009a).

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2.3 Bridge and Tunnel Projects in BENEFIT

2.3.1 Introduction

The aim of the paper is to analyze bridge and tunnel case studies from the financial crisis impact perspective. It describes the second stage of the qualitative analysis (part of Task 4.1 Stage 2), concerning bridge and tunnel infrastructure cases of the BENEFIT database. There are four bridge infrastructure cases noticed in the database and six tunnels:

- 4 bridges (Rion-Antirion Bridge - Greece, Millau Viaduct - France, Lusoponte – Vasco da Gama Bridge - Portugal, The Øresund Link – Denmark-Sweden), and
- 6 tunnels (The Øresund Link, Herrentunnel Lübeck - Germany, Coen Tunnel – The Nederlands, Berlin Tiergarten Tunnel - Germany, Södra länken - Sweden, Blanka Tunnel Complex – Czech Republic).

Among them 5 projects were realized in PPP formula: Rion-Antirion Bridge - Greece, Millau Viaduct - France, Lusoponte – Vasco da Gama Bridge – Portugal, Herrentunnel Lübeck - Germany, Coen Tunnel – The Nederlands.

However, the objective of the analysis is to explain what was the influence of the recent economic crisis on bridge and tunnel projects. In 2008 the world economy faced its most dangerous crisis since the Great Depression of the 1930s. The contagion, which began in 2007 when sky-high home prices in the United States finally turned decisively downward, spread quickly, first to the entire U.S. financial sector and then to financial markets overseas. The economic crisis hit Europe after the Benefit bridge and tunnel cases (except for the Second Coen Tunnel – the Netherlands – open to traffic in 2014 and Blanka Tunnel Complex – Czech Republic – inauguration in 2015). Some projects have been in operation phase for several years, including: Rion-Antirion Bridge – Greece - inauguration in 2004, Lusoponte – Vasco da Gama Bridge – Portugal - inauguration in 1999, the Øresund Link – Denmark-Sweden - inauguration in 2000, Herrentunnel Lübeck – Germany – inauguration in 2005, Berlin Tiergarten Tunnel – Germany – inauguration in 2006, Södra länken – Sweden – inauguration in 2004, Millau Viaduct – France – inauguration in 2004.

Therefore, the analysis will be mostly related to operational phase and considered in terms of changes in traffic, actual traffic vs forecasted, as well as revenues, but also in terms of outcomes social, institutional and environmental spheres.

Moreover, the bridge and tunnel cases vary in size. There are big investments internationally driven, like the Øresund Link, nationally driven, like Rion-Antirion Bridge, Lusoponte – Vasco da Gama Bridge, Millau Viaduct Berlin Tiergarten Tunnel, and regionally driven, like Herrentunnel Lübeck, Blanka Tunnel Complex. That might cause different reaction to crises and different level of resilience on it. Also, economies of countries in which bridge and tunnel cases were realized vary a lot resulting in different resilience to the global crisis.

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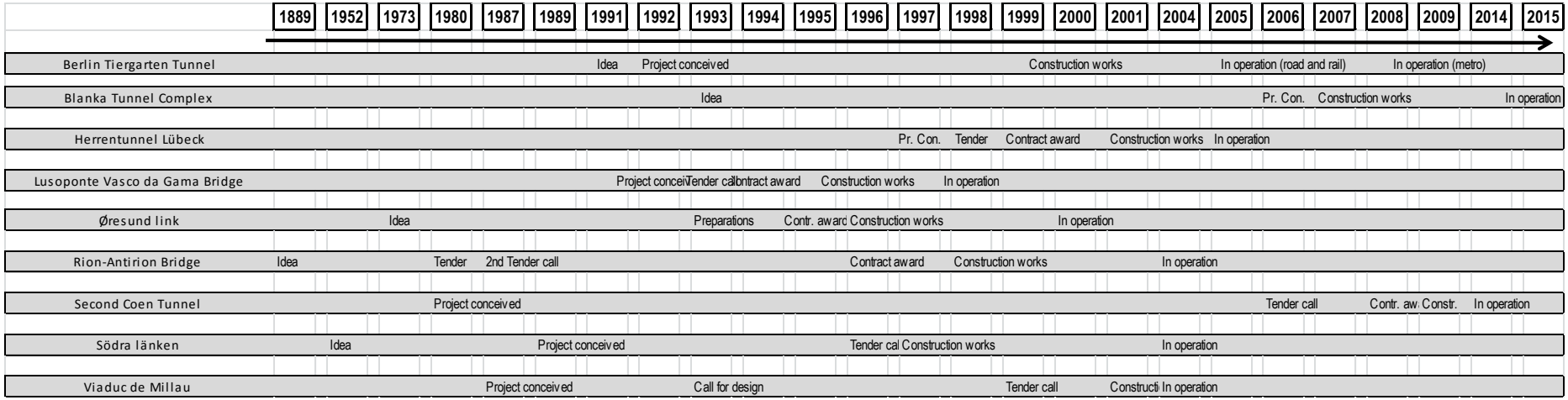

Figure 2.13: Timeline of the BENEFIT bridge and tunnel cases

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2.3.2 Data analysis

2.3.2.1 PPP case studies analysis

Rion-Antirion Bridge

The Rion-Antirion Bridge (Charilaos Trikoupis Bridge) is named after Prime Minister Charilaos Trikoupis, who, in 1889, first envisaged a bridge connecting the region of Aetoloakarnania (town of Antirion) with the region of Achaia in the Peloponnese over the Patras Gulf. The project was not technically feasible then, and it took the Greek State over 100 years to initiate construction of a fixed link. The bridge was inaugurated on 12 August 2004 and the first to pass was the Olympic Flame of the 2004 Olympics.

The Bridge is a Design-Build-Finance-Operate contract effective as of 24 December 1997, with a concession period of 42 years or less, depending on whether the concessionaire Gefyra S.A. achieves a return on equity (ROE) of 11.5% earlier. Revenues are exclusively based on tolls. Consequently, any fluctuation in traffic volumes or in the traffic mix has a direct effect.

The concession for the Rio-Antirio Bridge was awarded in 1997 to “G.E.F.Y.R.A. S.A.” with shareholders as follows:

- VINCI Concessions S.A.A, 53.00%
- Hellenic Technodomiki, 15.48%
- J&P – Avax S.A., 11.20%
- Athena S.A., 7.74%
- Proodeytiki S.A., 7.74%
- Pantechniki S.A., 4.84%

Apart from VINCI Concessions, dominant French construction company and world leaders in infrastructure concessions, the rest were large Greek construction companies.

Today, GEFYRA S.A. has the following shareholders:

- VINCI Concessions S.A.A, 57.45%
- AKTOR Concessions S.A., 22.02% (merger of Hellenic Technodomiki into the AKTOR group)
- J&P – AVAX S.A., 12.14%
- Athena S.A., 8.39%

In year 2014, the bridge celebrated its 10 years of operation. During this period, more than 41 million passages were recorded. The annual average daily traffic (AADT) in 2005 was 12,000 vehicles, rising to a peak at 14,000 vehicles in 2009, beyond the forecast traffic. Following the crisis, this figure dropped to 8,300 vehicles in 2013, with a further reduction of 5% expected in 2014.

The bridge is open to all users: pedestrians, private vehicles and freight traffic. Private vehicles correspond to 85% of the traffic; trucks and heavy vehicles are 8%, motorcycles 5% and the remaining 2% buses.

According to the concession contract, the Public Partner undertakes not to carry out or to permit during the concession period the construction of any alternative connection within 80 km east and 60 km west of the Rion- Antirion Bridge, as well as not to subsidize any existing or future ferry services. The ferry crossing takes about 45 minutes versus 5 minutes over the bridge. In 2013, 82% of private vehicles used the bridge crossing and 18% the ferries, as opposed to a ratio of 93% and 7%, respectively in 2009. The trend is the reverse of that for heavy vehicles: in 2013 55% of the heavy vehicles used the bridge as opposed to 35% in 2009 (UAEGEAN, 2015a).

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The investment was finalized before the global economic crisis hit Europe, thus this case will be analyzed concerning indicators in relation to operation phase. Actual traffic volumes were 12-17% higher than originally forecasted. During 2004-2007 the overall number of vehicles sharply increased. Following the economic crisis this figure dropped to 8,300 vehicles in 2013, with a further reduction of 5% expected in 2014.

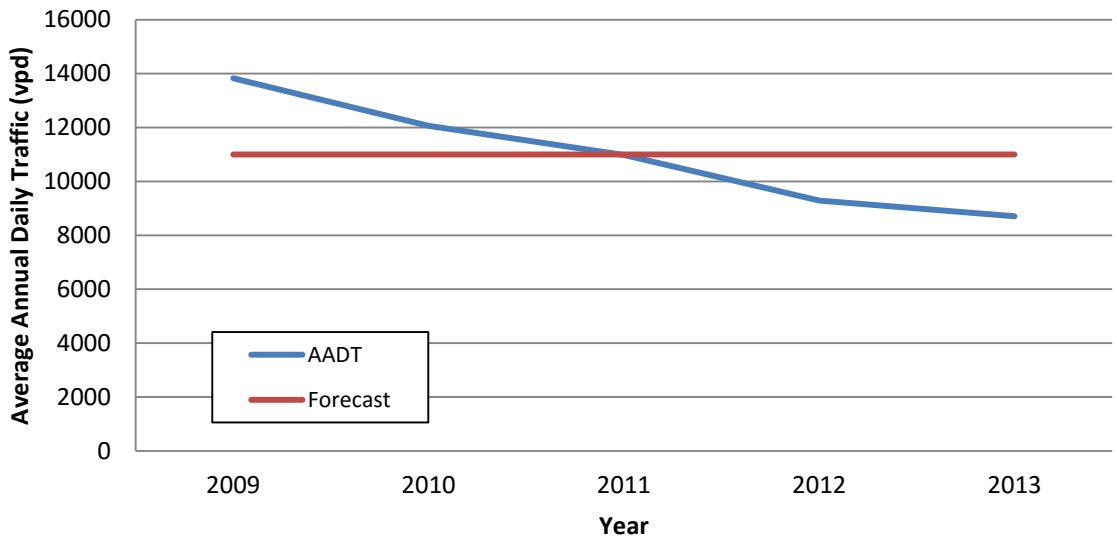

Figure 2.14: Annual average daily traffic for Rion-Antirion bridge

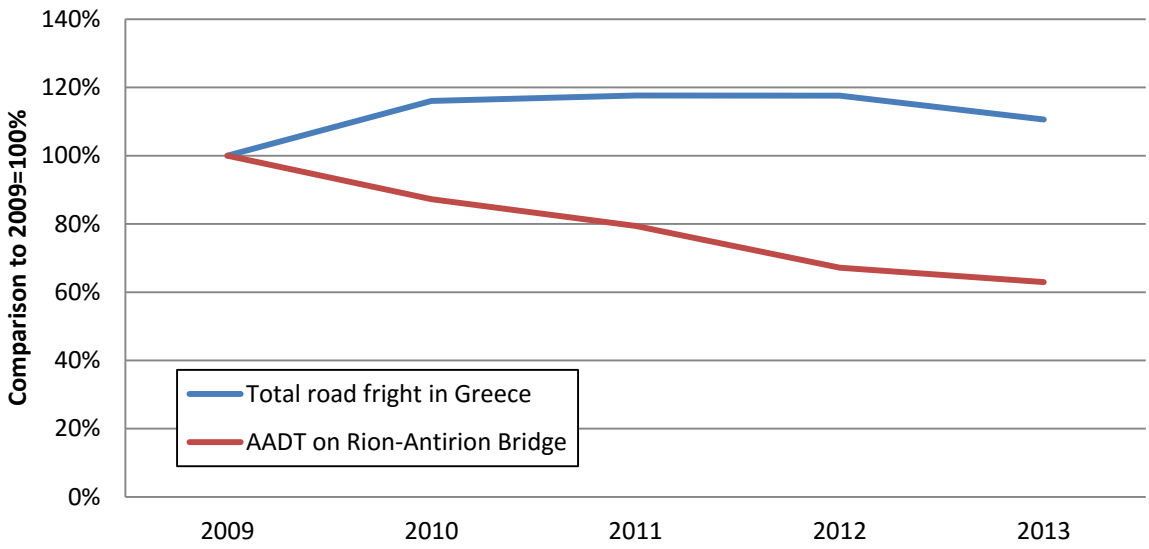

Figure 2.15: Comparison of road fright vs. AADT on Rion-Antirion Bridge - 2009-100%

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Main shareholder:

Figure 2.16: Stock prices 2007-2011: Vinci SA (EPA:DG)
Source: Google Finance, price in EUR

Strong sell-off the value of shares recorded another shareholder of Rio-Antirio consortium - French company VINCI, whose value in the crisis decreased three times.

Viaduc de Millau

Inaugurated on the 14th December 2004, Viaduc de Millau across the valley of the river Tarn is the chosen solution for taking the A75 motorway from Clermont-Ferraud south to Beziers. This is cheaper than the alternative of tunnelling through the hills flanking the river, and will shorten the journey by 100 km and by up to 4 hours in the holiday season, as well as removing much traffic pollution caused by continual traffic jams for local inhabitants in Millau.

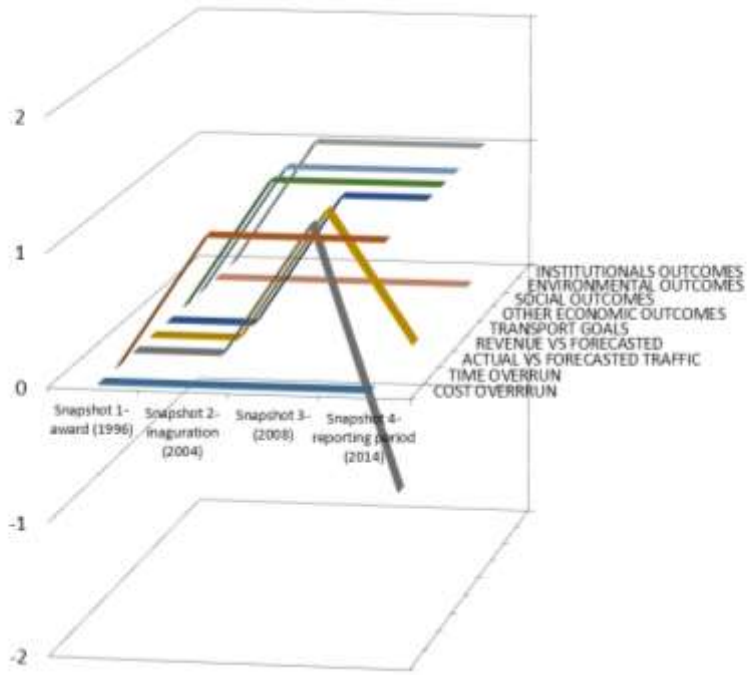

Figure 2.17: Outcomes of the Rion-Antirion bridge project within the Benefit matching framework

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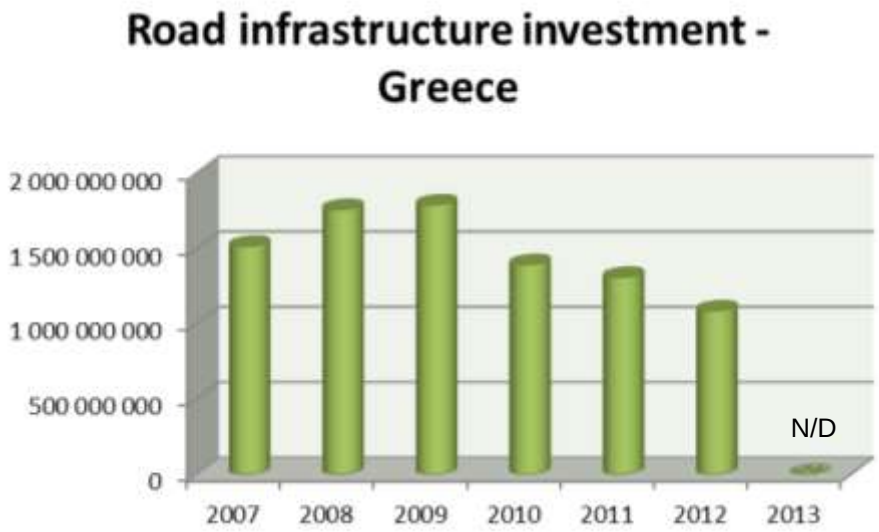

Figure 2.18: Road infrastructure investment in Greece
Source: OECD - The International Transport Forum, http://stats.oecd.org/
Year 2013 – no data available

Compagnie Eiffage du Viaduc de Millau (CEVM) is the concessionaire. The company is owned 51% by Eiffage SA, and 49% by the Caisse des Dépôts et Consignations (Deposits and Consignments Fund - French financial organization and part of the government institutions under the control of the Parliament). The project is characterized by an extremely long concession period - until 31st of December 2079.

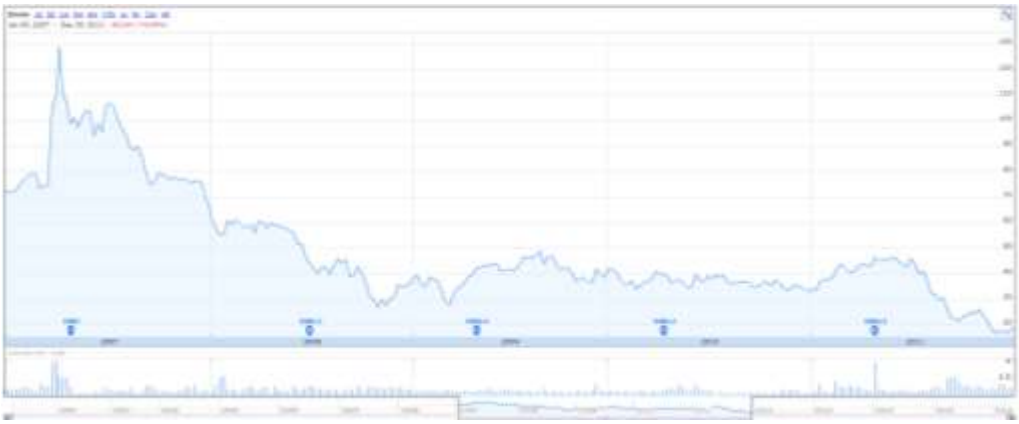

Figure 2.19: Stock prices 2007-2011: Eiffage SA (EPA:FGR)
Source: Google Finance, price in EUR

The investor - Eiffage shares extremely heavily decreased during the crisis, and decline continued even in 2011, reaching level of dozen €. It was only after 2012 when a slow, but steady increase in the value of the company began, up to the current level of 67 € per share (04.2016).

In the winter season the flyover is used by 4-5 thousand vehicles per day, while in the summer season it is used by up to 63.000 vehicles a day - altogether 4.7-4.8 million vehicles a year. On August 27th, 2015, 50.000.000th vehicle passed the viaduct.

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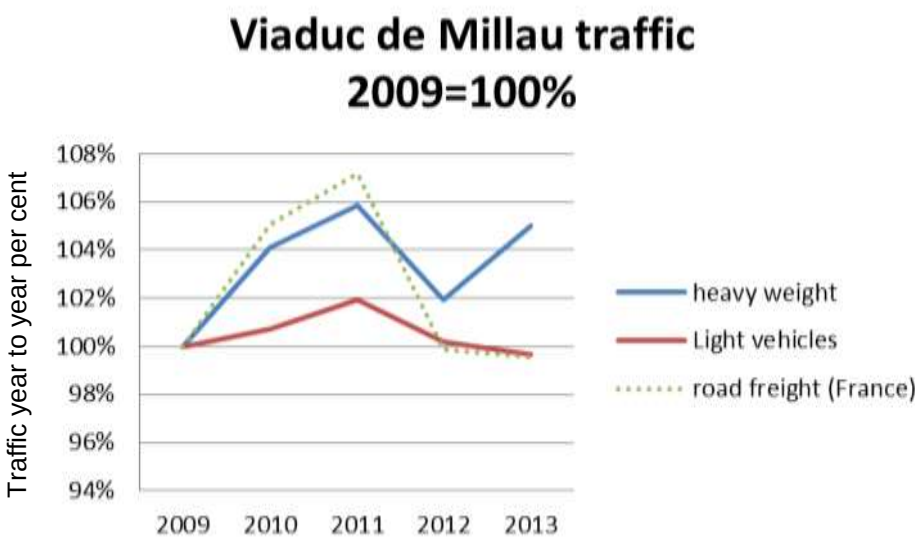

Figure 2.20: Viaduc de Millau traffic 2009-2013
Source: Compagnie Eiffage du Viaduc de Millau (CEVM), Bilan 2010/2011/2012/2013, http://www.leviaducdemillau.com/

While passenger / private cars are mainly seasonal, and do not show significant dynamics, so freight is growing faster than is the general market trend and this kind of traffic is most profitable for concessionaire according to toll rates (€6,50-€9,80 for passenger car and €29,00-€34,80 for heavy vehicles)[9].

Figure 2.21: Road infrastructure investment – France
Source: OECD - The International Transport Forum, http://stats.oecd.org/

[9] Tarifs 2016 VALABLES JUSQU'AU 31/01/2017, http://www.leviaducdemillau.com/sites/default/files/eiffage_viaduc_millau_tarifs_fr_2016-2.pdf

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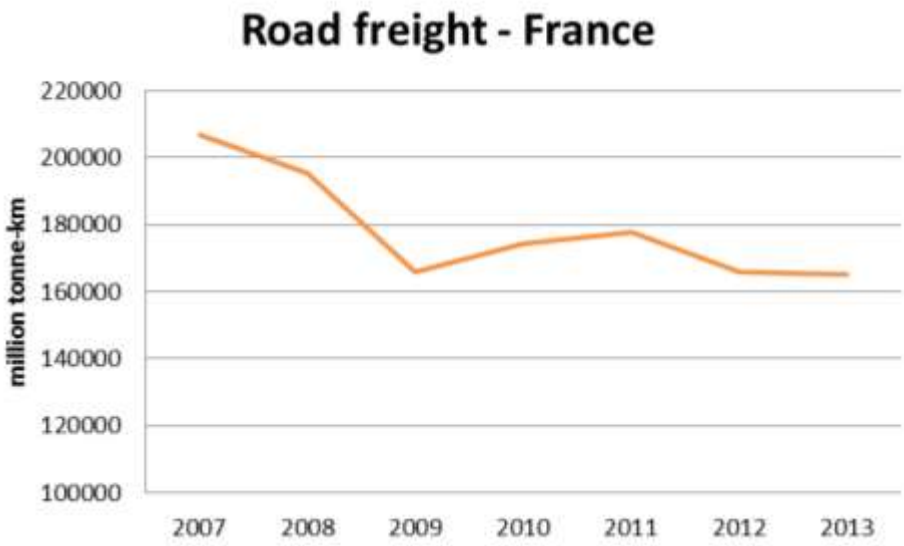

Figure 2.22: Road freight in France
Source: OECD - The International Transport Forum, http://stats.oecd.org/

Lusoponte Vasco da Gama Bridge

Vasco da Gama Bridge is 17km (11 miles) long (10km/6 miles of which pass over water), making it the longest bridge in Europe when opened, in 1998, and still it is today one of the longest bridges in the world (It has the same length as the road-rail tunnel-bridge linking Denmark and Sweden).

Lusoponte is the concessionaire operating the 25 de Abril bridge (brownfield project) and the Vasco da Gama bridge (greenfield project) over the River Tagus in Lisbon. The latter was originally awarded in 1994, as a design, finance, build, operate contract while the first was added to the original contract in 1996 along with the provision of exclusive rights over all new concessions for River Tagus crossings. The bridge is a legacy project of the 1990s for Lisbon and Portugal as it not only provided an additional crossing over the River Tagus, but also proved important in connecting the Southern and Northern parts of the country in support of development. It was completed in PPP formula. The initial concession was financed by private funds and European Union funds, along with the revenues from the Ponte 25 de Abril, but without public funds.

An important source of private debt was released from the European Investment Bank (EIB). In 1993, before the Euro, Portugal was only able to finance in medium term (usually on a 3-5 years maturity, even for government bonds). A 20 year loan was only possible by the EIB. Therefore most of the debt came from EIB and not commercial banks.

Initial shareholder structure was: Kvaerner Group (24.8%); Campenon Bernanrd SGE (22.0%); Bento Pedroso Construções (14.8%); Mota e Companhia (13.8%); Somague (13.8%); Teixeira Duarte (7.5%); H.Hagen (2.8%); Edifer (0.4%). That was changed and shareholders structure in 2014 appeared as follows: Macquarie Infrastructure (UK) Limited (31%); Vinci Construction Grands Projects (31%); Mota/Engil, S.A. (14%); Somague Itinere - Concessões de Infraestruturas, S.A. (17%); Teixeira Duarte - Engenharia e Construções, S.A. (8%). The construction of the new bridge was contracted with Novaponte, which is owned by the same shareholders of Lusoponte. Operating and maintenance (O&M) was also contracted with other company, Gestiponte, owned by the same shareholders. Several renegotiations have taken place over the past 15 years and they have significantly changed the concession characteristics. Such situation made changes in the risk allocation matrix and cost of

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debt has decreased. The most significant change has been that the project is no longer privately funded but, instead, has received various types of public funding such as direct financial compensation, an increase in the concession period and a reduction in concession maintenance costs. The traffic level expectations were generally met, except for after the crisis period which caused the traffic to be significantly below expectations (TIS, 2015).

The investment was finalized before the global economic crisis hit Europe, thus this case will be analyzed concerning indicators in relation to operation phase

As Vasco da Gama bridge is a part of road infrastructure, therefore analyzed traffic demand, infrastructure investment are related to such mode of transport.

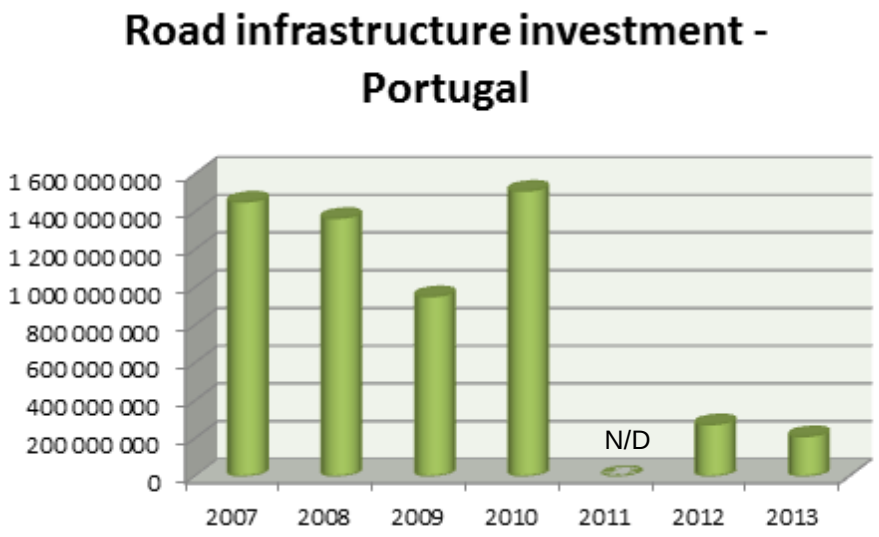

Figure 2.23: Road infrastructure investment in Portugal
Source: OECD - The International Transport Forum, http://stats.oecd.org/
Year 2011 – no data available

As it is noticed, expenditures on road infrastructure in Portugal are not greater than 1/5 of the amount that was issued on new road investment before the crisis. Such a large drop in investments negatively affects the condition of entire sector.

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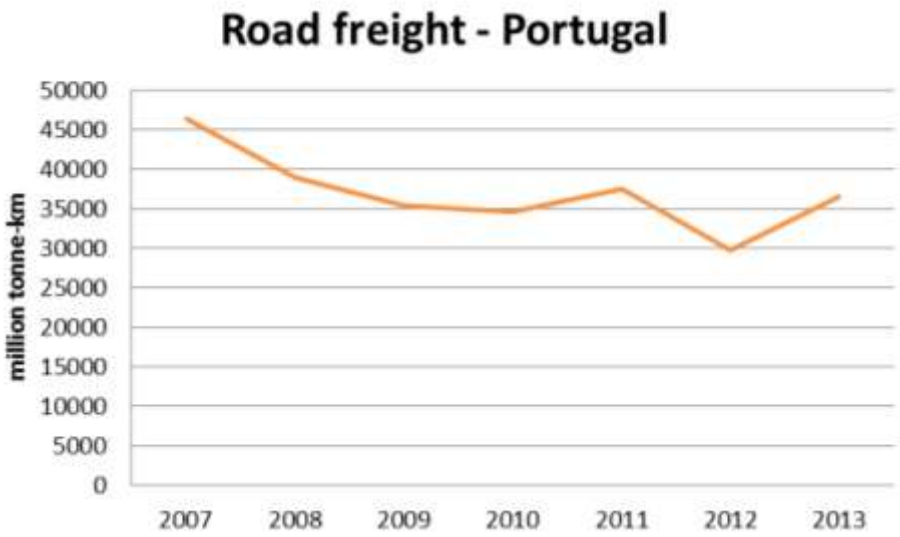

Figure 2.24: Road freight in Portugal
Source: OECD - The International Transport Forum, http://stats.oecd.org/

In comparison with the base year 2007, road freight felt down, for about 30% in 2012. That was one of the largest declines in Europe, reflecting the depth of the crisis.

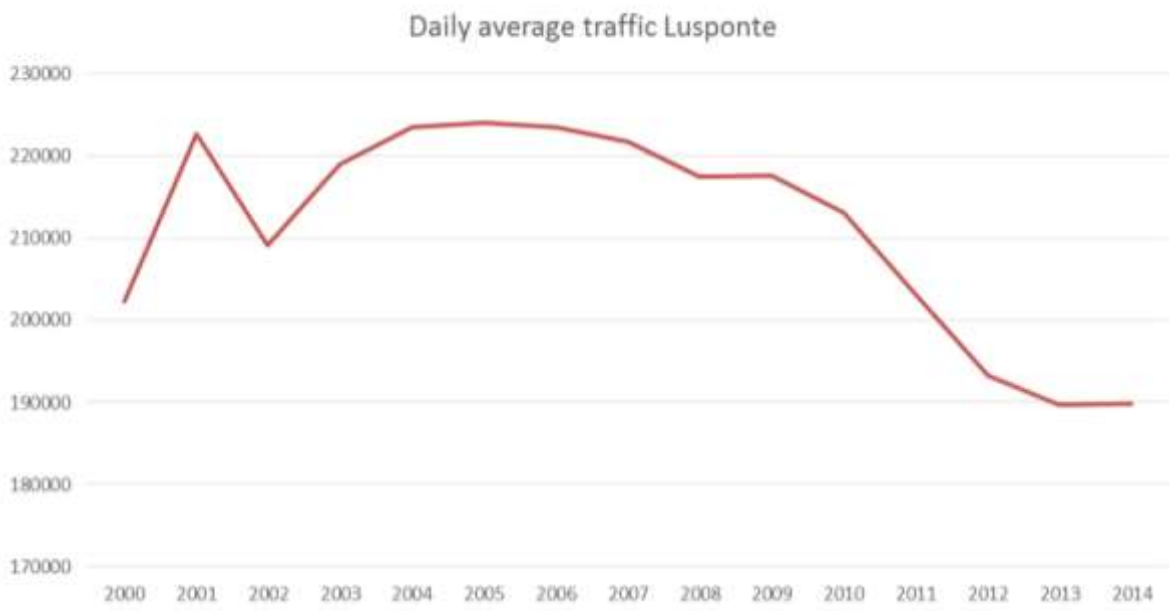

Figure 2.25: Average daily traffic at Lusoponte bridge

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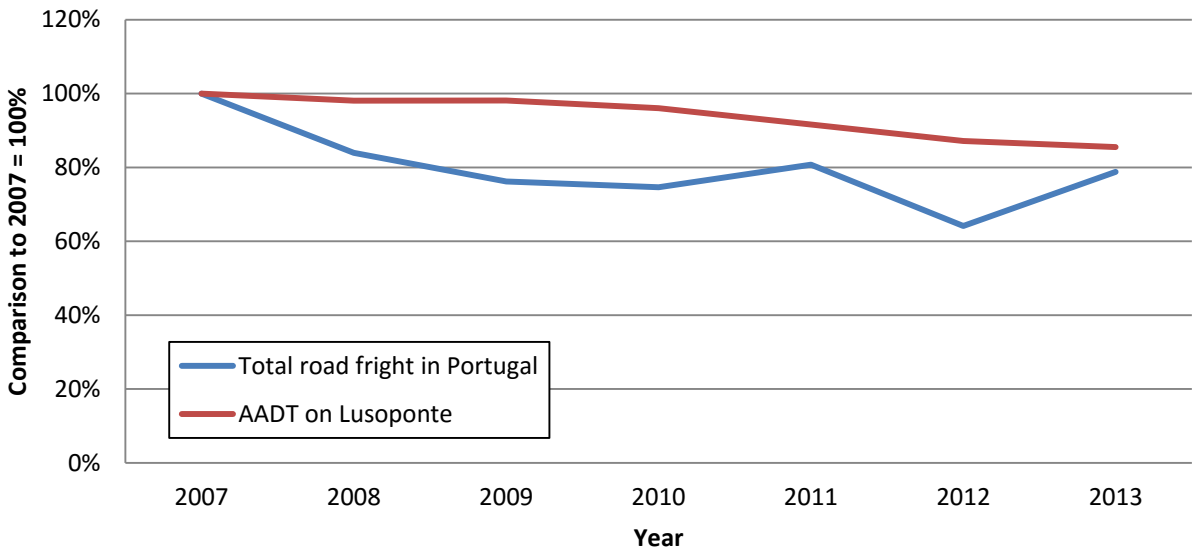

Figure 2.26: Comparison of road freight vs. AADT on Lusoponte - 2007-100%

Main Shareholders of the project:

Figure 2.27: Stock prices 2007-2011: Macquarie Infrastructure Corp. (NYSE:MIC)
Source: Google Finance, price in USD

Companies related to infrastructure particularly hardly reacted to the crisis. Most distinct example is the graph of the stock Macquarie Infrastructure Corp - the main shareholder of the consortium Lusoponte, whose rate fell from 40 USD to 0.79 USD, or for 98%.

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Figure 2.28: stock prices 2007-2011: Vinci SA(EPA:DG)
Source: Google Finance, price in EUR

Strong sell-off the value of shares recorded another shareholder of Lusoponte consortium - French company VINCI, whose value in the crisis decreased three times.

Another shareholder, a Portuguese company Mota-Engil closely corresponded to its share price with the condition of the entire Portuguese economy. The value of the company's shares fell from 8 EUR to the level of EUR 1 and still has not reached the value recorded before the crisis.

Figure 2.29: Stock prices 2007-2011: Mota-Engil SGPS SA (ELI:EGL)
Source: Google Finance, price in EUR

Herrentunnel Lübeck

The “Herrentunnel” is a tunnel situated on a federal highway (Bundesstraße) that connects the inner city of Lübeck with one of its outer districts, Travemünde. Construction works began in October 2001 and the tunnel was finished at the end of August, 2005. The concession period has been determined to 30 years, therefore, the tunnel will be returned to the city of Lübeck in 2035. The “Herrentunnel” project is a locally driven, public private partnership (PPP) project, realized according to the F-model for PPPs for German federal roads. The city of Lübeck – appearing as the contracting authority – has signed a contract with the concessioner (consortium of HochTief and Bilfinger Berger) in 1999, in order to replace the old, dilapidated bridge with a tunnel.

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This is a non-standard contract based on the “Fernstraßenbauprivat-finanzierungsgesetz”. The latter is a German law for private financing of transport infrastructure, which has been passed in 1994 in order to regulate the construction and operation of federal highways for private partners. It is evident that the German Federal Government has increased its political support towards PPPs with the passing of this law. Therefore, at the moment of contract award in 1999, there was a clearly communicated commitment towards PPPs.

The “Herrentunnel” project is co-financed by the German Federal Government and the concessioner, Herrentunnel GmbH & Co. KG. The German Government has contributed 90 Mio Euros to project financing. This corresponds to 50% of the total project value. Herrentunnel GmbH & Co. KG has contributed 18 Mio Euros in equity, and 18 Mio Euros in debt (equally contributed by shareholders HochTief and Bilfinger Berger). The remaining 54 Mio Euros comprise of 27 Mio Euros commercial debt and 27 Mio Euros Kfw debt.

With respect to performance, the “Herrentunnel“ project’s revenues fell short of expectations as the traffic volume was much less than forecasted. Because of that, tolls have already been increased four times. For 2016, a fifth increase has been announced. As the revenues have been so little in the past, the parties agreed on extending the obligation of paying tolls until 2045. Even though the construction cost or time did not exceed expectations, one critical failure factor is the above mentioned serious miscalculations regarding traffic volume: as the demand for the tunnel has been much lower than forecasted, tolls had to be increased several times. The continuous elevation of the tolls, however, reduces traffic levels even more, especially as there are alternative routes, such as the A20 motorways that do not include user charges. It is, therefore, not surprising that Lübeck’s population prefers using the 5 km longer bypass. It can be assumed that this is also a type of protest (KIT, 2015).

Figure 2.30: Stock prices 2007-2011: Bilfinger SE(ETR:GBF)
Source: Google Finance, price in EUR

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Figure 2.31: Stock prices 2007-2011: HOCHTIEF AG(ETR:HOT)
Source: Google Finance, price in EUR

The investment was finalised before the global economic crisis hit Europe, thus this case will be analyzed concerning indicators in relation to operation phase.

As Herrentunnel Lübeck is a part of road infrastructure therefore analyzed traffic demand, infrastructure investment is related to such mode of transport.

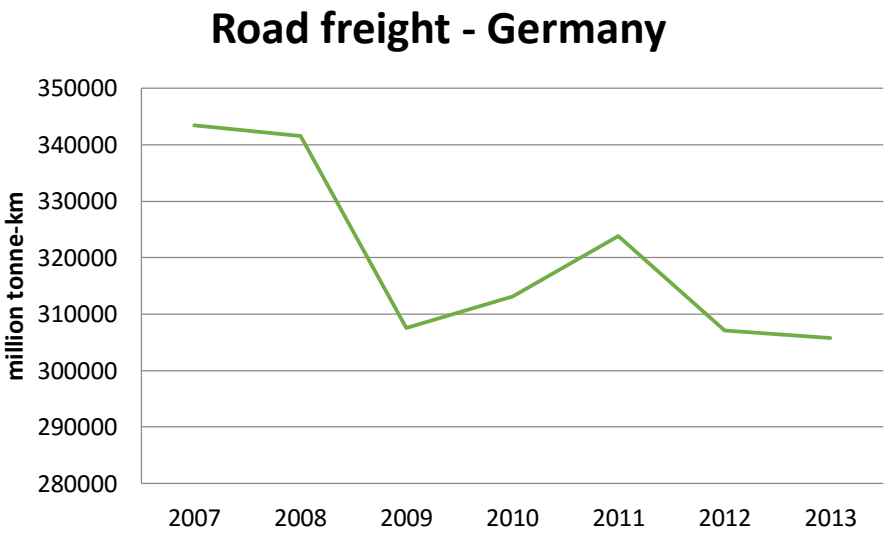

Figure 2.32: Road freight in Germany
Source: OECD - The International Transport Forum, http://stats.oecd.org/

In 2009 there was a significant, approximately 10% decrease in road fright and over next few years it has not returned to the level of 2008.

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The Second Coen Tunnel

The Second Coen Tunnel project is the first and largest (estimated value EUR 300 million NPV) Competitive Dialogue (CD) procured service-led infrastructure project in the Netherlands. It involves the maintenance of an existing, forty-year old tunnel and the construction of a second tunnel alongside the current one. More specifically, the project concerns the widening of approximately 14 km of highways at the north and south entrances to the existing Coen Tunnel, and expanding the tunnel's capacity from two lanes to three in each direction plus two further reversible lanes, enabling five lanes of traffic in one direction during peak hours. The road works (and subsequently operations and maintenance) consisted of reconstructing one interchange, the main motorway, access roads, emergency lanes, an infrastructure fuel station, and parking facilities. The Tunnel was officially opened 16th May 2013. However it was opened to the traffic in July 2014.

The Dutch Highway Agency – Rijkswaterstaat - was the authority responsible for contracting on behalf of the public sector and, following this, the implementation of a new project monitoring system. The project was procured as a Public Private Partnership to design, build, finance and operate. The PPP contract was awarded under the competitive dialogue procedure in accordance with the Directive 2004/18/EC of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts.

The Coen tunnel Company is a PPP consisting of Dura Vermeer, TBI-Bouw, Vinci concessions, Besix Group, CFE, Arcadis, and Dredging International. Construction was carried out by Dura Vermeer, TBI-Bouw, Arcadis, Vinci Grand Projects, and Besix Dredging International, and a key subcontractor was Croon Maintenance. Financing is achieved through senior debt (EUR 550M) provided by Fortis, Bayern LB, Royal Bank of Scotland, Bank Nederlandse Gemeenten (BNG), KfW IPEX-Bank and the European Investment Bank (EIB). Mezzanine-loans (EUR 21M) were provided by Fortis and BNG. Equity bridge-facility was offered by Fortis.

The Coen Tunnel is a DBFM-contract (Design, Build, Finance and Maintain) with duration of 30 years and a total value of approximately € 500M. Coen Tunnel Company is responsible for design, building and maintaining of the Second Coen Tunnel with access roads and facilities. The Dutch State (through Rijkswaterstaat) will continue to own and manage the asset. The banks financing of the project are repaid through availability fees and a one-off transfer fee when the project is completed. Rijkswaterstaat is the guarantor for the banks. The contract contains re-negotiation terms resulting from the economic crisis (UT, 2015).

As the Second Coen Tunnel is a part of road infrastructure, therefore analyzed traffic demand, and infrastructure investment are related to such mode of transport.

During the crisis road freight in Netherlands was generally stable. Possibly, declines from 2011 should be analyzed in the context of an existing alternative infrastructure and increasing rail freight in transit (Betuweroute - a double track freight railway from Rotterdam to Germany).

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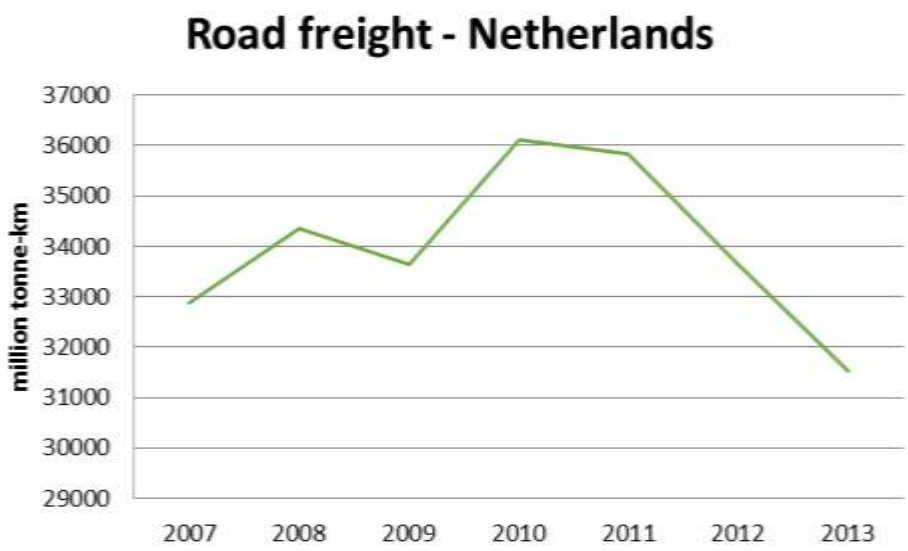

Figure 2.33: Road freight in Netherlands
Source: OECD - The International Transport Forum, http://stats.oecd.org/

Øresund bridge and tunnel

The project was financed in a specific formula, where the SPV (Special Purpose Vehicle) financing the construction with money borrowed on the market has full guarantees of Sweden and Denmark. Capital and interest repayment takes the toll fees, and because of the larger than expected traffic, and thus incomes, the process will be completed probably six years ahead of schedule.

230 million people have crossed the Øresund Bridge either by train or car since it was opened in 2000 –141 million by car and the remaining 89 million by train. The 141 million travelling by car were distributed over 62 million vehicles in the period 2000–2011.

Although the crisis started in 2009, contributed to the slight decrease in traffic on the Øresund bridge, the project must be regarded as a great economic success. The new infrastructure has generated several million new trips every year. Since the opening of the Øresund Bridge in 2000 and as a result of Øresund commuting, the Danish economy has received a substantial financial injection totalling 4,4 billion EUR.

Like the rest of Europe, the Øresund Region has been affected by the financial crisis. The crisis has led to a halt to the increase in relocation, commuting and traffic across the Øresund. In 2011, the number of daily commuters totalled 18,000, slightly lower than in 2008, when commuting was at its highest level with almost 20,000 commuters across Øresund. In 2011, an average of 91,500 individuals crossed Øresund (by car, coach, train and ferry) and 24,700 vehicles crossed Øresund every day. This is an increase of one percent in passenger numbers and a decrease of two percent on the year in the number of vehicles (Steenstrup, 2012).

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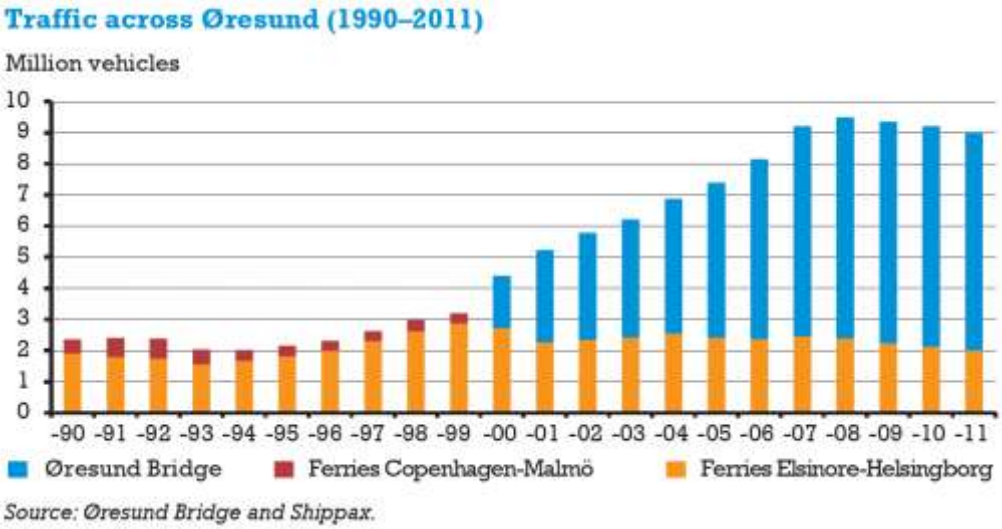

Figure 2.34: Traffic across Øresund by kind of transport 1990-2011

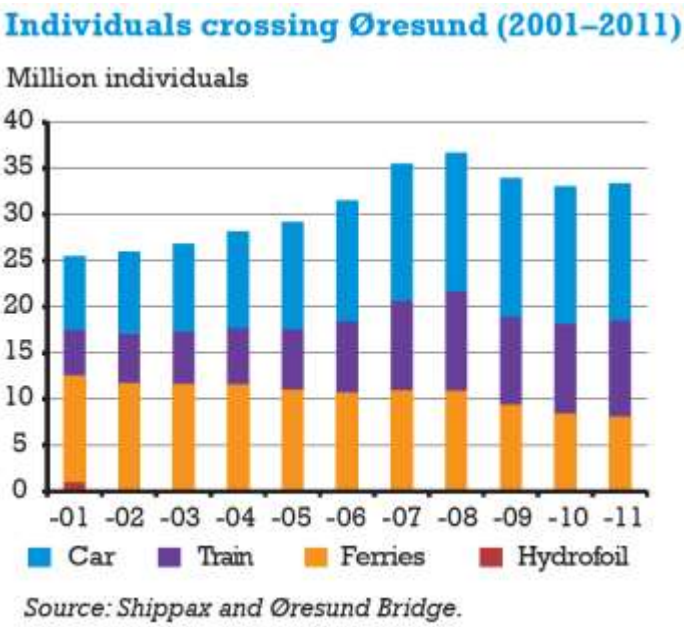

Figure 2.35: Individuals crossing Øresund by kind of transport 2001-2011

Moreover, for both countries joined by the new infrastructure, issues of employment are extremely important, especially for people living in Sweden, who found a job in Denmark (about 50.000 people) and commute to work.

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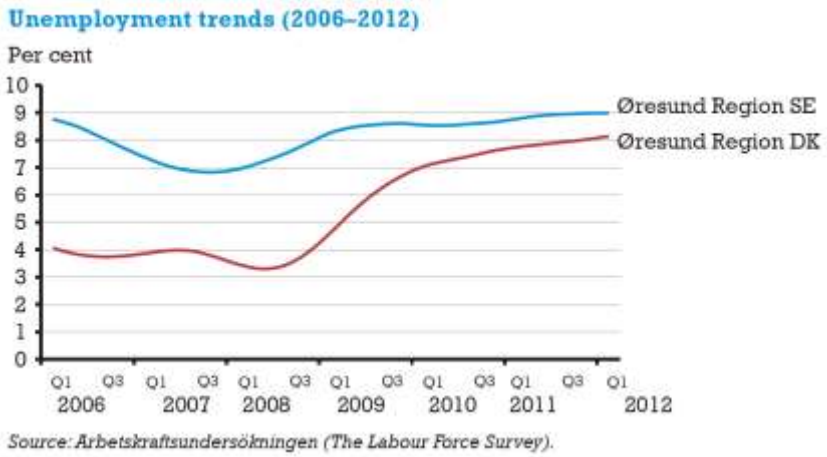

Figure 2.36: Unemployment trends during crisis

The importance of the bridge for regional development is confirmed by traffic statistics: 90 %, or most of the journeys by Øresund trains are within the Øresund Region, where 90 percent of passenger travel is regional. Four out of five train passengers live in Sweden, and only one in five in Denmark. Sweden saves 178 million euro per annum in unemployment benefit because unemployed Swedes find work in Denmark.

The project itself, thanks to a convenient and relatively cheaply combined the two countries contributed to the development of not only the labor market, but also tourism, which recorded a solid, a few percent annual increases (except in two years of decrease: -3% in 2008 and -5% in 2009).

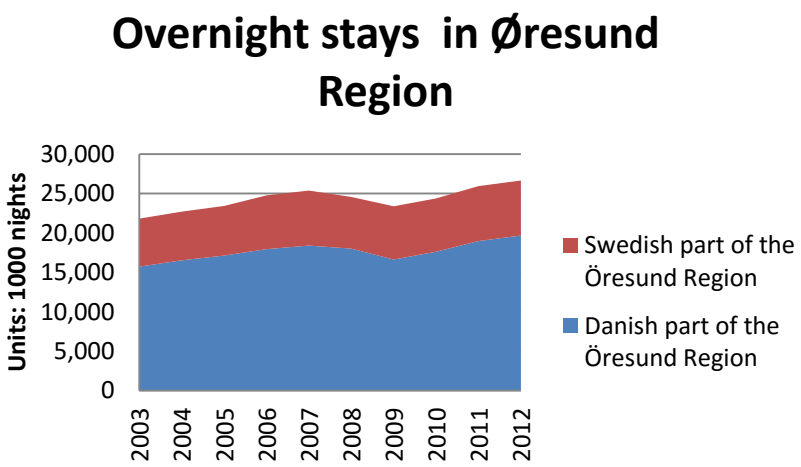

Figure 2.37: Overnights stays in Øresund Region 2003-2012
Source: Örestat, on-line: http://www.orestat.se/

Only hotels and holiday dwellings having a capacity of at least 40 bed places and camping sites having a capacity of at least 75 pitches are included.

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Figure 2.38: Road freight in Denmark
Source: OECD - The International Transport Forum, http://stats.oecd.org/

In 2009 there was a 7% decrease of freight traffic in Denmark. But relatively quickly, already in 2011 it returned to the previous level.

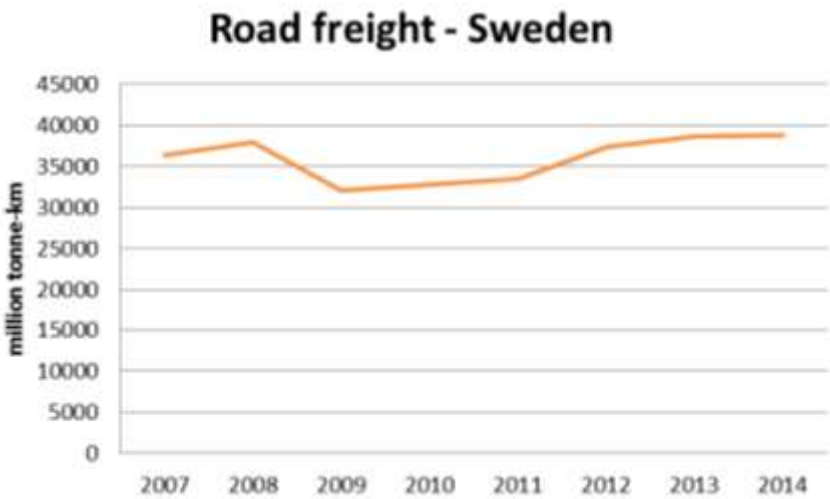

Figure 2.39: Road freight in Sweden
Source: OECD - The International Transport Forum, http://stats.oecd.org/

In Sweden, the collapse of the transport market was much stronger, it reached 15%. Slower was also a return to the pre-crisis condition - the level of 2008 was exceeded only in 2013.

Although the crisis has not affected the decline in total traffic, significantly reduced revenue is result of high fees for of heavy vehicles that resulted traffic drop in 2009 by more than 14%.

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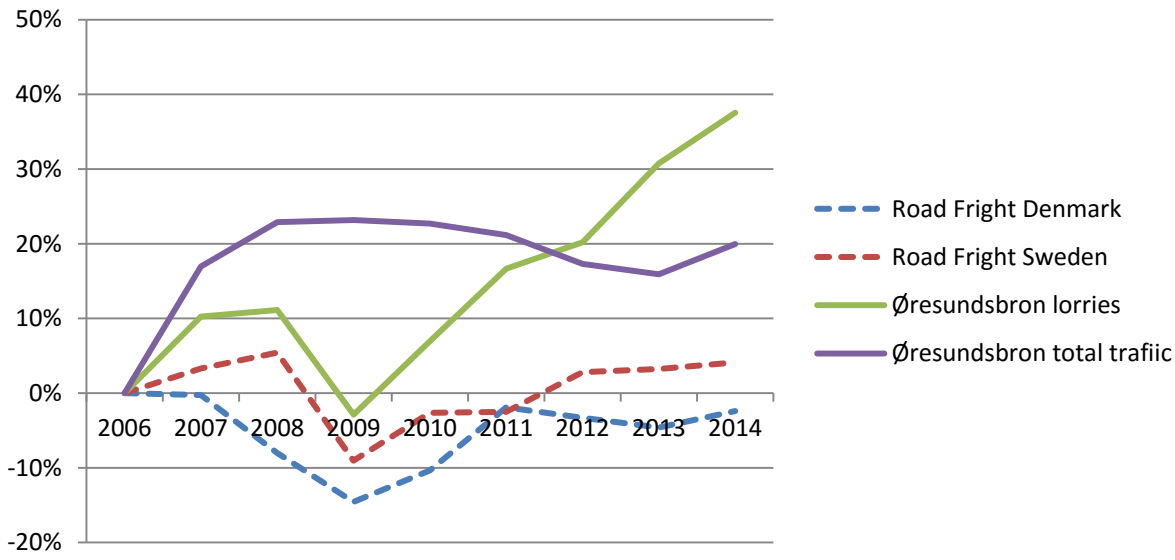

Figure 2.40: Øresundsbron traffic vs. road freight in Denmark and Sweden

Source: Øresundsbron traffic https://www.oresundsbron.com/en/traffic-stats
Road freight: OECD - The International Transport Forum, http://stats.oecd.org/

2.3.2.2 Public case studies analysis

Södra Länken

Södra Länken (the Southern Link) is an urban motorway tunnel linking major roads in the south of Stockholm. It is associated with the nearby Hammarby Sjöstad waterfront regeneration area and Årsta fältet development (the latter on the site of a section of road made redundant by the Link).

The main objective of the project was to link Stockholm's major roads, relieving traffic congestion in the south of the city and consequently reducing air pollution and traffic accidents. The concept of a southern ring road was first discussed in the 1930s and included in the 1952 Stockholm plan and 1960 traffic plan. In the 1970s and 1980s, increasing environmental awareness and low rates of economic growth led to a hiatus in road construction, despite an increase in road traffic and concerns about congestion constraining economic development. The ring road concept was developed as part of a wider vision of improving the transport network.

The idea of building part of the ring road as a toll-financed tunnel emerged during the mid-80s and was formally proposed in 1989. This solution would avoid the complex process of gaining permission to build a motorway through a densely populated area and would limit the impact of increasing traffic volumes.

Although Environmental Impact Assessments and cost-benefit analyses were conducted, public opposition and the lack of approved designs for toll stations delayed progress. The cost was estimated at SEK 4.77bn in 1992 (USD 0.98bn in 2010 prices). The scope of the project was reduced in 1993, reducing the estimated cost, but cost estimates increased subsequently, perhaps partly due to rising wages in the construction industry in the late 1990s. However, the final project cost in 2005, SEK 8.2bn (USD 1.33bn in 2010 prices), was close to that envisaged in the financing structure agreed in 1998 (OMEGA, 2015).

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The construction phase was completed in 2004, thus before the last global financial crisis. Delays and changes in scope were mainly a result of stakeholders' activities.

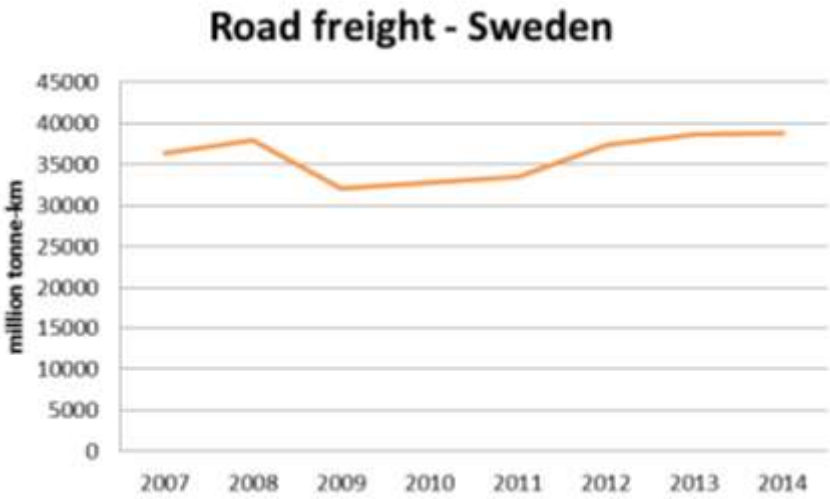

Figure 2.41: Road freight in Sweden 2007-2014
Source: OECD - The International Transport Forum, http://stats.oecd.org/

Blanka Tunnel Complex

The tunnel 'Blanka' forms a part of the city of Prague's ring road system. It runs under a heavily urbanized environment right on the edge of the historic centre of Prague. It stretches from Brusnice - to the west of the Prague Castle area - to the municipal district of Troja in the Northeast connecting the right and left banks of the Vltava river. It was designed to relieve the historic centre of Prague from transit traffic and to speed up the transit across the city. However, from the outset, there has been a strong opposition from various environmental groups and activists claiming the promised improvements in Prague traffic are largely illusionary. The original amount of 21 bn Czech crowns (cca 766 million euros), mistakenly presented as the final total costs for the whole project guaranteed not to be exceeded (as claimed by the City Hall representative (Toman, 2007)), has soared to the current bill of more than 43 bn Czech crowns (1,56 bn euros, as of May 2015). The Tunnel was officially opened in September 2015.

The budget of Blanka Tunnel Complex has been exceeded twice as assumed. The idea to build the Blanka Tunnel Tomplex has always been pursued primarily by the representatives of the city of Prague. There has been a cross party support for the realization with the exception of the Green Party. However, the central government involvement was considered as very limited and mainly related to regulations. Changes in regulations have partly contributed to increases in total costs of the project. Among them additional requirements for safety measures in tunnels by the State mining administration (SMA) played a particularly important role. The SMA also fined the contractor for landslides during the construction works.

The performance of the project is not taken as successful. The budgetary exceeding was also due to insufficient specifications of the project deliverables, flawed contracts with weak limits giving too much flexibility and a little motivation to contractors, missing project management tools, inadequate approach to legal disputes by the city of Prague, force majeure events, geological issues and new regulations, safety and structural requirements (UAEGEAN, 2015b).

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It seems like implementation context on the level of institutional support, regulatory and administrative stability was extremely significant in case of Blanka Tunnel Complex. It contributed highly in budget exceeding and delays.

It is hard to assess influence of economic crisis on the project as it seems in this case the most important were above mentioned implementation context, management problems, risk division etc. As Blanka Tunnel Complex was opened in September 2015 it is also hard to assess how it has been dealing with operation phase – the period till now is too short.

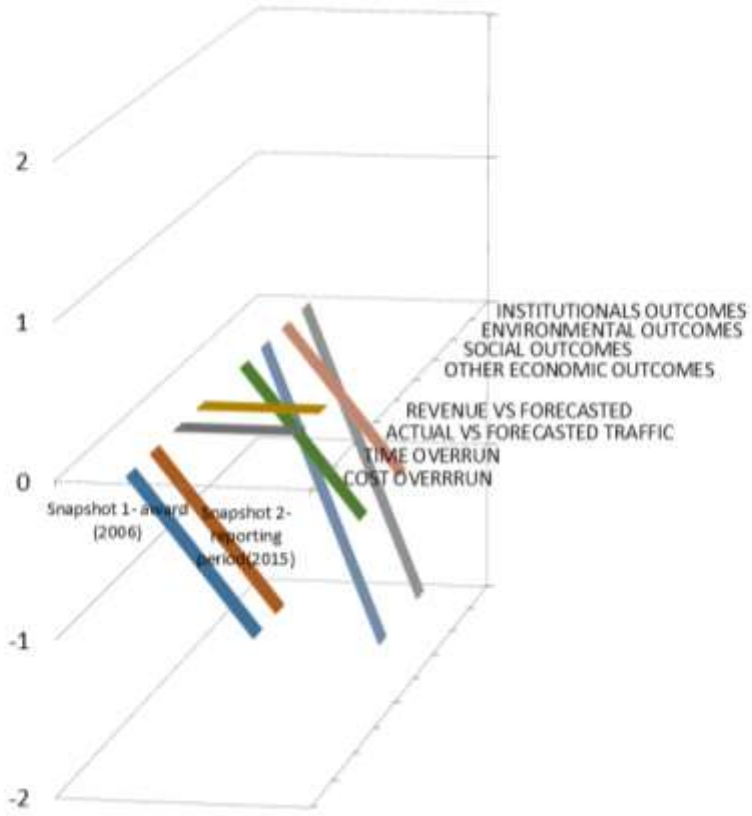

Figure 2.42: Outcomes of the Blanka Tunnel Complex project within the Benefit matching framework

Tiergarten Tunnel

Following the reunification of Germany and the choice of Berlin as capital city, the Tiergarten Tunnel was built to provide a road and rail link through central Berlin, connecting long-distance rail lines, freeing up road space for regeneration and redevelopment projects, and eliminating traffic through Tiergarten Park. The road is part of a federal long distance road and the rail link is part of the EU TEN-T Network, connecting long distance lines via the new Hauptbahnhof (Central Station).

The main objective of the project was to improve the city's transport infrastructure to cope with expected increases in traffic volumes, and to integrate the railway into the national and European network. For the city government, it also provided an opportunity to reduce traffic and improve the urban environment in the city centre. Deutsche Bahn aimed to improve journey times and reliability.

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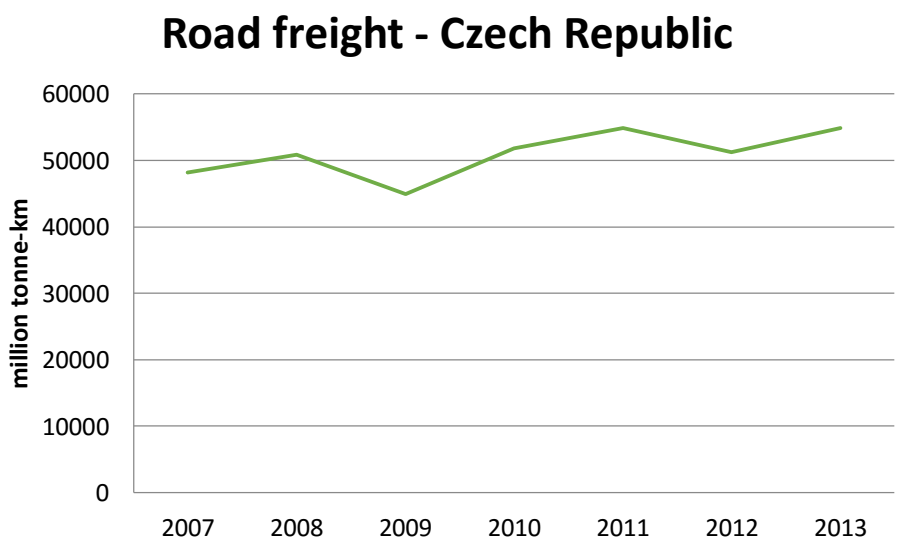

Figure 2.43: Road freight in Czech Republic
Source: OECD - The International Transport Forum, http://stats.oecd.org/

The project faced public opposition and opened, in 2006, several years behind schedule. The original plan also included a metro tunnel (which finally opened in 2009) and a city railway tunnel (yet to open). The project was mainly financed with public federal funds. The Federal Government is obliged to provide German railway infrastructure according to the „Act on expansion of federal track systems" (Gesetz über den Ausbau der Schienenwege des Bundes – BSWAG). For that reason the North-South railway connection was mainly funded by the Federal State. Not only the long-distance railway project but also the local railway, metro and road tunnels are state-funded and partly co-financed by other involved institutions (OMEGA, 2015).

The project was consisted of four physically separated, but jointly planned road and rail tunnels:

- Tunnel Tiergarten Spreebogen (TTS) for road traffic (Total costs 2006: approx. EUR 390m);
- North-South Connection for long-distance railway (Total costs 2006: approx. EUR 3.1bn);
- Metro U5/55 (Cost estimate 2007: EUR 370m & Cost estimate U55 extension to Alexander Place (U5) starting 2010: EUR 400m.);
- City railway (S-Bahn) S2 (Predicted investment costs for completion of the whole North-South route 2006: approx. EUR 200m).

Plus the

- Berlin Transport Node (Total costs 2006: EUR 6.333bn, adjusted for inflation 2006).

Adding those together would yield the 9+ billion Euro. Whereas the road section of the tunnel alone was recorded at Euro 390m in 2006.[10]

Road traffic was overestimated, as forecast traffic for railway was 251 trains per day (1992 for 2010), for road 60,000 Vehicles per Day (VPD) (1994) – 50,000 VPD (2006), and traffic in 2007 was: 288 trains per day and 44,000 VPD.

The construction of the Tunnel was generally completed before the global crisis impact. Moreover Germany was less vulnerable to the recent crisis than the USA or many other European Countries.

[10] http://www.stadtentwicklung.berlin.de/bauen/strassenbau/download/Brosch_TT.pdf, 2006

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The strong recovery of the German economy was driven less by the US than by emerging economies.[11] However, in 2009 there was a significant, approximately 10%, decrease in road fright in Germany. Notwithstanding, the country is a transit one and there should be taken into consideration new, alternative infrastructure that appeared during the period of time.

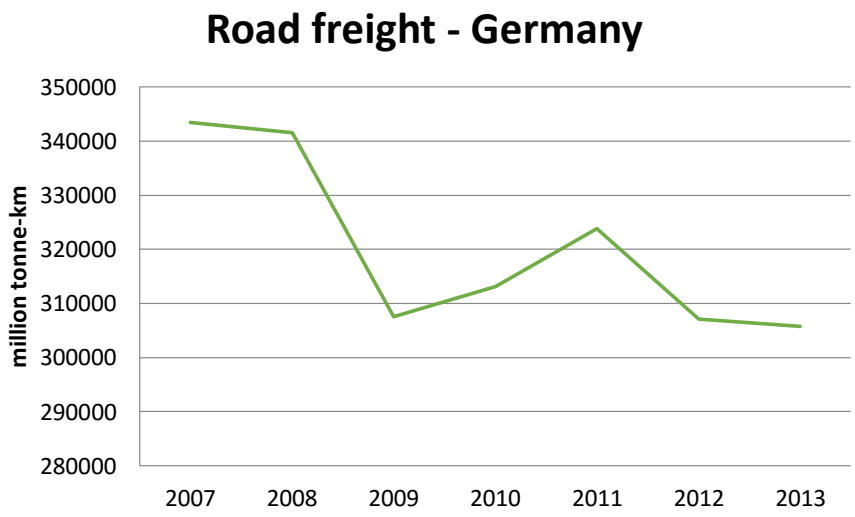

Figure 2.44: Road freight in Germany 2007-2013
Source: OECD - The International Transport Forum, http://stats.oecd.org/

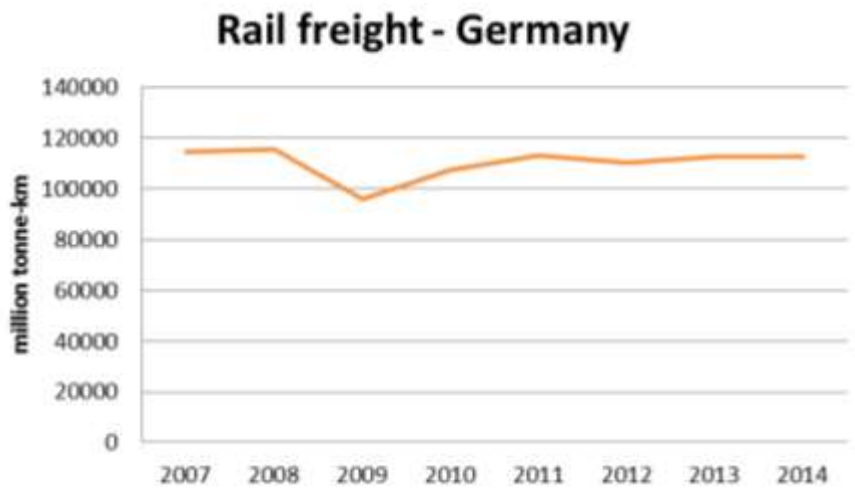

Figure 2.45: Rail freight in Germany 2007-2014
Source: OECD - The International Transport Forum, http://stats.oecd.org/

2.3.3 Conclusions

As previously noted, the infrastructure of bridges and tunnels is inherently exclusive, monopolistic in nature, facilitating the crossing of natural barriers. Some of the projects analyzed (Berlin Tiergarten Tunnel, Sodra Lanken or Blanka Tunnel) provide the infrastructure to facilitate the functioning of large

[11] http://www.spiegel.de/international/business/global-debt-disaster-what-the-financial-crisis-means-for-germany-a-779306.html

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metropolitan areas, improving traffic (in Tiergarten also trains and metros) between the districts of cities.

Certainly, investments are important for local development, improving the attractiveness of real estate in the area, or to reduce congestion, but it is difficult to identify for this type of project direct, broad economic effects, besides those recognized in the methodologies of the CBA, such as saving time, reducing pollution, accident costs etc. the scale of the impact is too small to affect the development of entire regions, as is the case with the Oresund link (described below), for which it is possible to calculate both direct and indirect benefits brought by this particular infrastructure for Oresund region, both the Swedish and the Danish side. Those projects are also difficult to relate to others, implemented as PPPs, for which the necessity of obtaining commercial financing are built highly accurate predictive models, both in terms of future traffic and associated revenues and infrastructure maintenance costs.

Moreover, analyzed cases in PPP formula had (apart from Herren Tunnel) more exclusive character, allowing users to save tens of minutes or tens of kilometers during the journey, making use of the infrastructure, despite the charges, attractive.

Analyzing the impact of the crisis on the construction and maintenance of infrastructure projects in the PPP structure there should be taken into consideration both, the effect of the crisis on the road transportation (the reduction in traffic), and on the condition of companies engaged in projects of bridges and tunnels in the formula of Public-Private Partnership.

In the analyzed case studies the projects were completed before the hit of the crisis, that is why the negative impact of the crisis have relevance for current income e.g. Rion-Antirion Bridge. However, for many road infrastructure projects planned as PPPs, the crisis meant a lack of financial close and in consequence, ceased their implementation. For instance; the $950m Port of Miami Tunnel project has collapsed because the chosen concessionaire Babcock & Brown could not raise the capital to close on the deal. Babcock's market capitalization dropped from about $8 billion to $60 million or by more than 99% in the 2008.[12]

It can be assumed that the decline in traffic on other structures was similar to the drop in road transport in each country. And so, in the Netherlands - a country with mainly transit traffic, drop in road transport of goods in 2009 amounted to 2%, but in other economies, such as Germany and Portugal amounted to about 10%, and in France up to 15%, that was certainly translated in revenues through infrastructure charges.

As mentioned above, the crisis was reflected in problems with financing bridge and tunnel projects in PPP formula, delaying or even causing projects' collapse. Private partners who engage in infrastructure PPP projects were in a crisis very significantly affected by reduced prices - much deeper than it concerned general market, reaching 50 to 99% (e.g. the fall of Macquarie Infrastructure Corporation - the main shareholders in Lusoponte Bridge - 40 USD to 0.79 USD). For public companies, so a strong decrease in the valuation by the market, in conjunction with the overall situation, meant a lack of access to new capital and consequently the implementation of new projects.
Important for the condition of the entire market of road infrastructure were also very significant disturbances in expenditures of individual countries on road infrastructure. In some countries, spending on infrastructure felt by tens of percent after the crisis (Austria, Portugal) and some countries treated the infrastructure expenditures as a way to struggle with the crisis by increasing their level (Denmark, Finland, Canada, Australia). The condition of the companies operating in the industry worsened, as large fluctuations in annual expenditure had an adverse effect.

[12] http://tollroadsnews.com/news/miami-port-tunnel-availability-concession-collapses

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2.4 Airports Projects in BENEFIT

2.4.1 Introduction

This document describes the second stage of the qualitative analysis performed by the IST research team, as part of Task 4.1 Stage 2, regarding the airport infrastructure cases of the BENEFIT database. There are five entries in the database for airport projects, for five different European countries, as presented in Table 2.23.

Table 2.23: Airports cluster of BENEFIT database and available material for each

Airport	Country	Database entry	Narrative/ Wiki	Snapshot
Athens International Airport	Greece	☑	☑	☑
Berlin Brandenburg Airport	Germany	☑	☑	☑
Larnaca and Paphos International Airports	Cyprus	☑	☑	☑
Modlin Regional Airport	Poland	☑	☑	☑
Sá Carneiro Airport	Portugal	☑	☑	-

The purpose of this analysis is to understand what happened to airport projects as a result of the most recent economic crisis, and whether the Benefit matching framework is able to represent these effects in terms of airport characteristics and in terms of project outcomes.

The airport projects included in the database were carried out during a period where one or two major disruptive elements can be identified in the air transport business - the growth of the low-cost carriers and the economic crisis with strong effects in fuel economics. Thus, it is important to distinguish which performance impacts could be related to each of these elements in order to correctly identify the effects of the crisis on Benefit airports. In fact, the relevance of this issue is made greater from the understanding that low-cost carriers typically use smaller airports, which is the case for most of the airport cases in the Benefit database: all but one carry around or under 5 MPA and one was actually built for low-cost carriers (Modlin airport in Warsaw).

Along with the effects of a global economic crisis from 2008 on, in the EU there was a sovereign debt crisis which made EU countries vulnerable during the 2008-2012 period. This economic crisis hit Europe after the Benefit airport cases (except Berlin and Modlin airports) had been in operation for some years. Berlin, Larnaca and Paphos airports were conceived in the early 1990s while Sá Carneiro and Modlin airports were conceived later, in 2000s. In 2002, Athens International airport starts operations; in 2008/2009, Larnaca, Paphos and Sá Carneiro airports are in operation; Modlin starts to operate in 2012; and Berlin is postponed (Figure 2.46)**.**

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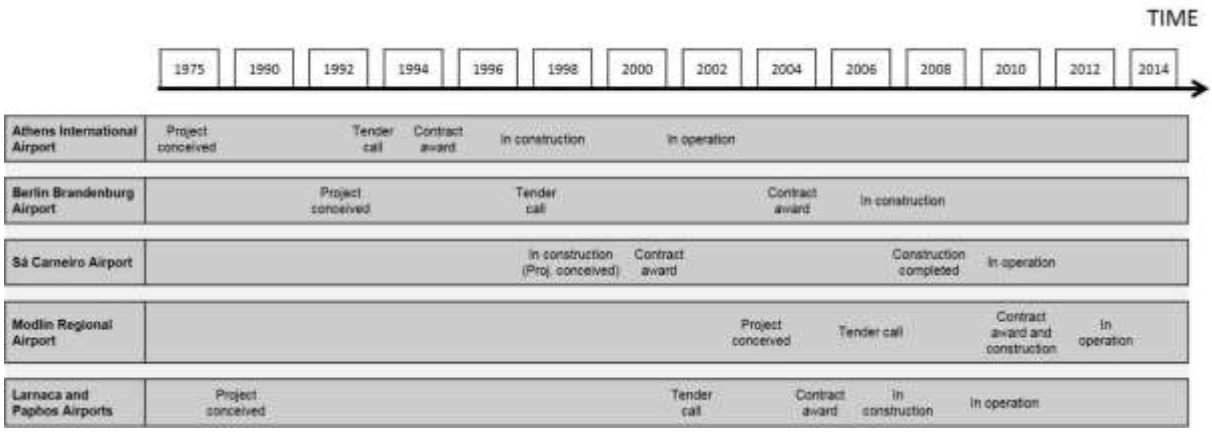

Figure 2.46: Timeline of the BENEFIT airports cases

Thus, the effects of the crisis on the outcomes of different cases will be investigated on different matching framework elements. Those under construction during the crisis might be affected in performance related to **time to completion** or **cost to completion**, whereas those already in operation might more likely be affected in terms of the **actual traffic and revenues as opposed to forecasts**, and in terms of additional **outcomes in the social, institutional and environmental domains**.

Because the Benefit airports vary in size (measured in air passenger traffic, for example), their resilience to the crisis is expected to differ between cases (see the section 2.4.2 on literature). Athens international airport is Greece's largest airport with 15 million passengers per year (MPA). Berlin aims to host an annual amount of 30 MPA. Larnaca handles on average over 5 MPA and Paphos airport, principally used by tourists, handles approximately 2 MPA. Modlin airport is a regional airport with maximum capacity of around 2 MPA (its main goal is to support Chopin Airport, the main regional airport of the city of Warsaw, receiving only low-cost carriers). Finally, the Sá Carneiro airport presents an air traffic of around 5 to 7 MPA.

Beginning with a literature review (section 2.4.2) on the effects of economic crises on airport projects in particular, this analysis will use a case study approach, looking at each of the individual airport cases and carrying out the following analyses (section 2.4.3):

1. Coding the Benefit airport cases' narratives and database forms in search of any reference to the economic crisis and its effects on the project outcomes;
2. Sourcing actual airport demand data from the Eurostat databases over the 2006-2014 period and the percentages of low-cost carriers when available, in order to capture significant changes in the demand curves relatable to the crisis, comparing them to national and regional tourism, business and economic indicators as a baseline;
3. With a deeper knowledge of the cases from the previous steps in the analysis, identifying snapshot indicators and performance elements that changed significantly over the 2006-2014 period, and selecting the changes that are relatable to the crisis.

Finally, a summary of the findings of individual case studies will be carried out with the purpose of looking for similarities, dissimilarities, and relationships with the findings of existing literature (section 2.4.4).

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2.4.2 Literature review

Among numerous consequences of economic instability on the air transport business stated in literature, some examples are the following: a reduction in traffic demand for the transport of passengers and cargo; changes in traffic flows (e.g. through connecting routes); lower company profits and a dramatic financial conditioning of airline companies which led to a change in strategy (Stimac et al. 2015).

Stimac et al. (2015) studied the consequences of the latest economic crisis in the air transport industry and how airports have reacted by changing their strategies for sustainable development. The economic crisis affected all sectors significantly, including tourism, which is closely related to the air transportation system. This negative trend is strictly related to the economic parameters but also with changes in number of passengers. When the world economy grows, the need to travel increases, and this results in increasing numbers of passengers at airports. When the global economy is in decline, the number of passengers also falls. Stimac et al. (2015) also present the relationship between economic parameters, changes in the number of passengers and the number of tourist arrivals divided by European country. According to these authors, the global economic crisis was significantly manifested in the air transport industry when profits started to decline significantly.

Despite the overall evidence, the reaction to the crisis period seems be directly related to the size of each airport. In big-sized airports in general, the economic crisis in passenger traffic began to be felt in the middle of the year 2008, and lasted until the end of 2009. These types of airports seem to record a smaller negative trend of passenger traffic due to the solid development of network destinations (Stimac et al. 2015). Frankfurt and Heathrow airports are examples. The smaller the size of the airport, the more significant are the fluctuations observed in the trend of passenger traffic between the observed airports and the average amount of passenger traffic during the impact of the crisis. Additionally, the effect of the crisis shows later, in 2009, for smaller airports.

Finally, among the cases studied by Stimac et al. (2015), airports with more than 95% share of low-cost carriers showed significant fluctuations in passenger traffic regardless of the impact of the economic crisis. The negative trend started in the observed airports in 2008 and continues until the beginning of 2012 in their sample.

For an in-depth discussion on those issues, several authors may be referenced. Coto-Millán et al. (2014) mention two main literature findings on airport efficiency during crisis periods. Barros (2008) looked into Argentina's airports technical efficiency during a crisis and found that the major airports barely felt the effects of the crisis whereas the small regional airports had lost efficiency during the period; however, the author found that the overall technical efficiency grew during the crisis, which could point to a positive response to the economic downturn. Voltes-Dorta and Pagliari (2012) found that cost efficiency, on the other hand, decreased over the 2007-2009 period on 194 airports around the world. Coto-Millán et al. (2014) study the case of Spanish airports during the economic crisis and find that their productivity decreased during the crisis as a result of a significant reduction in technological change component, despite any positive response in terms of technical efficiency.

2.4.3 Case study analyses

2.4.3.1 Athens International airport

Athens airport is the first successfully completed PPP structure for a European airport. It was built as a greenfield and completed in 2000, after which it received a transfer of operations from Hellenikon Airport. Because the economic crisis hit Europe after it had been in operation for some years, the

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effects of the crisis for this case will be investigated on the performance indicators related to operation, namely actual versus forecasted demand and revenue, and the assessment of outcomes.

Both the case narrative and the database entry make one mention of the crisis. It is related to how revenue streams, both aeronautical and non-aeronautical, were reduced during the economic crisis. Despite that, the airport company managed to maintain a healthy financial condition by enforcing cost controls and promotions/incentives, sustaining adequate profitability during the worse period.

The reduction of airport revenues is related to a drop in demand, shown in Figure 2.47, which was particularly accentuated for outbound Greek travel demand, as a result of the strong impact of the European sovereign debt crisis. Moreover, during the crisis, many long-haul services to the airport were cancelled or stopped operating during the winter season.

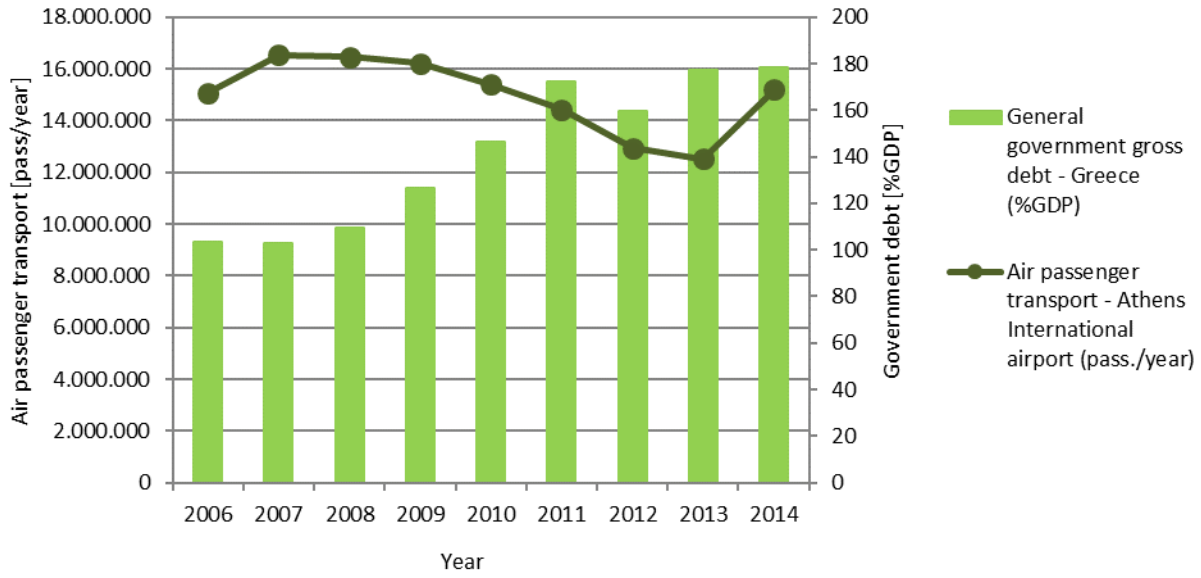

Figure 2.47: Air passenger transport (passengers per year) at Athens International airport during the 2006-2014 period, and general government gross debt (as a percentage of GDP) for Greece as an indicator of the crisis

Source: Data from the Eurostat database (ec.europa.eu/eurostat)

The case database entry makes a further mention of the airport's limitations in dealing with the economic crisis: its success is highly dependent on exogenous factors, such as macro-economic conditions both at national and international level, the attractiveness of Greece and Athens as destinations, the neighboring countries/cities competition and that it has not been active as a business developer. As a large airport serving the Attiki region, Athens International airport demand mainly follows the levels of economic activity in that region (Figure 2.48).

The airport's recovery in 2014 can be attributed to a number of factors. Firstly, it is a sign that the economy is no longer decreasing, but seems to have stabilized at last (Figure 2.47 and Figure 2.48), which resulted in a 14% increase in Greek resident traffic. Secondly, it is also the result of a robust upward trend in tourism activity (Figure 2.49), which grew 31% that year. Thirdly, it is the consequence of a significant airline capacity increase: several new airlines started flights to and from the airport, the homebased carrier strengthened its network significantly, the low-cost carrier Ryanair started operations to and from eight destinations at the airport, and some of the existing airlines increased frequency.

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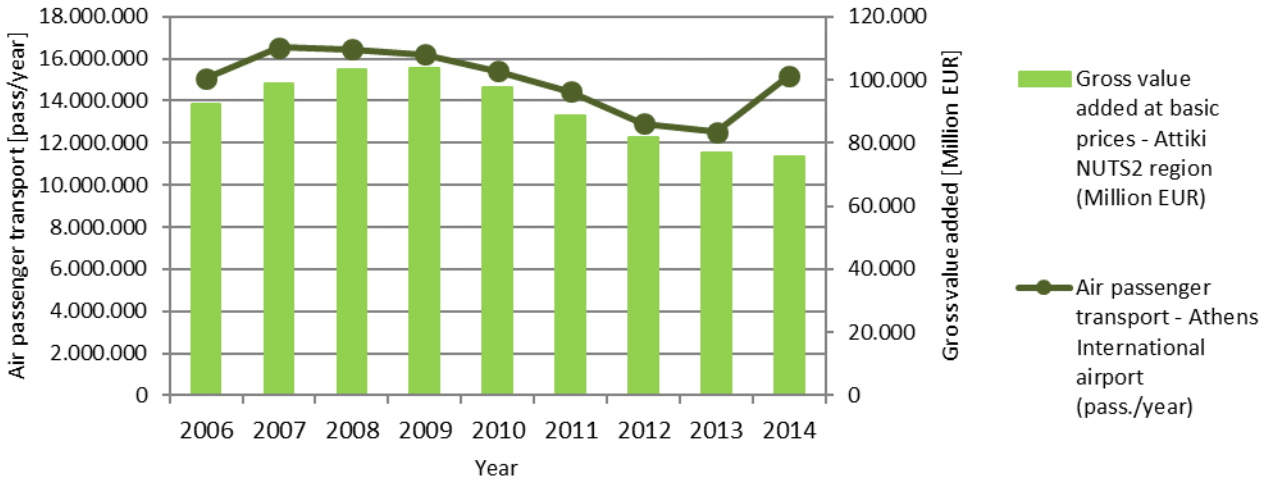

Figure 2.48: Air passenger transport (passengers per year) at Athens International airport during the 2006-2014 period, and gross value added at basic prices (million euros) for the Attiki NUTS2 region served by Athens International airport, as an indicator of the region's economic activity

Source: Data from the Eurostat database (ec.europa.eu/eurostat)

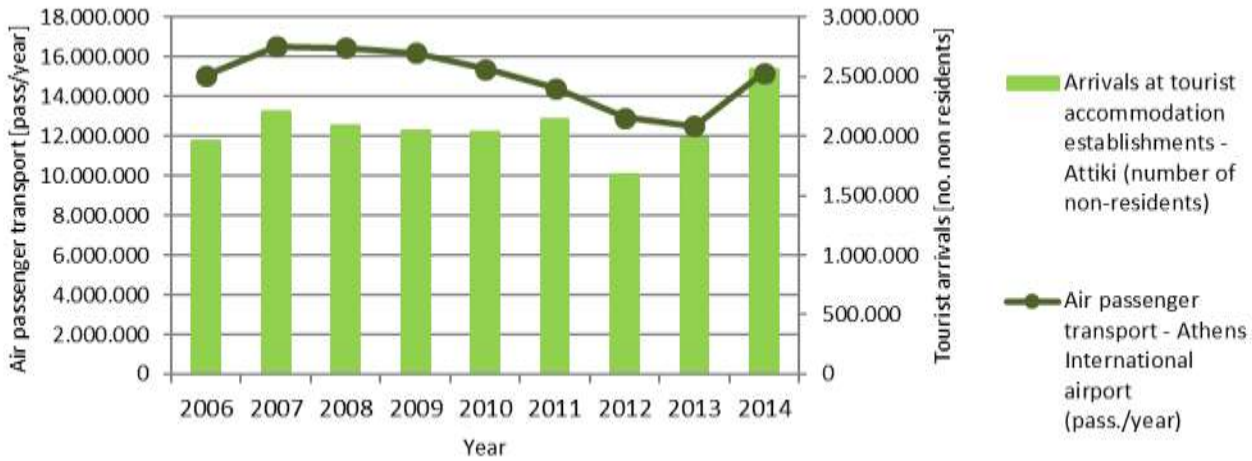

Figure 2.49: Air passenger transport (passengers per year) at Athens International airport during the 2006-2014 period, and arrivals at tourist accommodation establishments (number of non-resident arrivals) in the Attiki NUTS2, served by Athens International airport, as an indicator of tourism activity in the region

Source: Data from the Eurostat database (ec.europa.eu/eurostat)

Snapshot data represents the drop in demand that occurred during the crisis in the *actual versus forecasted traffic* outcome (Figure 2.50). At reporting time, the recovery was not yet documented. A significant drop in the financial economic indicator relating to implementation context paints the picture of the crisis situation.

The diversification of airport revenues creates resilience against the impact of decreasing passenger volumes and safeguards operating profits during the crisis, as non-transport revenues can generate

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higher profit margins than transport revenues. The drop in the business model revenue support indicator represents a slight decrease in the weight of non-transport revenues in the airport business. This is consistent with what was happening in the rest of European airports throughout the economic downturn: around 2011, the value and share of non-aeronautical revenues at airports decreased; however, by 2014 they were recovering (from ACI data).

The only indicator in the Athens International airport matching framework that changes significantly over the crisis is the cost saving component of the business model, which goes from 0,433 to zero. The fact that it goes to zero means that there is no cost saving, but there is also no cost overrun or tendency for cost overruns. This decrease in value happened because the pre-crisis indicator is calculated using the construction phase formula, since the snapshot was taken at the airport inauguration, whereas the post-crisis indicator is already calculated using the operation formula. For this reason, the impact of the crisis could not be read from the change in these indicators.

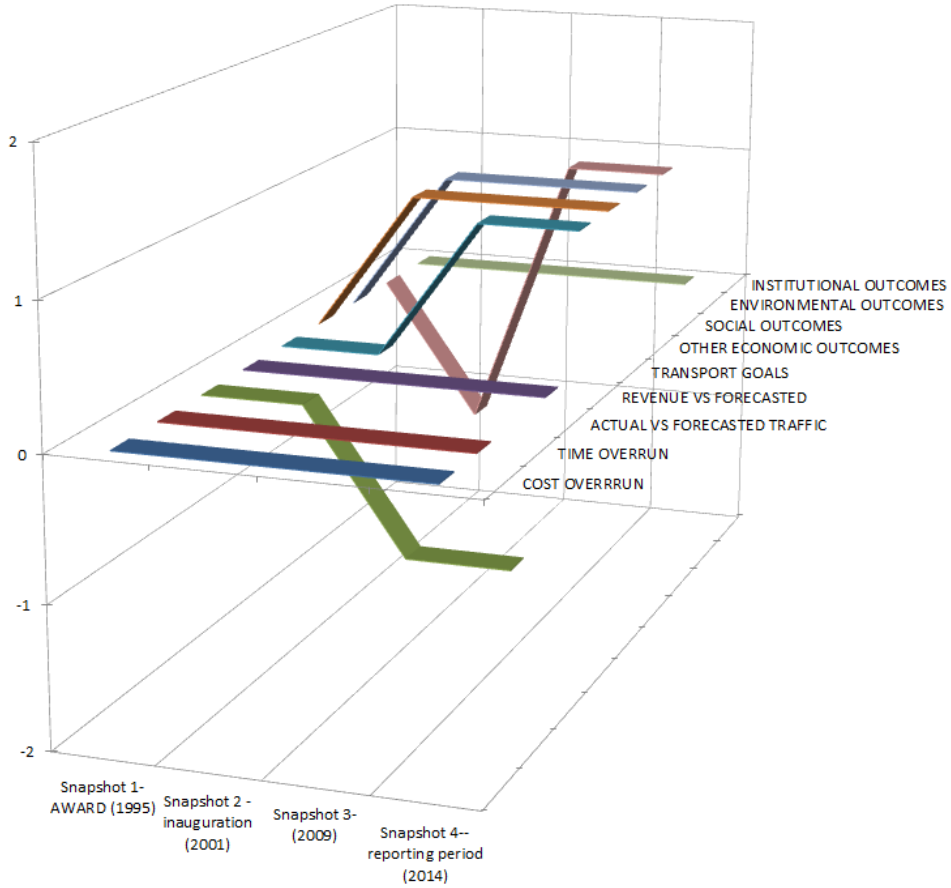

Figure 2.50: Outcomes of the Athens International airport project within the Benefit matching framework

2.4.3.2 Berlin Brandenburg airport

Berlin Brandenburg airport is not yet in operation due to severe delays in construction. An analysis of Benefit database material returns no reference to the effects of the economic crisis in this process of time and cost overrun. The bankruptcy of major contractor Imtech Deutschland added to the time delays, however, it cannot be considered a direct effect of the crisis on the project. The company's bankruptcy in 2015 happened after a sequence of events affecting the company's reputation and results, such as the 2013 write-downs, an accounting scandal with hundreds of millions in losses, a

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major change in management, a bribery investigation and a cartel investigation following an overcharging accusation.

Time and cost overruns are evident in the matching framework outcomes. The indicator that changes significantly over the crisis period is the cost saving component of the business model, from -0,05 to -0,3, which represents the increasing cost overrun. However, as mentioned above, there is no explicit link between the economic crisis and this indicator change.

2.4.3.3 Larnaca and Paphos airports

Larnaca airport is the largest commercial airport of Cyprus and is located in the southern part of the island, near the city of Larnaca. Paphos airport is the second largest airport of Cyprus, located in the southwestern part of the island, near Paphos city. In 2008 and 2009, respectively, the construction of the new facilities at Paphos and Larnaca airports was completed.

Construction was finished just before the beginning of the crisis, therefore the effects of the crisis should be investigated on the performance indicators related to operation, namely actual versus forecasted demand and revenue and the assessment of outcomes.

In 2004, Cyprus entered the European Union and decreased governmental debt during the following years (Figure 2.51). The economic stability period may have affected the rate of the traffic growth as it has in fact increased until the crisis period. Cyprus, as a tourist and insular country, is highly dependent on air transport and air passenger traffic is highly dependent on the tourism sector as well. The development of the country also depends on the international economy and other external factors such as political stability and connectivity in the region. As an island, Cyprus depends on air traffic to these two airports for communications. While Larnaca serves multiple air traffic flows, associated with basic communications and the regional economy, Paphos mainly targets the tourist market.

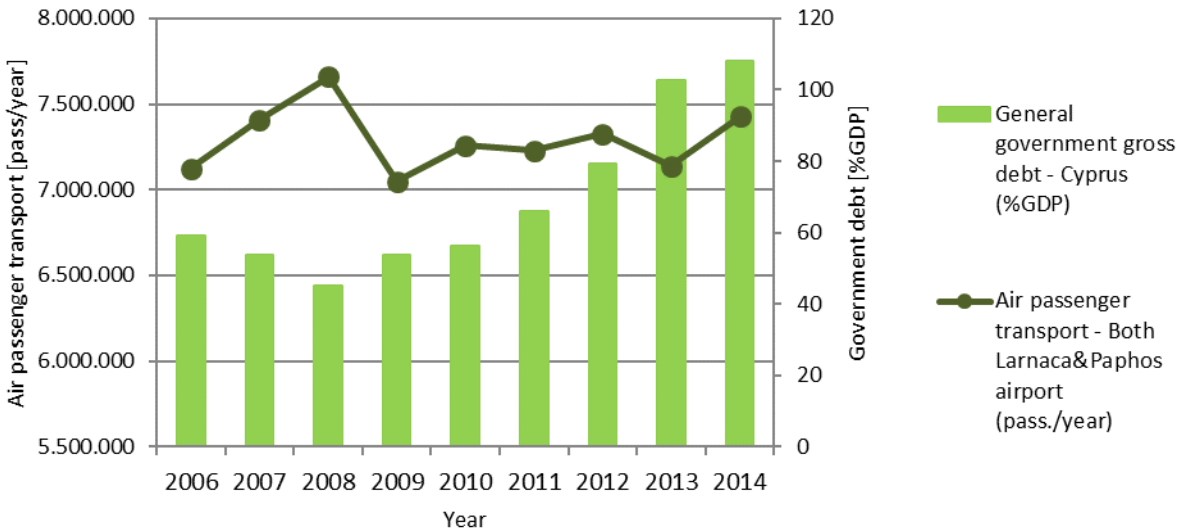

Figure 2.51: Air passenger transport (passengers per year) at both Larnaca and Paphos International airports during the 2006-2014 period, and general government gross debt (as a percentage of GDP) for Cyprus as an indicator of the crisis
Source: Data from the Eurostat database (ec.europa.eu/eurostat)

In 2008, Cyprus joined the Eurozone and a new government was elected. Then, several measures and political decisions have had an impact on the country's economy, adding to the global instability

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and leading to the loss of access to international capital markets in 2011. Nevertheless, the tourism sector was not much affected since the number of air passengers per year did not change significantly (Figure 2.52). The economic downturn may have affected the rate of the air traffic growth as it has in fact decelerated, however it must have been countered by other elements, namely an overall growth in tourism activity and a strong entry of low-cost carriers in the airport since it started to increase in 2013.

Cyprus was affected by the EU sovereign debt, and in 2012 the Cypriot Government applied for economic assistance from the European Union and the International Monetary Fund (IMF). This status of Cyprus' economy and the sustained recession that is expected may be factors for the increase of uncertainty in the project and reasons for traffic demands and revenues to be below forecasted, since both airports started operating their terminal expansions just before this crisis period, in 2008/09. Larnaca and Paphos airports' actual traffic in 2012 was 7.5M passengers versus 8.5M forecasted. In fact, traffic demand had decreased around 5% in 2009 and in 2013 (apart from those years, passenger traffic had increased annually by 2% - 3%). In addition, in 2012, air traffic controllers in Cyprus were involved in protests against a government worker wage freeze and other deficit-reduction measures. Air traffic control stoppage also affected several passengers and had an impact on the airport performance. This added to the social and political instability in this period and may be an additional reason for the decrease in air transport observed in the next year.

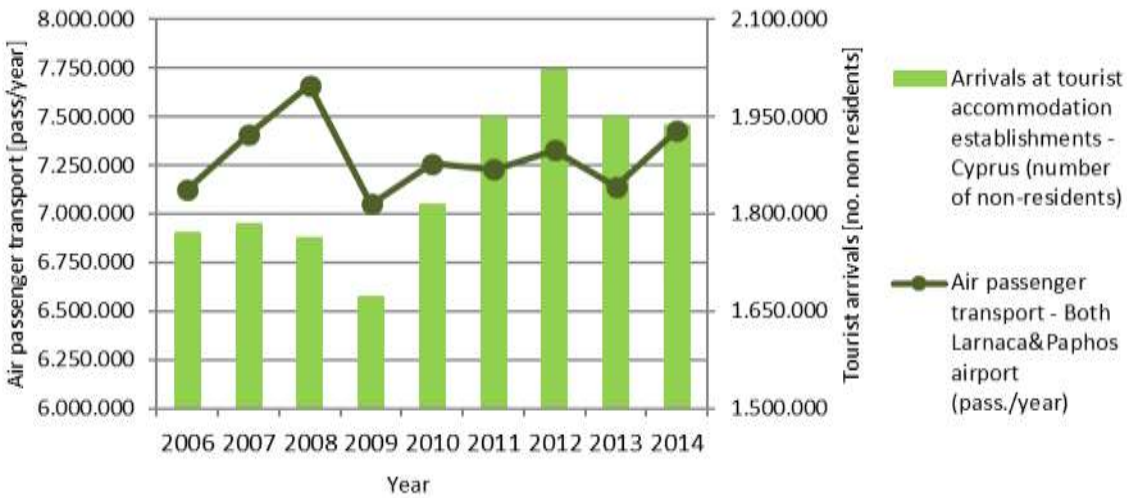

Figure 2.52: Air passenger transport (passengers per year) at both Larnaca and Paphos International airports during the 2006-2014 period, and arrivals at tourist accommodation establishments (number of non-resident arrivals) in the Cyprus NUTS2, served by those airports, as an indicator of tourism activity in the region
Source: Data from the Eurostat database (ec.europa.eu/eurostat)

In 2013 was a year of political and economic stability. This had an impact on tourism and business travel, and, consequently, on airport performance (Figure 2.53**)**. Air traffic starts to increase considerably. Plus, at the end of 2014, several airlines (low-cost carriers) started to operate to serve the tourism industry, since Paphos is to be the cultural capital of Europe in 2017 and a rise in visitors is expected in the range of 15-25%.

At the end, it is difficult to assess the full economic impact as the period of inauguration of the new terminals coincides with the economic crisis and the developments in the wider area. Definitely, access to the island country has been significantly improved. The GDP at project award time was improved (GDP 2005 (Project award): 88.6%; GDP 2014: 90.5%). Plus, the population density of the region at the time of completion of the project was also increased (2005: 81.9 inh/km^2; 2013: 123.5

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inh/km^2) highlighting the development of the region. Apart from offering new employment opportunities, the new airport has sustained the tourism industry and therefore jobs in that sector.

Finally, institutional and financial economic indicators of the snapshots data are also consistent with the context previously described and the political and economic changes witnessed in the country. The institutional indicator, for instance, decreased slowly when the country joined the euro area and a new government was elected (year of economic and political changes / constraints). In terms of outcomes within the matching framework, the negative actual vs forecasted traffic indicator (Figure 2.53) is consistent with the demand values analyzed above. The indicator that changes significantly over the crisis period is the cost saving component of the business model indicator, however this can be related with the change in formulas for calculating the indicator after construction delivery, and no explicit link is made to the impact of the crisis.

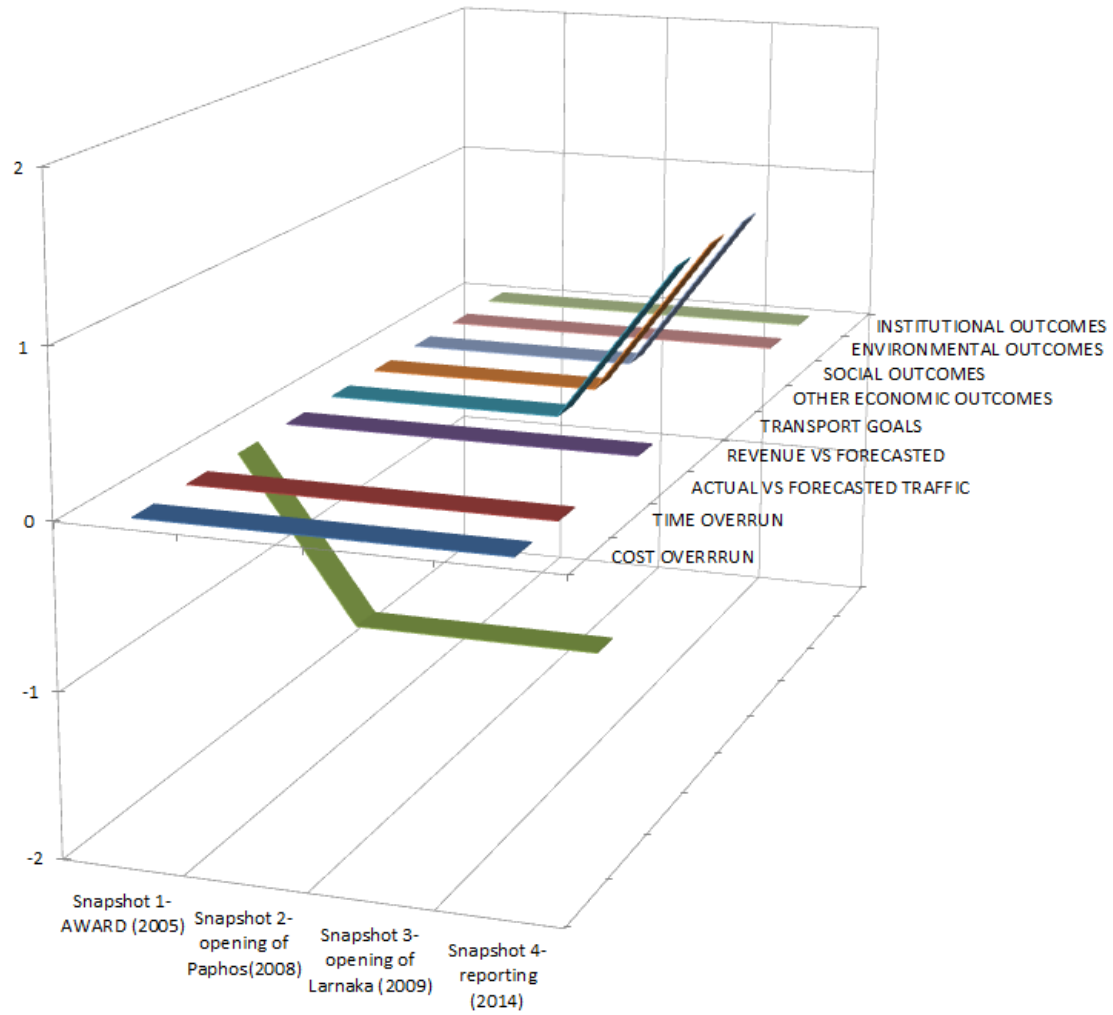

Figure 2.53: Outcomes of the Larnaca and Paphos airports project within the Benefit matching framework

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2.4.3.4 Modlin airport

Modlin airport is a regional airport located north of Warsaw city, in Poland. In operation since 2012, it was formerly a disused military airfield. Nowadays it has a maximum capacity of around 2 million passengers per year and its main objective is to give support to the Chopin Airport, the main airport of Warsaw city, using low-cost carriers (Ryanair services).

Since Poland's accession to the EU and the introduction of the 'open skies' policy, with budget airlines entering the market, passenger traffic at all Polish airports has been increasing by over 30% every year (see Eurostat data on air transport). Despite the 2009 European crisis period, in 2011 the Chopin Airport had an increase of number of passengers by more than 11%. Hence, it seems that the positive effects of entering the EU and open skies outweigh the impact of the crisis on the country's economy, as more people can afford to travel by plane, whether on business or on holiday.

Still, Modlin airport closed after a few months of operation due to technical and safety issues and re-opened in June 2013. Despite this constraint, the number of passengers almost duplicated in the period 2012-2014 (see Eurostat data on air transport). According to forecasts, in 2015 the number of passengers in Modlin airport is to increase to 2.5 million.

In addition, several planned main roads in Poland were not realized because of the financial crisis of 2009 and, thus, the connections to/from the Modlin airport were compromised. This is shown in the transport outcomes indicators, as it compromised the ability of the project to deliver transportation goals as expected (Figure 2.54). Nevertheless, it is the 6th airport in the country with the highest growth rate in number of passengers and the GDP at project award time was higher than expected (GDP 2008: 81.1% of Poland average; GDP 2012: 86.3% of Poland average). Plus, the population density of the region at the time of completion of the project was also increased (2008: 110 inh/km^2; 2013: 113 inh/km^2) highlighting the development of the region in that time.

2.4.3.5 Sá Carneiro airport

The Sá Carneiro Airport case is an expansion project carried out while the airport was in operation. The airport was already operating for over 50 years when this expansion was conceived. Its purpose was to add capacity in support of a business plan to increase demand up to 5 MPA in 2010, and in further steps up to 15 MPA. Construction was finished before the beginning of the crisis, therefore the effects of the crisis should be investigated on the performance indicators related to operation, namely actual versus forecasted demand and revenue and the assessment of outcomes.

The EU sovereign debt crisis was particularly severe in Portugal, especially from 2011 on, with the austerity package imposed by the IMF/CEB/EC bailout. Despite this, the case narrative and database entry form make no mention of the crisis. There is however a connection to the crisis in the case contents - the airport operator ANA, which holds the concession for Portuguese airports, was a public company when the expansion project was procured and built, but recently, in 2013, it was sold to Vinci for a 50-year period. This privatization is a direct consequence of the sovereign debt crisis in Portugal, as quick liquidity at a time when IMF bailout repayments were due was the main result that was achieved.

However, this does not speak to the project's performance. In this respect, publicly or privately owned, the airport has been able to grow in traffic throughout the crisis (Figure 2.55), and exceeded forecasts for 2010, reaching 5.3MPA, over the 5MPA target. and exceeded forecasts for 2010, reaching 5.3 MPA, over the 5 MPA target.

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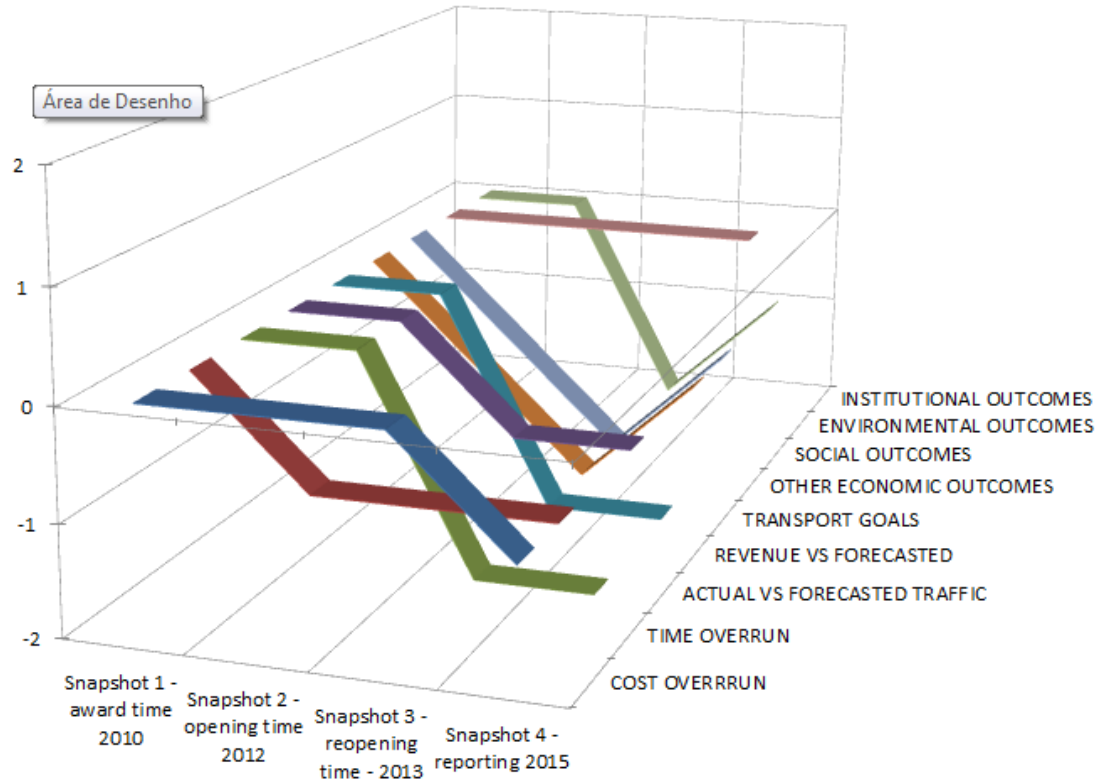

Figure 2.54: Outcomes of the Modlin airport project within the Benefit matching framework

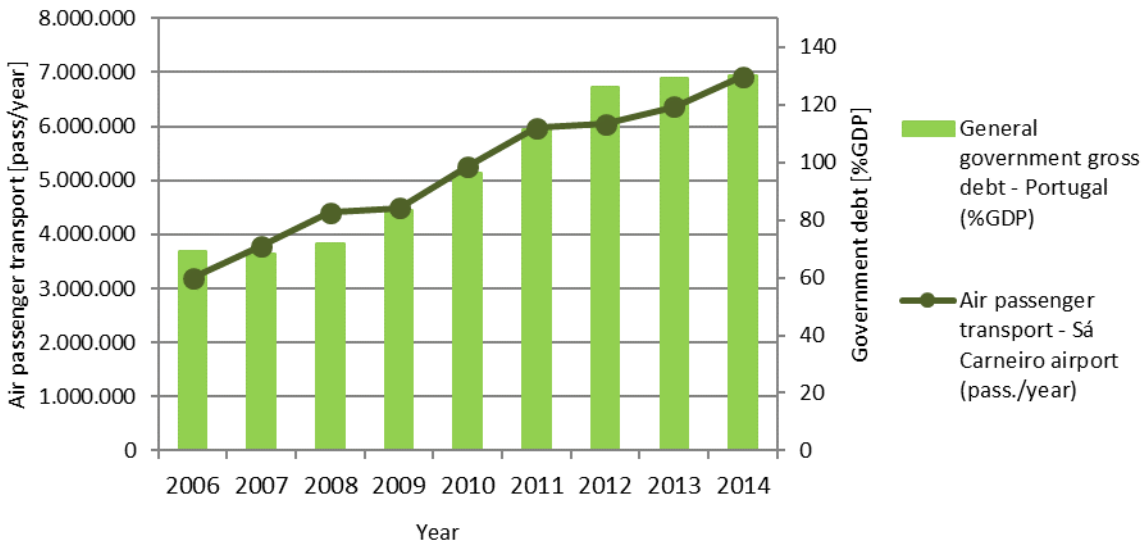

Figure 2.55: Air passenger transport (passengers per year) at the Sá Carneiro airport during the 2006-2014 period, and general government gross debt (as a percentage of GDP) for Portugal as an indicator of the crisis

Source: Data from the Eurostat database (ec.europa.eu/eurostat)

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The economic downturn may have affected the rate of this growth as it has in fact decelerated, in 2008-2009 and 2011-2012, however this effect must have been countered by other elements, namely an overall growth in tourism activity and a strong entry of low-cost carriers in the airport. From Figure 2.56, tourism activity decreases in 2009, starts a period of slow growth until 2012, from which time it starts to grow more rapidly.

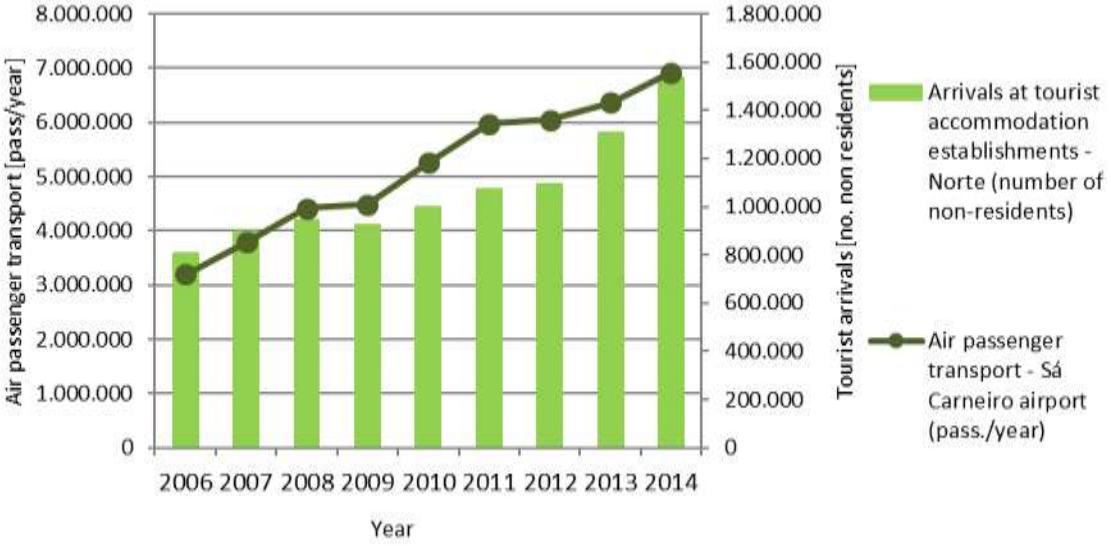

Figure 2.56: Air passenger transport (passengers per year) at the Sá Carneiro airport during the 2006-2014 period, and arrivals at tourist accommodation establishments (number of non-resident arrivals) in the Norte NUTS2, served by the Sá Carneiro airport, as an indicator of tourism activity in the region

Source: Data from the Eurostat database (ec.europa.eu/eurostat)

Most of the growth in air passenger traffic over the crisis can be attributed to the low cost carriers (Figure 2.57). This growth in tourism is supported by/supports a major growth in low-cost supply. By 2011, more than half the passenger traffic arrives/departs by low-cost carrier, and Ryanair alone carries 40% of the airport passengers. A high dependence on one airline can be seen as a risk in terms of business model, especially since it is a low-cost carrier: it can easily move to a competing airport, and it will make use of its strong bargaining power.

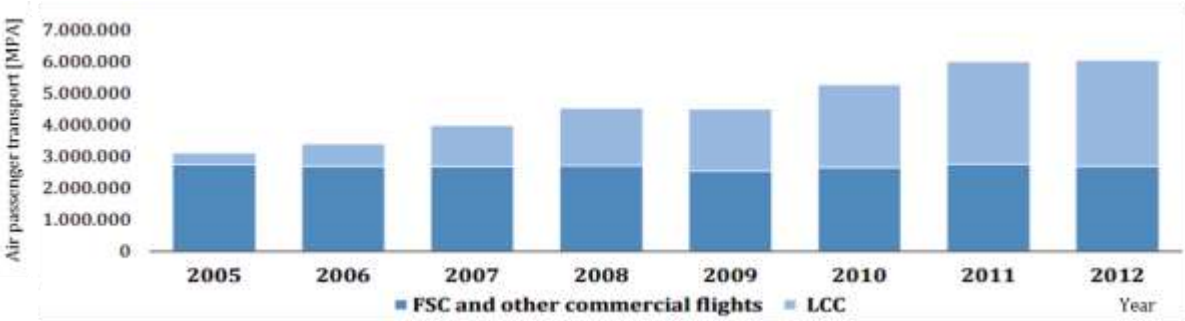

Figure 2.57: Air passenger transport (MPA) at the Sá Carneiro airport from 2005 to 2012, by type of carrier - flagship carriers (FSC) and low-cost carriers (LCC)

Source: Carballo-Cruz and Costa (2014), p. 42

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2.4.4 Summary

The Benefit airport cluster is small and diverse, therefore this qualitative analysis does not attempt to achieve generalizable conclusions, but rather hopes to better understand airport performance under crisis situations in the light of findings in the current literature.

What happens to airport project outcomes as a result of the crisis?

In terms of actual versus forecasted traffic, the sample is able to illustrate two points about airport performance under the crisis:

Firstly, as suggested in the literature, in the small sample of Benefit airports, smaller-sized airports begin to feel the effects of the crisis later than big-sized airports. Athens, at 15 MPA experiences a decrease in traffic from 2008, whereas Larnaca, at 5 MPA, and Paphos, at 2 MPA, start their negative trend one year later (Figure 2.58). Although Sá Carneiro, at 5 MPA, does not have a negative trend, it shows a delayed decreased growth in the year 2009. Although Sá Carneiro, at 5 MPA, does not have a negative trend, it shows a delayed decreased growth in the year 2009.

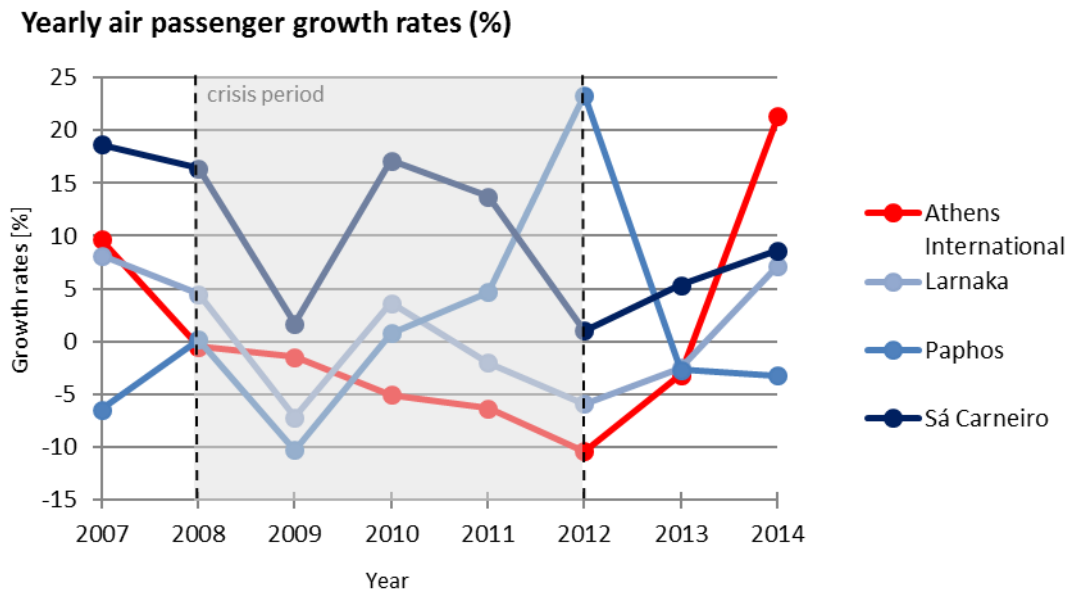

Figure 2.58: Yearly air passenger transport growth rates (%) in Benefit airports at the start of the economic crisis in Europe (2007-2014)
Source: Data from the Eurostat database (ec.europa.eu/eurostat)

Secondly, yearly air passenger growth rates in all Benefit airports reinforce the literature about resilience of airports to the crisis: the smaller-sized airports have an abrupt fall in traffic growth rate when the crisis hits, whereas Athens international, although it is on a negative trend, keeps a relatively stable traffic growth rate throughout the crisis years (Figure 2.58).

The distinction between “big” and “small” airports relates to air passenger traffic, but the determining factor that size is representing seems to be the airport connectivity – the extent to which it can be considered a hub. Another factor that size might be representing is whether the airport is supporting the travel flows of a stronger regional economy, or whether it is basically serving tourism flows.

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Case narratives and database entry forms did not establish direct relationships between the economic crisis and other project outcome indicators; however, as the magnitude of some of these outcomes depends on the traffic volumes served by the airport, they will at least be indirectly affected by the economic crisis.

Does the matching framework correctly identify the changes and adjustments introduced by airports during the crisis?

Benefit airport cases responded to the crisis by introducing some adjustments such as offering promotions and incentives, and enforcing cost controls (like Athens International). The growth of low-cost airline traffic was an opposing force to the economic crisis' impacts on the airport business, and in one case kept the demand growth positive over the period of the crisis (in the Sá Carneiro airport case). The matching framework was able to identify slight changes in the Athens International airport's ability to generate revenue. The changes in the cost saving component and their relationship with the crisis were more difficult to read and no explicit link was found in any of the cases.

Looking at each BENEFIT outcome in particular, we can establish some relationships between indicators and results during the crisis (Table 2.24). For the case of Athens airport, it is notable that traffic is reduced, but revenues are not, thus this is added as a line on this table.

Table 2.24: Changes in BENEFIT outcomes over the economic crisis, for airport cases

BENEFIT outcome	Cases where outcomes changed over the crisis	Factors of outcome change	Related BENEFIT indicator/variable
Cost to completion	Berlin (-) Modlin (-)	Failure to pass technical and safety inspections	• Cost saving (ability to construct, monitor, control, plan) • Governance
Time to completion	Berlin (-) Modlin (-)	Severe construction delays Failure to pass technical and safety inspections	• Cost saving (ability to construct, monitor, control, plan) • Governance
Actual vs forecasted traffic	Athens (-)	Demand decrease due to economic crisis Full government guarantees provide low incentive to attract traffic demand	• Financial-Economic context • Revenue support (demand risk allocation) • Governance
	Larnaca and Paphos	Demand decrease due to political and economic instability	• Financial-Economic context • Institutional context
	Modlin (-)	Closure due to safety failure (see cost and time to completion) Connection roads projects cancelled due to crisis	• Cost saving (ability to construct, monitor, control, plan) • Governance • Revenue support (network impact) • Financial-economic context
	Sá Carneiro (+)	Strong entry of low cost carriers and increase in tourism activity	• Financial-economic context • Revenue support (business scope, capability to operate)
Actual vs forecasted revenue	Athens (=)	Despite a decrease in traffic, the revenues were kept according to forecast due to cost cuts and incentives and promotions	• Revenue support (capability to operate) • Revenue robustness (risk of revenues)
	Modlin (-)	Revenue decrease related to traffic break (see time and cost to completion)	• Cost saving (ability to construct, monitor, control, plan) • Governance

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Table 2.25: Benefit matching framework indicators for Athens international, Larnaca and Paphos and Berlin Brandenburg airports

Athens International Airport	**2001** (before crisis)	**2014** (after crisis)
Implementation Mode Context		
Institutional indicator	0,60	0,57
Financial Economic	0,543	0,358
Transport Mode Context		
Overall Reliability/Availability Indicator IRA	100%	100%
Governance		
Overall Composite Indicator	0,750	0,750
Business Model		
Cost Saving	0,433	0,000
Revenue support	0,402	0,400
Funding Scheme		
Remuneration Attractiveness	0,410	0,407
Revenue Robustness	0,705	0,703
Transport Market Efficiency & Acceptability	0,833	0,833
Financing Scheme		
New Financing Indicator (1-WACC)	0,702	0,702

Larnaca and Paphos International Airports	**2005** (before crisis)	**2014** (after crisis)
Implementation Mode Context		
Institutional indicator	0,70	0,71
Financial Economic	0,555	0,425
Transport Mode Context		
Overall Reliability/Availability Indicator IRA	100%	100%
Governance		
Overall Composite Indicator	0,688	0,688
Business Model		
Cost Saving	0,665	0,437
Revenue support	0,364	0,363
Funding Scheme		
Remuneration Attractiveness	0,333	0,333
Revenue Robustness	0,667	0,667
Transport Market Efficiency & Acceptability	0,833	0,833
Financing Scheme		
New Financing Indicator (1-WACC)	0,678	0,678

Berlin Brandenburg Airport	**2004** (before crisis)	**2015** (after crisis)
Implementation Mode Context		
Institutional indicator	0,78	0,80
Financial Economic	0,628	0,717
Transport Mode Context		
Overall Reliability/Availability Indicator IRA	1,00	1,00
Governance		
Overall Composite Indicator	0,313	0,375
Business Model		
Cost Saving	-0,050	-0,300
Revenue support	0,287	0,290
Funding Scheme		
Remuneration Attractiveness	0,433	0,450
Revenue Robustness	0,717	0,725
Transport Market Efficiency & Acceptability	0,500	0,500
Financing Scheme		
New Financing Indicator (1-WACC)	0,956	0,963

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2.5 Ports Projects in BENEFIT

2.5.1 Introduction

Contrary to other kinds of infrastructures such as roads, bridges or tunnels and similar to airports, ports use to rely on international trade to success. Since 2007-2008, the international economic is undergoing a downturn situation. The current situation is being accompanied by a strong decline in commodities especially because of the Chinese economic deceleration. Besides, all the ports analyzed belong to regions especially affected by the economic crisis (Port of Agaete, Terminal Muelle Costa and Europe South Container Terminal in Spain, Piraeus Container Terminal in Greece and Ports of Leixoes and Sines in Portugal) which aggravate the context in which the projects are being conducted. In term of ports activity, the aforementioned situation implies a decline in port activity. I.e., a depletion in both containers and general cargo. Paradoxically, this downturn economic situation, both domestic and international, does not seem to have been affecting, on average, the success of these ports (container and cargo ports). On the other hand, two ports deserve a special attention: Agaete and Terminal Muelle Costa. Both ports rely mainly on passenger transport[13]. In this sense and paralleling the economic situation, an unexpected increase in tourism flows have been benefited Spain since 2010 triggered by the Arab Spring.

On the other hand, taking a closer approach, in some cases, the success of the project goes beyond controlled issues (tendering process, for example) and response to other causes. For instance, in the case of the Piraeus, among other factors and despite the economic crisis, the presence of Cosco, the international Chinese shipping line, and the dominant position of this port in the Mediterranean seem to be key to understand the success of the project. On the contrary, in other cases, such as the port of Sines, a bad planning at the beginning, together with a negative economic context and a strong competition from neighboring ports seem to be in the root of its bad performance.

The main idea that can be drawn from the aforementioned explanation is that each port needs to be understood, contextualized and analyzed individually so as to understand the true causes of their failures and/or successes. This is precisely, the aim of this study.

The paper consists of two parts. Firstly, the lessons learned per mode are addressed. Secondly, a more quantitative approach is conducted so as to provide a closer view of the figures of the projects.

2.5.2 Lessons learned per mode

Regarding the case of the port of Agaete, the authorities identified the lack of a closer and faster connection by sea between the two main islands of The Canary Islands. Until then, the main connection was from the two main ports in the two main cities of both islands (Santa Cruz in Tenerife and Las Palmas de GC in Gran Canaria). Agaete has the closer port to Santa Cruz of Tenerife. Moreover, the shipping company (Fred Olsen) operates with fast catamarans (Ro-Ro services). Both circumstances the closer distance and a faster mean of transport reduces the travel time by one hour and a half compared to the aforementioned services from city to city. On the other hand, the Terminal Muelle Costa (TMC) in Barcelona was conceived to provide both Short Sea Shipping (SSS) and, as in the case of Agaete, Ro-Ro services. In both cases, so far, one single shipping company operates the terminals: *Fred Olsen* in Agaete and *Grimaldi lines* in the TMC in Barcelona. Barcelona Europe South Container Terminal (BESCT) is the most expensive of the six projects analyzed here. The project was awarded to a joint venture, TERCAT S.A., formed by Hutchison Ports Holdings and Grupo Mestre. In the case of the Piraeus Container Terminal (PCT), the PPP project was oriented towards the following aims: firstly, upgrading and management of pier I. Secondly, the future construction of pier III. The

[13] Ro-ro services and short sea shipping services are also offered in Agaete and Terminal Muelle Costa, respectively.

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project was awarded to the Piraeus Container Terminal S.A. whose sole shareholder was “Cosco Pacific Limited”. Contrary to the previous cases, the project was handled at national level (Ministry of Merchant Marine of Greek) and they opted for a negotiation rather than a tendered procedure.

The four projects can be labelled as successful cases from almost the beginning; whereas the BESCT project suffered from cost and time overrun as well as a lack of a suitable traffic forecast. Nonetheless, the terminal has been able to overcome the previous situation and, in 2013, container exports grew strongly. In 2014 port container traffic at the port of Barcelona was close to its 2007 pre-crisis level. The PCT also suffered the economic crisis that hit strongly on the Greek economy by the time of the beginning of the project. Nonetheless, the awarded company, Piraeus Container Terminal s.a. could suitable manages the projects especially because of the followings factors:

- The dominant position of Piraeus in the Greek and Mediterranean container market.
- The strong financial position of the concessionaire, which has the resources to absorb several years of losses if necessary.
- Links between the terminal operating company and the major Cosco shipping line, which will increase its ability to meet the throughput guarantees.
- The ratification law granted Cosco Pacific various income tax exemptions in terms of VAT and depreciation obligations, which are more favorable compared to the standard obligations of a Greek corporation, including Concession of the Port of Piraeus (OLP). Also, accumulated losses could be offset against the taxable profits of later periods without any time constraint.
- Incentive of OLP and concessionaire equally sharing profits if an IRR of 16% is exceeded.
- Cosco's capability for long-term planning (further plans to expand—moves that the company expects will boost volumes to more than six million containers by 2016). It should be noted that it ordered 12 ERTG cranes (above its contractual obligations), allowing for an additional increase of 1.1 million TEUs in the capacity of piers II and III (4.7 million TEUs in 2015 instead of the 3.7 million TEUs originally planned).
- Chinese cultural attitudes, which seek to avoid the loss of face associated with failure. The political support provided by the Chinese Government may also be a significant success factor, either facilitating the renegotiation of the contract at some later stage, or providing Cosco Pacific with incentives to continue operating the terminal primarily for political reasons. -Now in competition with Cosco, the port authority operating Pier I terminal has increased productivity and improved operations and services, reporting a 27.5 % increase in container throughput from 2011 to 2012. Previously inefficient and with outdated infrastructure, the port struggled to secure financing (even from the EIB).

Contrary to the aforementioned cases, the case of the port of Leixoes (POL) in Portugal did not suffer from any delay and all outputs were according expectations. On the other hand, and similar to the case of the Piraeus, this projects provided a significant increase in both productivity (from 21 containers/h/portic to 30 containers/h/portic) and traffic (from 0.8% to 4.9%).

Finally, and also in Portugal, the port of Sines (POS) was also conceived as a container terminal and it is the project with the worse performance of all cases here analyzed. The project suffered from delay and a lack of a proper traffic forecast and revenue forecast among others factors. The project also had to cope with the strong competition of other ports (transhipment hubs) of the regions such as Algeciras in Spain or Tanger Med in Morocco.

2.5.2.1 Cost to completion

As shown in Table 2.26, the BESCT project was, by far, the most expensive project. Agaete, Terminal Muelle Costa and Piraeus deserve to be highlighted because of their good yields and their lower costs in term of the rest of projects.

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Table 2.26: Budget of the projects

Projects	Cost
Port of Agaete	5.7 million (3.1 million in 1982 and 2.6 million in 1987
Terminal Muelle Costa (TMC)	22 million
Europe South Container Terminal (BESCT)	60 million
Piraeus Container Terminal (PCT)	153.6 million
Port of Leixoes (POL)	350 million
Port of Sines (POS)	330 million

2.5.2.2 Time to completion

Four cases suffer from delays. In the case of the port of Agaete, the delays were produced by governmental issues. The BESCT suffered a delay as a consequence of the movement of 640 M cement block during construction. Regarding Piraeus Container terminal, the delay was provoked by a union issue, which reversed a previous decision that allowed greater flexibility in employment conditions. Briefly, the labor unions won a major concession from the port management that newly hired personnel would be offered the same salary and working conditions. Finally, in the case of the port of Sines, the stage 1A was delayed by 26 months and stage 1B was delayed by nearly 6 months. The reason for the delay was as follows: the different stages of the project relied on the revenues generated during the previous stages. Nonetheless, the traffic volume has been lower than expected in each stage. The time line of Agaete was as follows:

1981: Initial planning project (*Project I*)
1982:
May 19th: Public tendering.
June 16th: Public works awarded to private construction firm (SATO).
July 28th: Contract signature.
August 30th: Start of public works. Public opinion against the project due to concerns on visual impact.
1983:
June 16th: Second planning (*Modified Project II*) is started. Public works are temporarily paused.
July 1st: Public works are definitively halted.
1985:
October 23rd: Administration and management of local ports are transferred from the central government to the regional government (by Royal Decree 2250/1985).
1986:
January. Regional government updates the existing project (Modified Project III)
Public works are restarted by the same building company (now, SATOCAN)
1987:
Agreement between the regional government and the island government (Cabildo Insular) to update the budget and speed up the works. Modified Project IV, with technical updates.
1993:
Main works are finished
Commercial use of the port is negotiated between regional government and central government.
1994:
December. Passenger and road traffic license is awarded to *Fred Olsen*, a ferry operator between Gran Canaria (Agaete) and Tenerife (Santa Cruz). Fred Olsen operates as a monopoly due to 'lack of capacity'. Pays a fee to regional government.
1999:

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Additional works required adapting the port to ‘fast-ferry’ operations. Fred Olsen performs them.
2014:
Large increase in passenger traffic since 2000.
A second passenger license is currently being negotiated (sharing existing facilities)
There is a project for further enlargement of the port of Agaete (*Plan de Puertos de Canarias*, 2013) to be carried out from 2015 onwards.
2015:
(January) Passenger services opened to competition. Two private ferry operators (*Fred Olsen* and *Líneas Armas*) will share port facilities.

2.5.2.3 Traffic

The port of Agaete was a success regarding the traffic expectations, especially because it led to an increased mobility of residents and tourists. The traffic in 2013 was of 773,509 passengers and the traffic forecast in 2020 is around 900,000 passengers. Regarding TMC, the traffic evolved according to expectations. Probably, the huge increase in tourism in Spain since 2010 because of the Arab Spring have been backing these goods figures in both projects. Proceeding with the next project, The BESCT saw its traffic declined under its initial expectations mainly because of the impact of the economic crisis. On the contrary, the traffic in the PCT has been slightly increasing despite that the economic crisis also hit strongly the Greek economy by the time of the beginning of the projects, (Pier II: 12 million TEUs in 2011, 2.2 million TEUs in 2012 and 2.6 million TEUs in 2013). Moreover, the PPP project faced a strong competence with the Piraeus Port Authority which owned and operated the pier I. Nonetheless, Actual traffic in Pier II greatly exceeded forecasts, rising sharply from 1.2 million TEUs in 2011 to 2.2 million TEUs in 2012 and reaching 2.6 million TEUs in 2013, with capacity utilization of over 80%. Traffic has also been lower than expected in the case port of Sines at the beginning. Since 2010, traffic began to rise due to an increase in exports of national products such as marble, granite, paper pulp, chemicals or glass. Contrary to previous cases, the port of Leixoes matched its traffic forecast during all the project timeline.

2.5.3 Analysis of typologies and outcomes per mode

2.5.3.1 Implementation context

This typology is comprised of two indicators: institutional indicator or financial economic indicator. Five out of six projects were carried out, in one way or another, during the economic crisis that began in 2008. Fortunately, four of these projects had a good performance despite the crisis.

2.5.3.2 Transport mode typology

The transport mode typology includes two indicators that aim at describing the quality of service offered by the new transport project in comparison with the quality of service expected:

- Reliability of the transport service: in the field of public transport, reliability is understood as the number of missions arriving on time;
- Availability of transport service: in the field of public transport, availability refers to the time of day and the time of year when the service is accessible to users.

Both the reliability and availability have a score of 1 for five out of six cases. The port of Sines shows an Ira index (reliability and availability) of 75%.

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2.5.3.3 Governance typology

Governance typology includes 11 indicators describing efficiency/effectiveness of governance and flexibility of the contract. This indicator has rather to be analyzed contract by contract insofar as the overall indicator is an average of the different contracts.

The port of Agaete provides an overall composite indicator of 0.375 in 1982 and 0.5 in the other two snapshots (1994 and 2015). The change in the indicator comes from the fact that the works of the port began in 1982 and, in 1994, it is when the passenger and road traffic license is awarded to *Fred Olsen* and begins to operate. For the other two cases, the indicator also accounts 0.375 in the last snapshot for the TMC, BESCT and PCT. As it was previously highlighted, for this last case, the national government handled the negotiation instead of a tender process. The port of Sines provides a slightly better index (0.375). Finally, the Port of Leixoes provides the highest governance indicator of the six cases. Compared to the previous cases, the Port of Leixoes have better indicators in those of "bonding requirements", "all exploitation, commercial/revenue and financial risks" or "clauses indicate that client has an option to terminate the agreement without cause".

2.5.3.4 Business Model typology

The business model typology is disentangled in two parts: cost saving and revenue support.

2.5.3.4.1 Cost saving

This part of the business model illustrates the project's ability to keep its costs under control in relation to the construction phase, the operating phase and the degree of innovation of the project.

The capacity to operate as well as the degree of innovation is note significant in the cases treated here. Regarding the costs, the TMC and the BESCT suffered from cost overrun. Two extra million in the case of TMC and 200 extra million in the case of BESCT. With regards to the PCT, the awarded company was able to keep cost under control during all the stages. Nonetheless, the company estimated its operating costs in 2005 to be as much as 40% higher than those of efficient competing ports. The main reason behind that was the lower productivity in comparison to European standards. On the contrary, the port of Leixoes was capable of keeping the cost under control during the project timeline.

2.5.3.4.2 Revenue support

Revenue Support reflects the project's ability to optimize and secure revenue. Four types of revenue are taken into account by this indicator: revenue from the Greenfield part of the project, revenue from the Brownfield part of the project, revenue from other transport activities and revenue from activities other than transport.

In this sense, the service offered in the port of Agaete has been a success and the source of revenues has been ensured. The company is coping with a large increase in passenger since 2000. The shipping company *Fred Olsen* offers tourist packages to visit some attractions in both islands. It also offers a (free) bus shuttle service from Las Palmas de Gran Canaria to Agaete and from Santa Cruz de Tenerife to Los Cristianos in the South of the islands were the company operates three routes to El Hierro, La Gomera and La Palma. This service ease the connection by road between the city and Agaete, which strengthens its demand, compared to the airport.

On the other hand, the TMC has experienced a remarkable increase in the port´s SSS activity. Although the economic crisis hit the initial figures of the BESCT, in 2013, port container traffic was close to its 2007 pre-crisis level. In 2014, the whole port container traffic experienced 7% year-on-year increase. Regarding the port of Leixoes, most of the revenues come from usage charges whereas secondary revenues such as assets promotion, sub-concessions and royalties. In the case of the port

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of Sines, The terminal has failed to attract transhipment traffic primarily because of the massive investments that have taken place at two competing transhipment hubs – Algeciras and Tanger Med – which have been able to capture the economies of scale that are absent at Sines. The project is located in a region which generates relatively small container flows.

2.5.3.5 Funding Scheme typology

The funding scheme typology is disentangled in two parts:

- The remuneration scheme, used to evaluate the project's ability to pay its concessionaire;
- The revenue scheme, used to assess the project's ability to generate financial revenue.

The regional government obtained €1.2 million from public funds for the usage of the dock facilities (*by Fred Olsen*). It also obtained 17,000 euros for renting warehouses and terminal facilities.

On the other hand, the *Grimaldi lines* agree to ensure a minimum traffic requirement in the case of TMC as well as 4.2M as annual fee. The BESCT also established some commitments regarding certain minimum traffic growth. Additionally, the company pays 2.15 euros per TEU, 22M for the concession and 28M for occupation and use of port public domain.

In regard with the PCT, the project is headed by Cosco Pacific Limited, a large state-owned Chinese terminal operator associated with Cosco Container Line, which allow the company to absorb several years of losses. Additionally, the company has demonstrated a high capability for long-term planning. Finally, the port authority in charge of the pier I have increased productivity and improved operations and services; reporting a 27.5% increase in container throughput. The agreement ensures a maximum IRR-16%. If exceeded, profits available for distribution shall be evenly distributed to the Concessionaire and OLP, at commensurate rates (50%- 50%). The percentage of gross revenue offered by Cosco was 21% for the first 8 years and then 24.5% with the second bidder offering 19.0%.
In the case of the port of Leixoes, the contract includes a tariff with both a fixed and a variable part. The first goes to the concessionaire (port authority) whereas the second goes to the concession. Finally, in the case of the port of Sines, throughput has been lower than expected, and concession fees per TEU rise with throughput. Thus, earnings from concession fees have been very much lower than expected.

2.5.3.6 Financing Scheme typology

The financing scheme typology aims at assessing the financing of the construction of the project. There is a lack of suitable financial information for the cases analyzed here. Briefly, the financing indicators for the last snapshot are 1, 0.3, 0.438, 0.3, 1 and 0.835 for Agaete, TMC, BESTC, PCT, POL and POS respectively.

2.5.4 Economic Crisis

The economic crisis affected differently each project, despite all of them belong to regions (Portugal, Greek and Spain) where the economic crisis was especially strong. Five out of six projects took place during the economic crisis. Nonetheless, four of them had, on average, a good performance. On the one hand, the BESCT suffered a decline in traffic, and thus in revenue, because of the crisis. Although, by 2013, the port was close to its 2007 pre-crisis level. On the other hand, the PCT project, and contrary to what could be expected in a projects conducted in Greece during the economic crisis, the traffic exceed the initial expectations. Something similar occurred in the port of Sines that took place in Portugal, where since 2010, the traffic rose thank to the increase in national exports such as marble, granite, paper pulp, chemicals or glass. Regarding Agaete, the port also avoided the negative effect of the crisis and, in fact, a new passenger services have been opened to competition in 2015. Finally, both the port of Leixoes and the TMC evolved according to expectations in spite of the economic crisis.

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2.5.5 Conclusions

In general, all projects can be considered as successful cases except the port of Sines. Despite the projects share a common mode (ports), it is difficult to draw conclusions given the differences in each projects. Firstly, two out of six ports are focused on passenger's transport whereas the rest of ports are focused on traffic of containers and cargo. Secondly, each case took places in different countries and under different circumstances. For instance, the Piraeus container terminal was carried out during the economic crisis that hit strongly on the Greek economy. Despite that, the project was a success. In Portugal, which was also hit severely by the economic crisis, the port of Leixoes had a good performance from the very beginning and did not suffer from extra cost, delays or traffic forecast. On the contrary, and also in Portugal and during the same period, the port of Sines showed a bad performance from the beginning and the projects addressed several issues during the timeline of the project.

The causes behind the success or failure of these projects seem to rest on the foundation of the aim of the projects. More precisely, for instance, the dominant position of Piraeus in the Greek and Mediterranean container market played an important role in the success of the project as well as the importance market share of Cosco Pacific, the awarded company. On the other hand, the port of Sines did not have such a dominant position in the container markets and let alone with the strong competition of two competing transhipment hubs – Algeciras and Tanger Med – which have been able to capture the economies of scale that are absent at Sines.

With regards to passenger ports, in general both ports (Agaete and Terminal Muelle Costa) benefited from the remarkable increase in tourism since 2010 in Spain. Moreover, and focused on the case of Agaete, the authorities identified the lack of a closer and faster connection by sea between the two main islands of The Canary Islands. Until then, the main connection was from the two main ports in the two main cities of both islands (Santa Cruz in Tenerife and Las Palmas de Gran Canaria in Gran Canaria). Agaete has the closer port to Santa Cruz of Tenerife. Moreover, the shipping company (Fred Olsen) operates with fast catamarans (Ro-Ro services). Both circumstances the closer distance and a faster mean of transport reduces the travel time by one hour and a half compared to the aforementioned services from city to city.

Summarizing, before analyzing important issues related to the tendering process or the traffic forecast among other aspects, the analysis of the strengths and real necessities of the projects seem to be key to the future success; at least in ports projects.

2.6 Summary of the Qualitative Analysis

Roads

The review of the road cases showed that most of projects in countries in which the crisis impact was low to moderate, are performing well. The consequences of global crisis may be most clearly seen in the cluster of countries with high impact of crisis that mostly includes southern European countries and UK. However, the most of the UK projects are performing also in line with expectations and does not appear to be severely impacted by the crisis. In other countries in the high impact cluster most of projects faced difficulties. However, there are some projects that are still performing reasonably well (Athens ring road in Greece, A5 Maribor – Pince motorway in Slovenia, and M-45 in Spain).

The critical success factors that led to success of these projects include:

- Long term planning
- Top priority projects

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- Realistic traffic projections
- Medium size projects
- Strong regulatory body and governmental support
- Responsible and well experienced concessionaire
- Introducing innovations (Norway, Poland, UK)

The consequences of the global financial crisis on the poorly performing projects are reflected through:

- Many projects have to be renegotiated (Portugal, Greece, UK)
- Reducing the scope of projects /significant reduction of the project size (Greece)
- An increased government participation (Greece)
- Introduction of user paid tolls (Portugal, Greece)
- Payment of claims (Greece)
- Cost underestimations (Serbia)
- Time overruns (Serbia, Greece)
- Substantial drop in AADT and revenues (Spain, Portugal, Greece)
- An imbalance of the risks shared between the public and private partner (Greece)
- GDP lower than expected (Slovenia, Portugal, Greece)
- Cash flow difficulties as a consequence of public budget restrictions (Spain, Greece, Portugal)

Urban Transport

The impact of crisis on Urban Transport projects is even more difficult to access, since it should be analyzed on the network level, particularly in the operational phase, and most probably the impact has been larger on peripheral, supporting networks, compared to central lines. The crisis had underlined the capacity of cities and countries to support urban transport policies and projects and the importance of proper planning and design of sustainable urban transport networks taking into account realistic demand. For some projects, like Brabo 1 in Portugal, the economic crisis has had a direct impact by impacting the financial capability of private sector, which led to delays in the tendering phase.

The 2008 crisis caused a slowdown in ridership in many countries, but did not reverse the general trends of increasing ridership in urban transport since 2000. In France, Germany, and Italy, there were almost no negative trends in the increase of ridership, while in countries severely hit by crisis, like Spain and Portugal, and Central and Eastern European countries the decrease was substantial as a result of worsened economic situation. In addition to cases of reduced ridership, and consequently revenues, the secondary revenues, such as advertising, have also dropped. Finally, since these systems rely to a large extend on support from public budgets, these grants were severely affected by crisis, even in countries where there was no or was limited ridership slowdown. The crisis has also caused the increase in operating costs, such as cost of materials and taxes.

Operators of urban transport network tried to reduce operating costs, either through reducing wages and maintenance costs, or through reducing service offer. The financial crisis has also increased pressure on the level of investment to extend or renew metro systems. After the crisis private partners are more reluctant to invest in urban transport systems.

Overall, the global financial crisis seems to have relatively small impact on financing of urban transport projects, except in countries hardly hit by crisis, where it exposed structural weaknesses.

Bridges and Tunnels

Most of bridge and tunnels projects included in the BENEFIT database were in the operation phase in 2008 and only two projects were in the planning or construction phase.

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The performance of these projects does not appear to be severely impacted by the crisis. As a result of crisis, the traffic levels mainly decreased, impacting the revenues as well. The decrease was relatively modest, thanks to the exclusivity of most of the projects. However, in countries that were less hit by crisis (Scandinavian countries or Czech Republic), the traffic levels mainly recovered, except in cases where there was competing infrastructure (like Herrentunnel)). On the other side, it appears that decrease in traffic level that happened after 2011 (following the initial recovery of traffic after the crisis) in Germany, The Netherlands, or France, may be part of a long-term trend in road mode of transport, as a result of shift towards more sustainable transport modes. In countries that were severely hit by crisis, like in Portugal (Lusoponte bridge), the crisis caused the change in risk allocation matrix, increased public support and extension in the concession duration.

For projects that were completed after the crisis, the issues in the construction phase were mainly related to the traditional project management issues and planning, and not to the crisis.

The most important success factors that led to success of bridges and tunnel projects is good planning, regarding the estimated traffic, and their exclusivity and protection from competition.

Airports

The analysis of airport cases found in the BENEFIT database confirmed the finding that small airports were hit by crisis with delay compared to large airports. However, the smaller-sized airports have an abrupt fall in traffic growth rate when the crisis hits, whereas larger airports typically keep a relatively stable traffic growth rate (although sometimes negative) throughout the crisis years. Some airports like Sa Carneiro in Portugal were able to keep traffic growth, although the growth rate has been substantially lower in 2009.

Two factors that improved the resilience of airport cases and to mitigate the impact of crisis included the growth in tourism and the growth of low-cost airline traffic. The importance of good intermodal connections was also outlined in the analysis, particularly for Modlin airport in Poland.

Benefit airport cases responded to the crisis by introducing some adjustments such as offering promotions and incentives, and enforcing cost controls.

Ports

All six BENEFIT port cases are located in southern European countries, hardly hit by crisis: Portugal, Spain and Greece. However, all of them, except the port of Sines in Portugal, showed positive overall performance despite the crisis.
The major factors that contributed to success of these projects are good planning and appropriate project justification, as well as commitment and financial capability of concessionaires and link to major shipping line that allowed the traffic growth even in the case of adverse economic conditions (as in the case of Piraeus Container Terminal in Greece). In addition, the success of two projects that involve passenger traffic was related to the growth in tourism.

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2.7 Intermodal analysis

Funding and financing of transport infrastructure bears similarities as well as differences between transport modes. For instance, project's **exclusivity and connectivity to the transport network** are important factors in achieving targeted performance, especially in cases of capital infrastructure objects as tunnels and bridges. It also affects largely its resilience to crisis. In evidence, those are the **projects of national interest, long time planned, technically mature** what made them perform in line or above expectations even in unstable environment, as during or after the global financial crisis. For this mode, projects were resilient to crisis despite of technical difficulty and large investment; unlike, for example, road projects where abovementioned project characteristic lead to many crisis-induced difficulties. Huge investment requirements in road sector may cause serious time or cost overruns, especially in road and rail projects with low levels of financial-economic and institutional conditions.

The analysis also showed importance of **good governance**, especially in times of crisis in terms of **competence** (institutional and other) of the public authorities monitoring implementation for both PPP and traditional delivery of infrastructure. In case of urban transit projects, the competence of the (local) public authorities may be critical for achieving expected performance, as it involves following closely stakeholder objectives. Good governance can be looked upon also as an expression of public authority competence and good institutions which are crucial in difficult times for number of reasons. One of those being conducting **competitive tendering** which allows choosing competent and experienced contractor or service provider, and also defining and negotiating **contracting arrangements** that can be adaptable enough for sudden and unpredictable severe changes in the projects' surrounding (e.g. to GFC).

Some modes also allow for a **wider range of value adding activities and services,** which create additional traffic and incomes. For that reason, impact of the crisis was not so significant for airport projects, and they managed to keep their expected traffic growth even during or after the crisis. That conclusion can be even expanded to road projects that exclusively serve the airports, and therefore have traffic more resistant to change. In addition, the increase in tourism helped many airport and port projects to keep traffic level increasing, although at a slower pace.

Regarding the BENEFIT Matching Framework, so-far analysis showed that there is no direct link between the indicators and change in expected outcomes as a result of crisis, but the answer lies in the combination of influences that are crisis-specific, and which lead to changes in outcomes. However, one factor was identified to have an impact on all outcomes throughout the modes, and that is **implementation context** and its **indicators financial – economic context and institutional context**. That conclusion very clearly emerged after analyzing the projects by clusters of countries, based on changes of macro-economic indicator during the crisis. However, special consideration was given to the sample of projects from UK, as UK managed to retain continuity and expected performance in almost all analyzed projects regardless of being an economy severely hit by crisis. As it came out, that resilience was a consequence of **strong legislative and governmental support**, especially in terms of implementation of PPP projects.

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3 Revision of Typology Indicators

3.1 Introduction

The scope of the analyses carried out within the context of task 4.1 stage 2 was, amongst others to validate and provide directions for the further development of the Matching Framework and its typology indicators. The various analyses conducted concluded that further consideration was needed for the indicators of the Business Model, Governance, Funding Scheme and Financing Scheme Typologies. The present chapter concerns the revision of the mentioned typologies along the lines of recommendations made.

These considerations per typology are presented in the following.

Governance Typology
The Governance composite indicator is typically constant for all snapshots for a particular project. It appears that changes in the governance during project implementation have rarely been picked up. This has particularly been the case for urban transport projects where political sensitivity has a huge repercussion on risk sharing and as the contracting authorities seem to be unable to let the private concessionaire assume wholly construction, operation or commercial risk. On the other side, for road and ports projects, it appears that the Governance indicator was able to show the difference between well and poorly performing projects.

In addition, the Governance indicator performed consistently in the numerical analyses and its presence in the various findings could be justified through the qualitative analysis.

Business Model Typology
The Business Model Typology consists of two indicators which are composite including many factors.

The cost saving indicator was capable to indicate problems during implementation, related to change in ownership structure, or low traffic levels, for several projects in different modes (roads, airports, bridges and tunnels). Similarly, based on this indicator, it was possible to distinguish well from poor performing port cases. However, it should be noted that it is more focused on the construction phase, while in the urban transport mode the operational phase is critical.

In addition, while the presence of the cost saving indicator could be sufficiently explained in the numerical analyses findings, certain factors seem to be more important than others and a respective weighting should be applied. In addition, findings from the qualitative analysis suggest the importance of the capability of the public authority. Some findings indicated that the capability of the public sector was more important when addressing a project's technical difficulty than that of the contractor competence. This relation should be further investigated.

A low value of revenue support indicator for most modes and projects indicates low capability of transport infrastructure projects to generate other types of revenues in addition to revenues from the main transport mode. Further, with this indicator, it is possible to distinguish between well and poorly performing cases. Notably, the most crucial factor included in the Revenue Support Indicator is the "Level of control". An appropriate weighting should be applied.

Although the revenue support indicator had been designed to include all possible sources of revenue for various types of projects, in some specific transport modes the indicator failed to provide reasonable information. A respective adjustment should be considered. The redesign of this indicator

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should include a revision of its estimation. This because it was noticed that such indicator has a very narrow interval of variation in comparison with others used in this research.

Funding Scheme Typology
The Funding scheme indicator was found to be sometimes counter-intuitive.

In the case of the remuneration indicator, high and low values do not always represent consistently the facts in a project. Considering its structure, this may be due to its incentives component, which would require further consideration. Moreover, the rationale behind the remuneration scheme should be further justified and explained by additional analyses.

The Revenue scheme indicator presented problems with respect to its variability. The values that such indicator takes do not follow the expected trend. These may be due to its structure as it also includes factors, which at some instances, cancel each other out, and possibly because, there exist a high correlation among the input factors considered. Hence, the indicator requires re-structuring and thorough validation (numerical and other), and possibly the separation of factors describing different phenomena.

Financing Scheme Typology
The financing indicator exhibits the following limitations observed originally in its design:
- Discontinuous interpretation
- Stakeholder view of risk.

This has been confirmed by the reality fit and by the quantitative analyses performed. For instance, its limited relevance was observed in the quantitative analyses findings. Therefore, this indicator should better align to the overarching concept indicators design which was defined for the Matching Framework.

More specifically, the indicator should be turn into a continuous variable. Further, this indicator should reflect the financing risk situation in general instead of focusing on the private sponsors' situation. This should improve the explanatory power of the indicator within the Matching Framework.

Moreover, the indicator in its present form should be investigated with respect to its suitability to be used as an indicator for project creditworthiness.

3.2 Business Model Typology Indicators

3.2.1 Introduction

Two are the key considerations with respect to the Business Model Typology indicators:
- The influence of the capability of the Contracting Authority (CCA)
- The significance of the "level of control".

In order to address the first key consideration, Capability of the Contracting Authority, new information was collected with respect to the cases with available snapshot data. This information concerned features describing the CCA which were identified as having a positive (or negative) effect on project delivery as suggested by the literature review (see Chapter X). Features were grouped depending on the project phase and assessed through a binary value (YES/NO) and scored respectively as [0,1] depending if the result is considered positive or negative for the project. The overall score of each group was normalized to the unit (1) as with all other indicators. The features and the respective groups are presented in Table 3.1 below. The CCA is expected to be combined with the capability of the contractor as, according to recommendations of D4.2, the CCA is equally important in achieving project outcomes. It is, therefore, considered that CCA is to be combined with the capability of the

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contractor in the composite subindicators representing the respective project phase in the Cost Saving Sub-function of the Business Model Typology. The details of the CCA factor composition are illustrated in Figure 3.1. The CCA factor composition is validated in the next section.

Table 3.1: Assessment of the Capability of the Contracting Authority

Experience and Expertise	Assessment
Planning of Specific Infrastructure (X_{CA1})	
Was there a clear policy with respect to this project?	Yes = 1 ; No = 0
Was there a Political decision to adopt PPP or Public procurement?	Yes = 1 ; No = 0
Was there a feasibility study conducted?	Yes = 1 ; No = 0
Was there inaccurate information pre-project identified during the project?	Yes = 0 ; No = 1
Monitoring the implementation (construction) of specific infrastructure & Stakeholder Management during Construction (X_{CA2})	
Does the public authority responsible for the contract (at the time) have a good project management record? (the majority of projects completed on-time, budget and to quality)	Yes = 1 ; No = 0
Where there lengthy re-negotiations during project implementation?	Yes = 1 ; No = 0
Does the public authority responsible for the contract (at the time) have capable staff to monitor the project?	Yes = 1 ; No = 0
Did the project have support from various stakeholder groups?	Yes = 1 ; No = 0
Did the project have positive press reviews?	Yes = 1 ; No = 0
Operating the specific infrastructure (X_{CA3})	
Does the public authority responsible for the contract (at the time - each snapshot) have experience in operating the specific infrastructure?	Yes = 1 ; No = 0
Did the project have support from various stakeholder groups?	Yes = 1 ; No = 0
Did the project have positive press reviews?	Yes = 1 ; No = 0

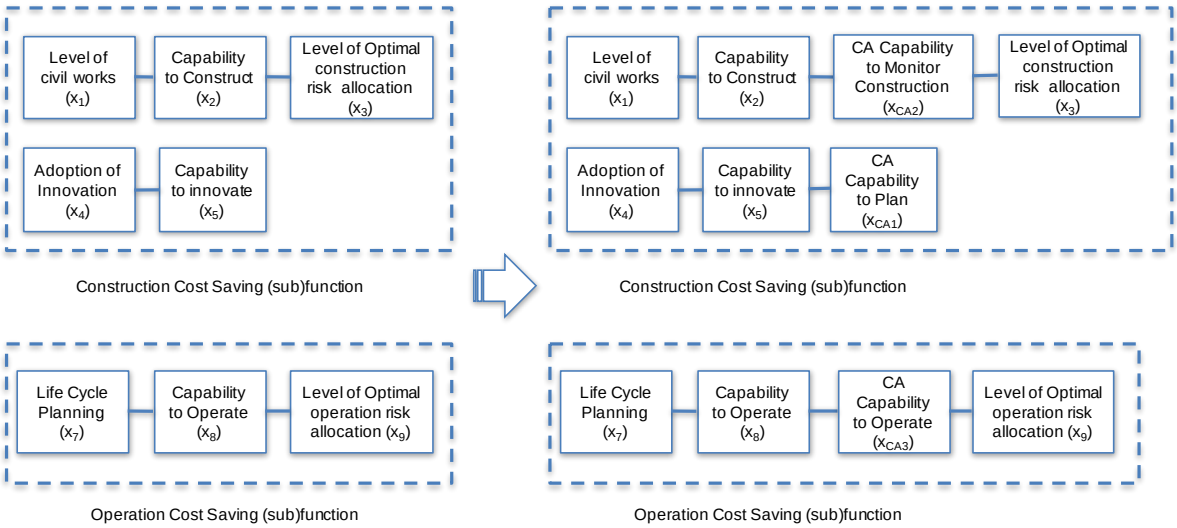

Figure 3.1: New Formulation of Cost Saving Function

With respect to the second key feature, level of control, the factor was included in the Revenue Support indicator of the Business Model typology as part of the composite subindicators describing the capability to generate revenues. Since its pivotal role was identified, the “level of control” is now being

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considered as an independent component of the Revenue Support Indicator. This assumption is validated in the next section. The new formulation is illustrated in Figure 3.2 below.

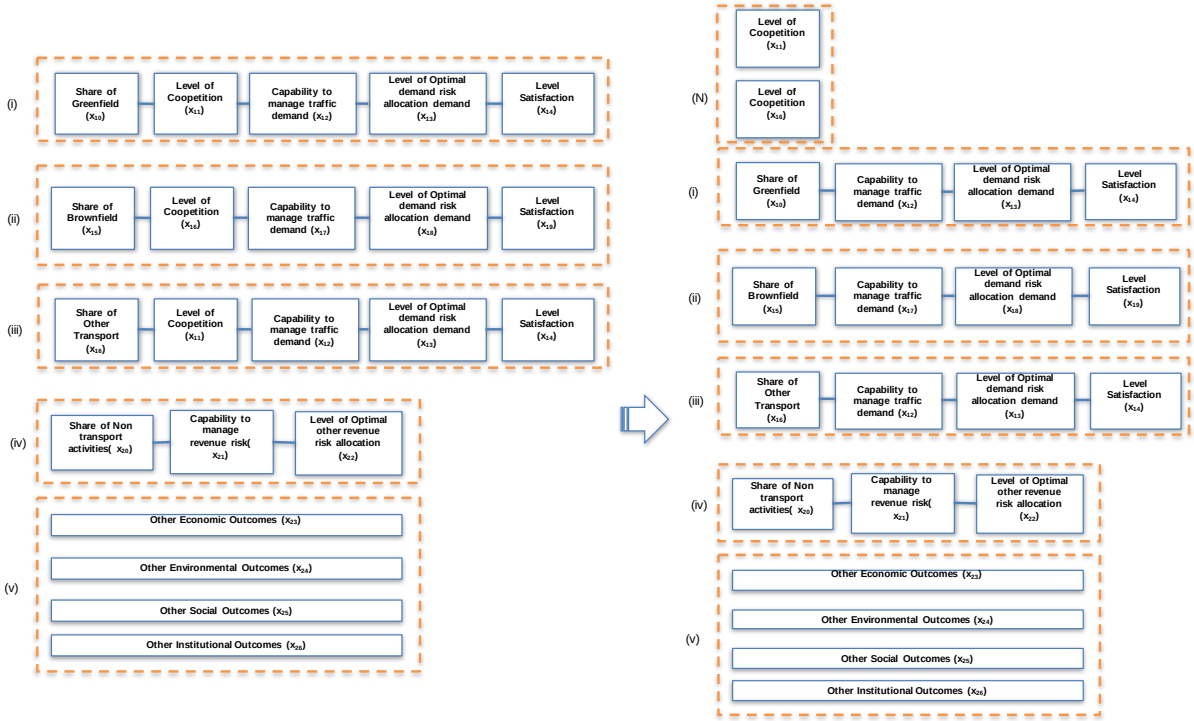

Figure 3.2: New Formulation of the Revenue Support Function

3.2.2 Validation of the BM indicators Using Snapshot Data

3.2.2.1 Spearman's non-parametric tests

In order to identify potential associations, Spearman's non-parametric tests were carried out. This specific test checks the correlation between two variables, in this case between a key characteristic and an outcome. Spearman's non-parametric test was chosen since the interest is to identify whether the relation between the key characteristics and the outcomes may be described by a monotonic function in situations in which there is no knowledge about the joint probability distribution of the two variables.

Table 3.2: Spearman's non-parametric test for the Cost Saving Indicator components

	X_2X_3	X_4X_5	$X_7X_8X_9$	$X_2X_3X_{CA2}$	$X_4X_5X_{CA1}$	$X_7X_8X_9X_{CA3}$	Cost	Time	Traffic
X_2X_3	1.000	,148	.574**	-	-	-	-,118	,170	-,019
X_4X_5	,148	1.000	,021	-	-	-	,170	,150	,018
$X_7X_8X_9$	.574**	,021	1.000	-	-	-	-,074	,076	-,056
$X_2X_3X_{CA2}$	-	-	-	1.000	,587**	,760**	,464**	,440*	,396*
$X_4X_5X_{CA1}$	-	-	-	,587**	1.000	,539**	,878**	,705**	,685**
$X_7X_8X_9X_{CA3}$	-	-	-	,760**	,539**	1.000	,421*	,355*	,403*

**. Correlation is significant at the 0.01 level (2-tailed);
*. Correlation is significant at the 0.05 level (2-tailed).

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The results are summarized in Table 3.2 where the correlations of both the new factors and the old ones are tested against the key project outcomes. It is interesting to note the improved significance of the new indicators on the outcomes. This is especially important as the test was conducted on the entire sample and not per mode, where the significance of the factors was identified previously (see D4.2).

3.2.2.2 Principal Components Analysis

Principal Components Analysis (PCA) was applied to both the Cost Saving and Revenue Support indicators in order to identify whether some factors may be dropped from the composite indicators. The results are shown in Figure 3.3 and Figure 3.4 and

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and

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respectively for the factors of the Cost Saving and Revenue Support Indicators. Notably, the analysis is applied on 123 observations for four (4) and six (6) variables respectively and therefore cover the following criteria: Rule of 10; 3:1 ratio; 5:1 ratio (Bryant and Yarnold, 1995; Nunnaly, 1978; Gorsuch, 1983) and Rule of 100 (Hatcher, 1994). However, as some variables show correlation (see Spearman's test), it would have been best to have used more than 150 observations (Hutcheson and Sotiriou, 1999), which, however were not available.

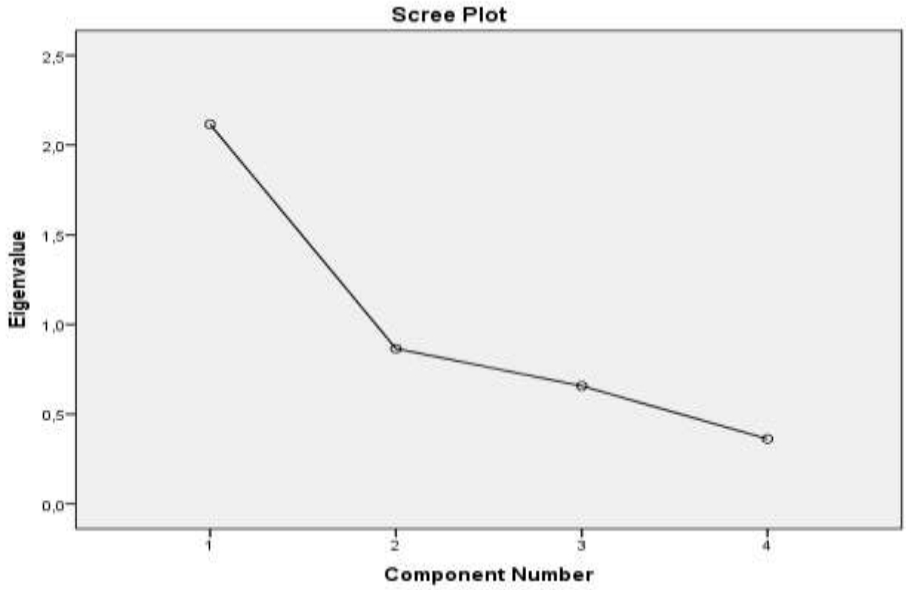

Figure 3.3: Eigenvalues for Cost Saving Indicator Factors

As noted from the scree plot (Figure 3.3) only one significant (value > 1.0) principal component was identified for the Cost Saving Indicator. For the Cost Saving indicator, factor loadings are presented in Table 3.3. Notably, all factors have values > 0,5 ($X_4X_5X_{CA1}$ is approximately 0,5). Given the fact that the present sample is rather small, the Joliffe criterion of dropping all variables below 0,70 was not adopted.

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Table 3.3: Factor Loadings for Cost Saving Indicator

Component Matrix	
	Component
	1
$X_2X_3X_{CA2}$	,854
X_1-$X_1X_2X_3$	-,681
$X_4X_5X_{CA1}$	,494
$X_7X_8X_9X_{CA3}$	,824

Extraction Method: Principal Component Analysis.

The scree plot of Figure 3.4 shows two significant (value >1) principal components identified for the Revenue Support indicator. The matrix of loading factors (Table 3.4) indicates that all variables are significant (>0,5).

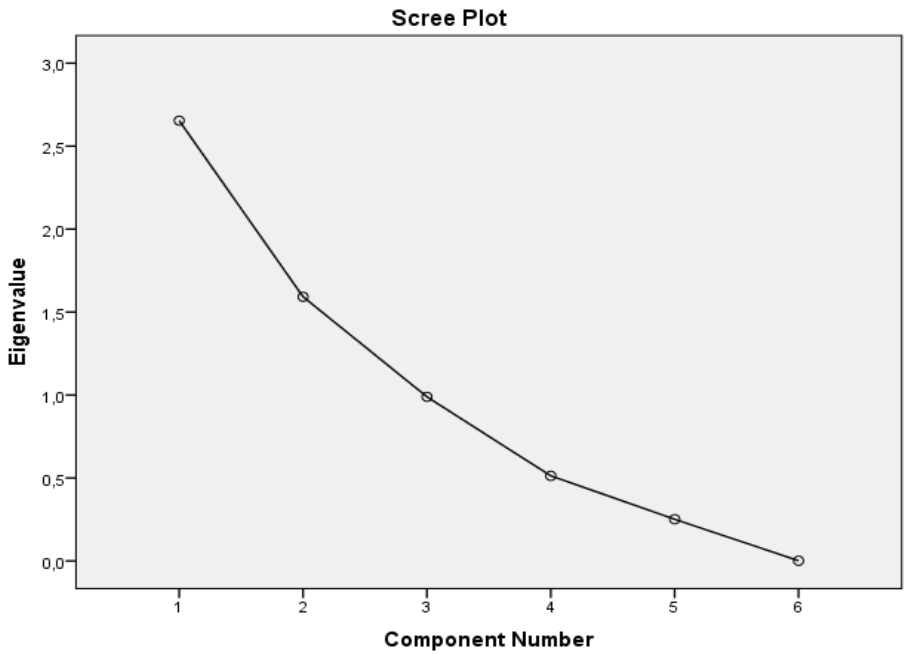

Figure 3.4: Eigenvalues for Revenue Support Indicator Factors

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Table 3.4: Factor Loadings for Revenue Support Indicator

Component Matrix		
	Component	
	1	2
X_{16}	0,963	-0,199
X_{11}	0,964	-0,197
$X_{10}X_{12}X_{13}X_{14}$	0,772	0,250
$X_{15}X_{17}X_{18}X_{19}$	0,293	-0,570
$X_{6}X_{12}X_{13}X_{14}$	0,266	0,712
$X_{20}X_{21}X_{22}$	0,211	0,787

Extraction Method: Principal Component Analysis.

3.2.3 Configuration of the BM Typology Indicators

Based on the analysis conducted in this section, the business model typology is configured through the two indicators Cost Saving and Revenue support as follows:

Cost Saving Function – Indicator
Following Figure 3.1, the Cost Saving Indicator is formulated as follows:

$\Phi_{CS}=x_2x_3x_{CA2}-(x_1-x_1x_2x_3)+x_4x_5x_{CA1}+x_7x_8x_9x_{CA3}$, during the construction phase, and

$\Phi_{CS}=x_7x_8x_9x_{CA,}$ during the operation phase,

When $\Phi_{CS}=0$, no cost saving is observed. When $\Phi_{CS}<0$, then cost overruns or a tendency for cost increase may be observed. Both expressions of Φ_{CS} *are normalized so as* $\Phi_{CS} \leq 1$.

Revenue Support Function
Following Figure 3.2, the Revenue Support Indicator is formulated as follows:

$\Phi_{RS}=(x_{11}+X_{16})$*respective share of brownfield+* $x_{10}x_{12}x_{13}x_{14}+x_{15}x_{17}x_{18}x_{19}+x_6x_{12}x_{13}x_{14}+x_{20}x_{21}x_{22}$

As in the previous formulation of the indicator, the component (v) referring to general outcomes **has been dropped** providing a more "operational" configuration of the indicator.

3.3 Governance typology

As output of the BENEFIT project Task 2.4, two dimensions clustering characteristics of project governance were identified, namely 'efficiency/effectiveness of governance' and 'contractual flexibility'. These two dimensions come from an extensive review of literature. A critical assumption was made in choosing these two dimensions. The scope of project governance is limited to transactions reflected in the project contract as suggested by Clarke (2004, 2007) and Mallin (2004, 2006). This means that the influence of external stakeholders on the project is not considered in the governance aspects. Further, it was initially assumed that cooperation-based project governance mechanisms reflected in the selected governance indicators generally have a positive influence on project performance and lead to more optimal project outcomes in comparison with traditional procurement and contracting procedures. Likewise, it was hypothesized that the implementation intensity of the selected formal governance mechanisms (contractual conditions) is positively associated with project performance.

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The latter two assumptions have been exhaustively substantiated by Eriksson and Westerberg (2011) and verified to a large extent by survey based research performed by Chen and Manley (2014) and Li, Arditi and Wang (2012). This shows the initial validation process undertaken in selecting the indicators.

On the basis of Chen and Manley (2014), Li, Arditi and Wang (2012) and Susarla (2012) research works, we found a set of relevant indicators that can be linked to 'efficiency/effectiveness of governance' and 'contractual flexibility' governance dimensions. The identified indicators also lead to reducing transaction costs according to Li, Arditi and Wang (2012). The indicators found in the literature have been extensively validated with statistical tests and exhibit high factor loadings. Factor loadings reveal the extent to which a certain variable is relevant to an specific latent variable or in this case to project governance latent variable. This further shows the initial validation process undertaken. To choose the proposed indicators, further checks were carried out including the examination of their disjoint nature, the evaluation of the indicators consistency with the proposed system model methodology (the matching framework), and more importantly their subtlety and measurability. The selected indicators are presented in Table 3.5.

Table 3.5: Governance indicators

Indicator	Factor loadings	Associated dimension
G1.The client selected only one service provider [bidder] to participate in the pricing stage	0.83^{++}	Efficiency/effectiveness of governance
G2.The client and the key service providers [bidders] collectively estimated the expected project cost	0.76^{++}	
G3.Encouragement of competition between bidders	0.84^{+}	
G4.Integration of design and construction	0.89^{+}	
G5.The key service providers [contractor] to pay a penalty if completion dates were not met	0.78^{++}	
G6.The key service providers [contractor] solely carried the risk of rising costs	0.77^{++}	
G7.The client and key service providers [contractor] [to share] shared equal proportions of profit due to cost under-runs	0.78^{++}	
G8. Bonding requirements	0.84^{+}	
G9. Commercial/revenue & financial risks are not concentrated	0.64^{+}	
G10. Clauses enable updating of service and/or price changes	*	Contractual flexibility
G11. Clauses indicate that client has an option to terminate the agreement without cause	**	

The factor G10 (denoted *) was found to be associated significantly with Pareto improving amendments. Pareto improving amendments are considered as renegotiations that improve the welfare of one party without worsening the other (e.g., Guasch et al. 2007, 2008) in Susarla (2012). These Pareto improving amendments usually lead to a reduction of transaction costs. This variable is evidently connected with the contractual flexibility component of the governance typology. Flexibility provisions reduce the likelihood of rent seeking by both parties lowering mal-adaptation and underinvestment (Susarla, 2012).

The factor G11 (denoted **) was found to be associated significantly with Pareto improving amendments. Pareto improving amendments are considered as renegotiations that improve the welfare of one party without worsening the other (e.g., Guasch et al. 2007, 2008) in Susarla (2012). These Pareto improving amendments usually lead to a reduction of transaction costs. This variable is connected with the contractual flexibility component of governance typology. Termination for

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convenience rights grants unilateral control to the client, reducing the likelihood that a contractor can engage in opportunistic rent seeking. The threat of unilateral termination by the client correspondingly lowers the likelihood of underinvestment by the contractor. Such enhanced performance incentives for a contractor correspondingly lower incentives for a client to force concessions or strategic termination, lowering the likelihood of mal-adaptation and underinvestment, facilitating smooth adaptation to unfolding contingencies and leading to Pareto improving amendments (Susarla, 2012).

For variables G2, G5, G6 and G7 (denoted $^{+}$) the factor loading reflects the relation to a latent variable most significantly associated with reduction transaction cost according to Li, Arditi and Wang (2012)

For variables G2, G5, G6 and G7 (denoted $^{++}$) the factor loading reflects the relation to formal mechanisms of project governance associated positively with project performance according to Chen and Manley (2014)

Note that factors associated with informal mechanism of governance (non-contractual conditions as identified by Chen and Manley (2014) and related to issues such as leadership, communication, decision making, competency) are not considered here, since they have a moderate effect on project performance if measured in terms of their contribution to transaction costs reduction (Li, Arditi and Wang, 2012). Note that, formal governance comprises contractual incentives for clear and equitable risk allocation (Lahdenperä 2010; Love et al. 2011 in Chen and Manley (2014)). Informal governance comprises non-contractual incentives to enhance mutual trust, enable cooperation, facilitate open communication, and share knowledge (Rahman and Kumaraswamy 2012 in Chen and Manley (2014)).

From Table 3.5 it is evident that the indicators selected consider aspects of project governance such as early involvement of the contractor in the design and estimation of costs, procurement procedures, integration of design and construction, incentives and dis-incentives regime, risk allocation, flexibility of the contract and actions that enable the contracting authority to maintain bargaining power during possible renegotiations. The above reflects many aspects of the relations between the contracting authority and contractors.

Further validation of the indicators was undertaken by carrying out Importance Analysis (IA), (see D4.2), using European case study projects with data reflected in 52 mutually independent records[14]. The IA used in this study is described elsewhere in this report. This analysis consisted of determining the relevance of the indicators as a function of its probability and degree of influence to generate cost and time under-runs in the case study projects studied. As a result of this analysis the indicator G7 in Table 3.5 was identified as irrelevant and accordingly removed from the set of indicators initially proposed. In the setting of the IA, the modelling approach (Bayesian networks) and the data used, it was also verified that the combined and optimal implementation of the procurement procedures and contractual arrangements reflected in the proposed governance factors significantly increases the likelihood of cost and time under-run occurring (up to 0.68 and 0.68 chance respectively).

G8 and G9 indicators values provided by the research partners were additionally cross-validated. We enriched the information attached to G8 and G9. To this end, we used information associated with the variables ‘risk of income’ and ‘incentives given to agent’ belonging to the funding scheme typology (elsewhere described in this report). As evident G8 and G9 share some input information with ‘risk of income’ and ‘incentives given to agent’ variables. As a result of the cross-validation, some values were corrected and it was possible to obtain additional variations for G8 and G9 over project life time reflected in different snapshots. In doing so, a new coding for G8 was necessary. G9 coding was not altered. The changes in the coding are reflected in the ‘scoring methodology’ section in Annex 1.

[14] The number of records used for the AI seemed to provide acceptable accuracy according to tests carried out by Onisko, Druzdzel and Wasyluk (2001).

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The validation of the set of indicators associated with governance included verification for usability. These verifications indicated that three out of 15 providers of information had difficulties in setting values for the indicators. In response, indicators descriptions and details on their usage were improved accordingly.

3.4 Funding scheme typology

3.4.1 Introduction

The analysis of the results of Matching Framework analysis revealed that the funding scheme indicators have a weak explanatory power over other project indicators and outcomes. The explanation for this outcome was that the funding overall indicators applied in the analyses were aggregating variables meant to reflect distinct effects on the viability and performance of the project. This caused loss of information and diffused the meaning of the indicator under analysis. This revision of the funding scheme typology regroups the indicators in aggregate indicators which contain a clearer meaning, eliminating the risk of loss of information for further analyses.

The revision includes the passage of the Incentive to Operational Performance to the Governance typology and the splitting of the aggregate indicator Remuneration Scheme into two.

3.4.2 Incentives indicator of the Remuneration scheme typology

1. The **Incentives to operational performance (from income)** reflects the incentives created by the formulation of remuneration scheme of the operator. The indicator tries to reflect how much the remuneration scheme is linked to the actual performance of the operator in terms of availability and quality.
2. In the previous formulation of aggregate indicators used in the analyses within Task 4.1-2, this indicator was weighted together with the cost recovery and income risk indicators in the aggregate Remuneration Scheme indicator. However, because these indicators reflected effects with rather different meanings, relevant information was being lost in the analyses.
3. On the other hand, the *incentives to operational performance* indicator fit appropriately into the Governance typology, which as whole reflects various types of incentives and concession performance issues. Input information of this indicator has been incorporated into the Governance aggregate indicator.
4. The aggregate Remuneration Scheme indicator, which now includes only *Cost Recovery* and *Income Risk*, could be renamed to *Remuneration Attractiveness*.

3.4.3 Market Efficiency and Acceptability indicators of the Revenue Streams typology

1. Like above, the indicators *Market Efficiency* and *Acceptability* derive from characteristics of the funding scheme but have a very different nature of the Revenue Streams indicators Cost Coverage and Revenue Risk, causing the results in the quantitative result of the aggregate Revenue Streams indicator to reproduce a diffuse meaning and loss of relevant information for the analyses.
2. In this scope, the analyses could benefit from considering a set of indicators that would have a clearer meaning and lower loss of information.
3. To this end, the consideration of an additional funding aggregate indicator which weighs the *Market Efficiency* and *Acceptability* indicators is proposed, with a similar weight for the two indicators:
   Transport Market Efficiency and Acceptability = 0,5* *Market Efficiency* + 0,5* *Acceptability*

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4. Additionally, the aggregate Revenue Streams indicator, which now includes only *Cost Coverage* and *Revenue Risk*, could be renamed to *Revenue Robustness*.
5. It should be noted, regarding the composite *Transport Market Efficiency and Acceptability* indicator, that still partly features the loss of information problem. For example, it may be that a project has a bad outcome or is not viable strictly due to the acceptability element, but the ability to identify this relation is partly constrained by the aggregation of the variables. The current proposal incorporates, as always, a trade-off between model simplification and loss of information.

3.4.4 Conclusion: Final Funding Scheme Typology indicators

In conclusion, the Funding Scheme will be composed of the following indicators:

- **Remuneration attractiveness**
  - Meaning: reflects the attractiveness of the remuneration scheme for investors
  - Composition: composed by the indicators Cost Recovery (income streams) and Risk of Income (weighting: no changes to the initial weighting formulation)
- **Revenue Robustness**:
  - Meaning: extent and risk of ability to cover the project costs from the revenues generated by or for the project
  - Composition: composed by the indicators Cost Coverage (revenue streams) and Risk of Revenues (weighting: the two indicators have equal weight)
- **Transport Market Efficiency and Acceptability**:
  - Meaning: composite indicator reflecting the political attractiveness of the project funding scheme from the perspectives of the efficiency of utilization of the transport infrastructure (allocative efficiency) and the acceptability of the funding scheme for voters
  - Composition: composed by the indicators Market Efficiency and Acceptability, with the same weight

The updated funding typology indicators application table is presented below.

3.4.5 Funding typology application table (updated)

Note: Final dimension scores range from 1 (best possible performance) to 0 (worst possible performance)

Table 3.6: Description of Funding Scheme Typology Dimensions

Dimensions and Sub-dimensions	Weight / Score	Indicator	Variable type and scale [direction of effect]	Assessment	Case study template related questions
DIMENSION: REMUNERATION ATTRACTIVENESS					
Cost recovery (remuneration scheme)	w: Cond. (>=100%)	Share of coverage of project costs assured by the funding scheme	Expected revenues as % of full project costs [+]	directly from case data (it may be assumed that the condition that the revenues are at least 100% is met in all private projects)	I.8.3
Risk of income (remuneration scheme)	w: score of cost recovery s: ∑(a.b)	a: Share of income stream i on total revenues	a: 0-100% [-]	directly from case data	Indicator a.: I.8.3

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Dimensions and Sub-dimensions	Weight / Score	Indicator	Variable type and scale [direction of effect]	Assessment	Case study template related questions
		b: Risk of income source i	b: scale: 1 (low risk) to 4 (high risk)	scenario: Assessment per remuneration method / income source: - Usage payment: 3 - Availability payment: 2 - Quality performance payments: 2 - Subventions: 1 case: if there is no data, expert opinion assessment based on context (competitive environment, State creditworthiness, etc.) may be realized	Indicator b.: - risk allocation: I.8.4 - severity of risk: not available in template
		wi: % of income stream i on total income	%	directly from case data (if case study doesn't provide exact data, the general knowledge of the income streams allows to apply approximate shares of each stream)	I.8.3
DIMENSION: REVENUE ROBUSTNESS					
Cost coverage (revenue streams)	w: 1	Share of coverage of project costs assured by the funding scheme	Expected revenues as % of full project costs [+]	- directly from case data (but not available in most case studies; in some cases the possible full cost coverage can be inferred from the remuneration scheme - e.g. a remuneration scheme fully based on user payments has >100% cost coverage; on the other hand, if the remuneration scheme is based on availability/quality, it may not be clear if that money comes from funds generated by the project) - Do not include public subventions (do not belong to revenues generated by or for the project)	I.8.5 (indirectly I.8.3). In public cases, apply I.8.3 data.
Risk of revenues (revenue streams)	w: score of cost recovery s: ∑(a.b)	a: Share of revenue stream i on total revenues	a: 0-100% [-]	directly from case data Subventions (money from public budget) should not be included	I.8.5
		b: Risk of revenue source i	b: scale: 1 (low risk) to 4 (high risk)	scenario: Assessment per remuneration method / income source: - User pays: 3 - Externality internalization: 4 - Consumption: 3 - Earmarking: 2 - Value capture: 2 Subventions (money from public budget should not be included) case: if there is no data, expert opinion assessment based on context (competitive environment, State creditworthiness, etc.) may be realized	Apply 'scenario' assessment scores, unless case study presents more detailed information.

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Dimensions and Sub-dimensions	Weight / Score	Indicator	Variable type and scale [direction of effect]	Assessment	Case study template related questions
DIMENSION: TRANSPORT MARKET EFFICIENCY AND ACCEPTABILITY					
Market and environmental efficiency	w: 1 s: smc1 (smc2 cond.)	smc1: Adherence of infrastructure use pricing scheme to (social) marginal costs of infrastructure use	Scale: 1 to 4 (1 - not related; 4 - fully related) [+]	- Does the pricing scheme reflect scarcity (airports and ports) or congestion costs (roads and railways)? - Does the pricing scheme reflect the internalization of external environmental and infrastructure (wear & tear) costs? Typical cases and suggested scores: 4 - Pure marginal cost pricing 3 - Congested airports / congested ports with market price 3 - Road infrastructure with "congestion pricing" (based on optimal congestion level) 3 - Rail/tram with price set to cover operational costs 2 - Not-congested infrastructure with user-pays pricing (including airports and ports) 2 - Not-congested infrastructure with no pricing 1 - Congested infrastructure with no pricing	I.8.5
		smc2: Application of consistent marginal cost pricing scheme in competitive infrastructure	1 - yes ; 0 -no [+]	If there is concurrent infrastructure, is the applicable pricing based on the same pricing principles? Under no detailed case information, it is suggested to assume that the answer is yes - 1. Examples: - At urban level there is typically competition between modes and they have different pricing principles: no - 0 - Tolled motorway with unrolled road next to it: no - 0 - Tolled motorway with user-pays principle next to competitive railway line: no - 0 - Port competing with other ports: yes - 1	I.9 - Conflicting pricing objectives

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Dimensions and Sub-dimensions	Weight / Score	Indicator	Variable type and scale [direction of effect]	Assessment	Case study template related questions
Public acceptability of funding scheme	w: 1 s: pa1 + 0.5*pa2	pa1: Direct benefits of project to Funding Agent(s)	Scale: 1 to 4 (1 - no benefits to funding agent(s); 4 - full alignment of benefits to funding agent) [+]	scenario: Score per Funding Agent: New Users (greenfield infrastructure): 4 Users previously non-charged (brownfield infrastructure): 2 Value capture: 3 General public taxpayers: 2 Other specific agents not directly benefitted from project: 1 case: subjective assessment on 'acceptability' of funding scheme	I.9 – Acceptability
		pa2: Perception that pricing revenue is applied towards a desired objective	Scale: 1 to 4 (1 - application of revenues not transparent ; 4 - application of revenue transparent and towards a desired objective) [+]	Are revenues allocated to an objective perceived as desirable? Typical cases: - User-pays principle - Polluter-pays principle - Urban tolls applied to fund sustainable mobility (collective transport, ...) Give a score only if the infrastructure use is priced. Otherwise, leave this indicator blank.	Inference from I.8.5

Notes:

Revenue stream vs. Remuneration scheme

- Revenue stream: revenues specifically generated by or for the project. The assessment of cost coverage and risks of revenues should not include money from the general public budget (subventions).
- Remuneration scheme: streams of income received by the project manager.

Scenario vs. case

For each indicator you may choose to make a general 'scenario' assessment based on more general characteristics of the project or 'case' assessment if you have more detailed information.

- Scenario assessment: based on general 'scenario' characteristics of the project. The assessment will be the same for any two projects with the same general characteristics.
- Case assessment: based on a more specific knowledge of the case, with additional quantitative or qualitative information

3.5 Financing scheme typology

3.5.1 Introduction

Considering the recommendations of D4.2, the financing indicator was revisited. The new financing scheme indicator conforms to the fundamental assumption underlying the development of all other BENEFIT indicators in that project structures with lower cost and lower risk should yield indicator values that tend to approach 1. Through this new financing indicator the lower the $WACC_{BEN}^{Adj}$ of a project (i.e. its overall cost of funds), the closer to 1 the indicator value will be.

The detailed structure of the new indicator is presented in the following.

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3.5.2 General formulation

The new financing scheme indicator considers the impact of the financing structure to the project based on the cost of funds of the various sources of capital. It, therefore, considers a variation of the concept of the Weighted Average Cost of Capital (Brealey et al 2011).

The BENEFIT version of the WACC is calculated by using theoretical values for the cost of funds of the different sources of capital committed to the project due to lack of more detailed information. Upon existence of available relevant information the financing indicator can be undertaken by a proper estimation of the project's WACC. In that case the adjusted WACC ($WACC^{Adj}$) would be estimated by dividing the WACC with the highest cost of funds found in the structure of all projects under consideration.

Notably, all projects, whether purely publicly financed or privately co-financed (e.g. PPP), are assumed to be drawing their financing from the following three sources of capital: (private) equity (E), (private) debt (D) and public sector funds (G). These sources of capital are divided to further subcategories.

In this approach, the new Financing Scheme indicator $\boldsymbol{I_{FS}}$ has the following form:

$$\boldsymbol{I_{FS} = 1 - WACC_{BEN}^{Adj}}$$

where:

$$WACC_{BEN}^{Adj} = \frac{WACC_{BEN}}{z} \quad , z \in \mathbb{Z}^{+}$$

and

$$WACC_{BEN} = K_E \times \frac{E}{E+D+G} + K_D \times \frac{D}{E+D+G} + K_G \times \frac{G}{E+D+G}$$

$WACC_{BEN}$ is the BENEFIT version of the Weighted Average Cost of Capital (WACC) of the project under consideration.

$WACC_{BEN}^{Adj}$ is the adjusted BENEFIT version of the WACC based on the scaling the theoretical costs of funds assigned to the different sources of equity and debt.

K_E is the cost of the equity committed to the project. In the absence of information that would enable the use of the Capital Asset Pricing Model (CAPM) for its estimation, theoretical values are used which are linked to the source of this equity contribution.

K_D is the cost of debt committed to the project. In the absence of information about loan interest rates or bond coupons, theoretical values are used based on the source of this debt contribution.

K_G is the cost of public sector funds to the projects.

E is the equity financing contribution (in monetary value or share %) to the project.

D is the debt financing contribution (in monetary value or share %) to the project.

G is the public sector financing contribution (in monetary value or share %) to the project.

z is the range of the theoretical scale that has been used to price the cost of funds for the various sources of equity and debt. In general z is assumed to be a positive integer number (in this case $z = 20$).

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Due to lack of detailed information, a number of simplifications have been adopted. These, in principle, concern assumptions with respect to the level or relative cost of capital of the various sources of financing. More specifically:

1. The effect of the corporate tax rate[15] on the debt cost of capital is assumed to be already reflected in the value of K_D.

2. For publicly financed projects K_G is considered 0, by definition. This is because for these projects the public sector does not have an expectation of making a financial return and all funds committed to them are usually "gifted". Likewise, public sector equity committed to publicly financed projects will also be considered to have a cost of funds equal to 0 ($K_E = K_G = 0$).

3. For privately co-financed projects the contribution of the public sector is differentiated depending on whether this is committed as a subsidy, as public sector (true) equity or as debt substitution (i.e. government guarantee).
   - In the case of a public sector subsidy K_G is considered 0, by definition.
   - In the case of true public sector equity the cost of funds should be expected to be high reflecting financial return expectations that would be (on average) commensurate to the expectations of other equity investors in that Project.
   - Finally, in the case of debt substitution the government is assumed to substitute the original debt facility with contingent government funds through the use of a guarantee. This guarantee is assumed to be provided for a (usually small) premium and consequently the corresponding cost of funds would be: $K_G = K_D^{Gov\ Grnt} = 1$.

3.5.3 Cost of funds for various sources of capital

Following on the above considerations, the various providers of private equity and debt, as well as public sector funds and other types of contributions are assumed to have the following cost of funds. This can be thought along the lines of the expected returns that these investors would anticipate from investing in an infrastructure project.

Table 3.7: Cost of funds for different sources of equity

Equity Category		Cost of funds (K_E)
Equity 1.	Private Equity (PE)-type funds and other short-term financial equity investors	20
Equity 2.	Individual affiliated investors (e.g. contractors, operators and other project sponsors)[16]	14
Equity 3.	Infrastructure funds and other long-term financial equity investors	11
Equity 4.	Commercial banks (equity investment)	8
Equity 5.	Public Sector (Government or similar)	Various*

<u>Note</u>
If the public sector equity is committed to a publicly financed project then $\boldsymbol{K_E = K_G = 0}$
If the Public Sector is participating as a true equity investor in a privately co-financed project then $\boldsymbol{K_E^{Public\ Sector} = \frac{\sum_{i=1}^{N} K_E^i}{N}}$ (i.e. the public sector would expect to earn at least as much as the average other investor in this project and would have a commensurate cost of funds)

[15] Usually $K_D = i \times (1 - T)$ where i is the interest rate and T is the corporate tax rate applicable (Brealey et al 2011)
[16] Including retail equity investors and/or crowdfunding (if applicable)

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Table 3.8: Cost of funds for different sources of debt

Debt Category		Cost of funds (K_D)
Debt A.	Debt investors: The general public (tradable bonds), institutional investors (e.g. pension funds, insurance companies, SWFs), non-leading banks, debt funds	6
Debt B.	Lead banks	5
Debt C.	EIB and other multilateral banks that are mainly self-financing	3
Debt D.	National or int'l development banks (e.g. EBRD, KfW in Germany, …)	2

Table 3.9: Cost of funds for additional Public Sector support categories

Variants	Cost of funds
Government guaranteed debt ($K_D^{Gov\ Grnt}$)	1
Public sector funds / Government subsidies (K_G)	0

For projects where more than one source of equity and/or debt have been committed then the overall cost of equity K_E and cost of debt K_D will need to be estimated by using the following formulas (cfr. Gatti 2013):

$$K_E^{Total} = \sum_{i=1}^{N} K_E^i \times \frac{E^i}{E}$$

and

$$K_D^{Total} = \sum_{j=1}^{M} K_D^j \times \frac{D^j}{D}$$

where:

K_E^{Total}	is the blended cost of funds for all equity contributions
K_E^i	is the cost of funds for the i source of equity
E^i	is the equity contribution from source i
E	is the total equity contribution to the project
K_D^{Total}	is the blended cost of funds for all debt contributions
K_D^j	is the cost of funds for the j source of debt
D^j	is the debt contribution from source j
D	is the total debt contribution to the project

3.5.4 Examples of estimation of I_{FS}

This section provides examples on the calculation of the new Financing Indicator. Five such examples are considered representing the range of typical financing schemes.

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Publicly financed project (public funds)
Assuming a project with a total project cost of €100 million financed entirely by the public sector (100%). In this case:

$K_G = 0$ (by definition)

$WACC_{BEN} = 0$

$WACC_{BEN}^{Adj} = 0$

$\boldsymbol{I_{FS} = 1 - WACC_{BEN}^{Adj} = 1 - 0 = 1}$

Publicly financed project (public funds & municipal bonds)
Assuming a project with a total project cost of €100 million financed by the public sector by 40% of total costs and for the rest (60%) Municipal bonds were issued. In this case:

$K_G = 0$ (by definition)

$K_D = 6$ (assumed Debt A)

$$WACC_{BEN} = \frac{60}{100} \times 6 + \frac{40}{100} \times 0 = 3.6$$

$$WACC_{BEN}^{Adj} = \frac{3.6}{20} = 0.18$$

$$\boldsymbol{I_{FS} = 1 - WACC_{BEN}^{Adj} = 1 - 0.18 = 0.82}$$

Privately co-financed project (no public sector support)
Assuming a project with a total project cost of €100 million financed by the private sector with a gearing ratio, D/E = 80/20. The Debt blending is considered to be provided by the European Investment Bank (60%) and commercial banks (40%). Equity is provided by two (2) project affiliated sponsors (70%), while the remaining 30% is provided by an infrastructure fund. In this case:

$$K_E^{Total} = \frac{70}{100} \times 14 + \frac{30}{100} \times 11 = 9.8 + 3.3 = 13.1$$

$$K_D^{Total} = \frac{60}{100} \times 3 + \frac{40}{100} \times 5 = 1.8 + 2.0 = 3.8$$

$$WACC_{BEN} = \frac{80}{100} \times 3.8 + \frac{20}{100} \times 13.1 = 3.04 + 2.62 = 5.66$$

$$WACC_{BEN}^{Adj} = \frac{5.66}{20} = 0.283$$

$$\boldsymbol{I_{FS} = 1 - WACC_{BEN}^{Adj} = 1 - 0.283 = 0.717}$$

Privately co-financed project (with government debt guarantees)
Assuming a project with a total project cost of €100 million financed by the private sector with a gearing ratio, D/E = 80/20 and supported by government debt guarantees. The Debt blending is

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considered to be provided by the European Investment Bank (60%) and the remaining 40% commercial banks guaranteed by the Government (100%) for a price (unknown). Equity is provided by two (2) project affiliated sponsors (70%), while the remaining 30% is provided by an infrastructure fund. In this case:

$$K_E^{Total} = \frac{70}{100} \times 14 + \frac{30}{100} \times 11 = 9.8 + 3.3 = 13.1$$

$$K_D^{Total} = \frac{60}{100} \times 3 + \frac{40}{100} \times 1 = 1.8 + 0.4 = 2.2$$

$$WACC_{BEN} = \frac{80}{100} \times 2.2 + \frac{20}{100} \times 13.1 = 1.76 + 2.62 = 4.38$$

$$WACC_{BEN}^{Adj} = \frac{4.38}{20} = 0.219$$

$$\boldsymbol{I_{FS} = 1 - WACC_{BEN}^{Adj} = 1 - 0.219 = 0.781}$$

Privately co-financed project (with government subsidy on initial costs)

Assuming a project with a total project cost of €100 million with a capital structure of 60% debt, 30% equity and 10% government subsidy. The Debt blending is considered to be provided by the European Investment Bank (60%) and the remaining 40% by commercial banks. Equity is provided by two (2) project affiliated sponsors (70%), while the remaining 30% is provided by an infrastructure fund. In this case:

$$K_G = 0$$

$$K_E^{Total} = \frac{70}{100} \times 14 + \frac{30}{100} \times 11 = 9.8 + 3.3 = 13.1$$

$$K_D^{Total} = \frac{60}{100} \times 3 + \frac{40}{100} \times 5 = 1.8 + 2.0 = 3.8$$

$$WACC_{BEN} = \frac{60}{100} \times \frac{90}{100} \times 3.8 + \frac{30}{100} \times \frac{90}{100} \times 13.1 + \frac{10}{100} \times 0 = 2.052 + 3.537 = 5.589$$

$$WACC_{BEN}^{Adj} = \frac{5.589}{20} = 0.2795$$

$$\boldsymbol{I_{FS} = 1 - WACC_{BEN}^{Adj} = 1 - 0.2795 = 0.7205}$$

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4 Matching Framework: The Assessment of Indicators

This chapter presents the impact of changes in the implementation context indicators on the performance of transport infrastructure projects. Three clusters of countries were identified based on the change in the financial-economic indicator and the impact on the disaggregated business model, funding scheme and financing scheme indicators is assessed.

4.1 Clustering of countries

The change of the Macro-economic and Financial indicator (FEI) from the BENEFIT Implementation context was used as indicator to identify the crisis in the countries included in the BENEFIT database.

The change of the FEI has been defined in three ways:

- The ratio of the minimum and maximum FEI values
- The ratio of the 2014 FEI value and maximum FEI value before the crisis
- The average compound change of the FEI indicator from year of the maximum MFI value till 2014

The maximum FEI value has been defined as the highest FEI value in the period from 2006 to 2008. Table 4.1 presents the maximum and minimum FEI values and the corresponding years. The table only includes countries for which the snapshots are available in the BENEFIT projects database.

Table 4.1: Maximum and minimum FEI values and corresponding years

Country	Max MFI	YearMaxFEI	Min FEI	YearMinFEI	2014FEI
Albania	0.567	2006	0.433	2014	0.433
Austria	0.700	2007	0.667	2009	0.667
Belgium	0.692	2007	0.600	2013	0.600
Switzerland	0.775	2008	0.725	2009	0.808
Cyprus	0.700	2008	0.425	2014	0.425
Czech Republic	0.667	2008	0.600	2013	0.658
Denmark	0.817	2007	0.658	2013	0.733
Germany	0.725	2008	0.658	2010	0.717
Spain	0.700	2006	0.467	2014	0.467
Estonia	0.742	2007	0.642	2009	0.725
Finland	0.792	2007	0.733	2014	0.733
France	0.683	2008	0.600	2013	0.617
United Kingdom	0.808	2006	0.583	2013	0.600
Greece	0.558	2007	0.292	2012	0.358
Croatia	0.625	2008	0.525	2014	0.525
Hungary	0.592	2006	0.533	2013	0.558
Italy	0.558	2006	0.450	2014	0.450
Montenegro	0.708	2008	0.525	2012	0.567
Netherlands	0.775	2007	0.658	2013	0.658
Norway	0.808	2006	0.733	2010	0.842
Poland	0.633	2008	0.600	2012	0.617
Portugal	0.642	2006	0.425	2014	0.425
Serbia	0.550	2008	0.408	2013	0.417
Slovakia	0.700	2006	0.608	2011	0.642
Slovenia	0.683	2007	0.433	2014	0.433
Sweden	0.792	2007	0.725	2012	0.775

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Table 4.2 presents the indicators used for cluster analysis.

Table 4.2: Indicators used for cluster analysis

Country	Min FEI/ Max FEI	2014 FEI/ Max FEI	Average FEI drop
Albania	0.765	0.765	0.0740
Austria	0.952	0.952	0.0286
Belgium	0.867	0.867	0.0655
Switzerland	0.935	1.043	-0.0069
Cyprus	0.607	0.607	0.1333
Czech Republic	0.900	0.987	0.0403
Denmark	0.806	0.898	0.0976
Germany	0.908	0.989	0.0444
Spain	0.667	0.667	0.1271
Estonia	0.865	0.978	0.0476
Finland	0.926	0.926	0.0032
France	0.878	0.902	0.0569
United Kingdom	0.722	0.742	0.1615
Greece	0.522	0.642	0.1476
Croatia	0.840	0.840	0.0722
Hungary	0.901	0.944	0.0281
Italy	0.806	0.806	0.0583
Montenegro	0.741	0.800	0.1236
Netherlands	0.849	0.849	0.0917
Norway	0.907	1.041	0.0052
Poland	0.947	0.974	0.0236
Portugal	0.662	0.662	0.1146
Serbia	0.742	0.758	0.0875
Slovakia	0.869	0.917	0.0583
Slovenia	0.634	0.634	0.1179
Sweden	0.916	0.979	0.0226

Using Max FEI/Min FEI and 2014 FEI/Max FEI indicators result in identical division of clusters, as presented in Table 4.3.

Table 4.3: Clustering of countries regarding impact of crisis

Cluster	Country	Min FEI/ Max FEI	Country	2014 FEI/ Max FEI
High impact of crisis	Greece	0.522	Slovenia	0.634
	Slovenia	0.634	Greece	0.642
	Portugal	0.662	Portugal	0.662
	Spain	0.667	Spain	0.667
	United Kingdom	0.722	United Kingdom	0.742
	Serbia	0.742	Serbia	0.758
Medium impact of crisis	Italy	0.806	Italy	0.806
	Denmark	0.806	Netherlands	0.849
	Netherlands	0.849	Belgium	0.867
	Belgium	0.867	Denmark	0.898
	France	0.878	France	0.902
Low impact of crisis	Czech Republic	0.9	Finland	0.926
	Norway	0.907	Poland	0.974
	Germany	0.908	Sweden	0.979
	Sweden	0.916	Czech Republic	0.988
	Finland	0.926	Germany	0.989
	Poland	0.947	Norway	1.041

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The values of maximum and minimum FEI sorted by clusters are presented in Table 4.4. The clusters of countries are presented in Figure 4.1.

Table 4.4: Maximum and minimum FEI values and corresponding years sorted by clusters

Country	Max FEI	YearMaxFEI	Min FEI	YearMinFEI	2014FEI
Albania	0.567	2006	0.433	2014	0.433
Austria	0.700	2007	0.667	2009	0.667
Belgium	0.692	2007	0.600	2013	0.600
Switzerland	0.775	2008	0.725	2009	0.808
Cyprus	0.700	2008	0.425	2014	0.425
Czech Republic	0.667	2008	0.600	2013	0.658
Denmark	0.817	2007	0.658	2013	0.733
Germany	0.725	2008	0.658	2010	0.717
Spain	0.700	2006	0.467	2014	0.467
Estonia	0.742	2007	0.642	2009	0.725
Finland	0.792	2007	0.733	2014	0.733
France	0.683	2008	0.600	2013	0.617
United Kingdom	0.808	2006	0.583	2013	0.600
Greece	0.558	2007	0.292	2012	0.358
Croatia	0.625	2008	0.525	2014	0.525
Hungary	0.592	2006	0.533	2013	0.558
Italy	0.558	2006	0.450	2014	0.450
Montenegro	0.708	2008	0.525	2012	0.567
Netherlands	0.775	2007	0.658	2013	0.658
Norway	0.808	2006	0.733	2010	0.842
Poland	0.633	2008	0.600	2012	0.617
Portugal	0.642	2006	0.425	2014	0.425
Serbia	0.550	2008	0.408	2013	0.417
Slovakia	0.700	2006	0.608	2011	0.642
Slovenia	0.683	2007	0.433	2014	0.433
Sweden	0.792	2007	0.725	2012	0.775

4.2 The assessment of indicator trends

This section presents the brief assessment of indicator trends for all projects in the BENEFIT database by clusters of countries, as well as by timing of snapshot and by the outcome of projects. Table 4.5 presents the number of cases assessed by cluster and by the time period.

Table 4.5: Number of projects assessed by cluster

Cluster	Before the crisis		During the crisis		After the crisis	
	No of projects	No of snapshots	No of projects	No of snapshots	No of projects	No of snapshots
High impact	9	10	16	20	21	22
Medium impact	1	1	/	/	3	3
Low impact	4	6	4	6	3	3

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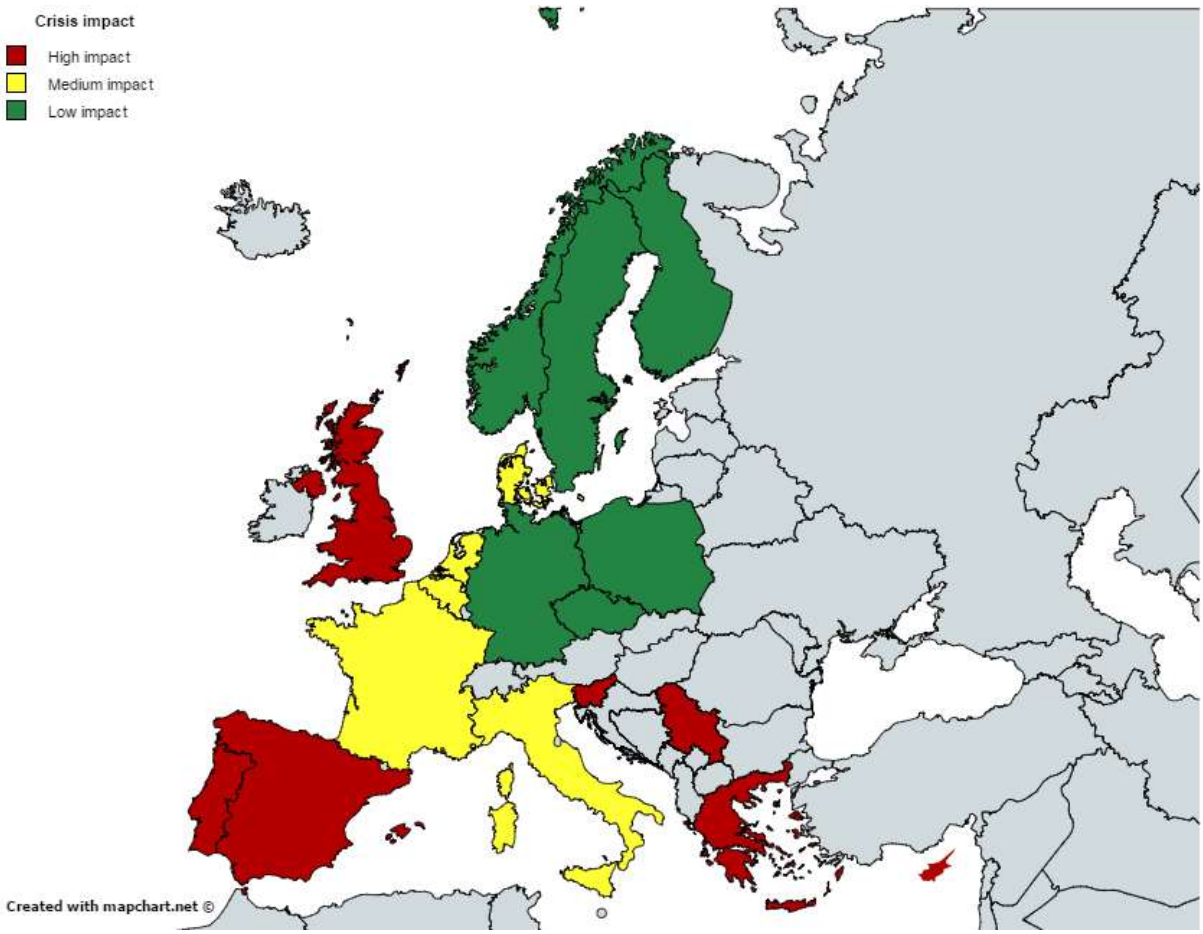

Figure 4.1: Distribution of countries by clusters

Figure 4.2 presents the impact of COST SAVINGS (CSI) indicator on COST OVERRUN. Before crisis, only projects with COST OVEERUN were located in the high impact cluster. For Medium and Low impact clusters and for period after the crisis, higher values of CSI indicator are generally related to better performing projects regarding COST OVERRUN. However, for High impact cluster no trend can be observed.

Similarly, when same trends are analyzed for roads and bridges & tunnels (Figure 4.3), it is not possible to identify trends for road projects in the BENEFIT database, while bridge & tunnel projects that are performing in line have higher CSI indicator compared to underperforming projects.

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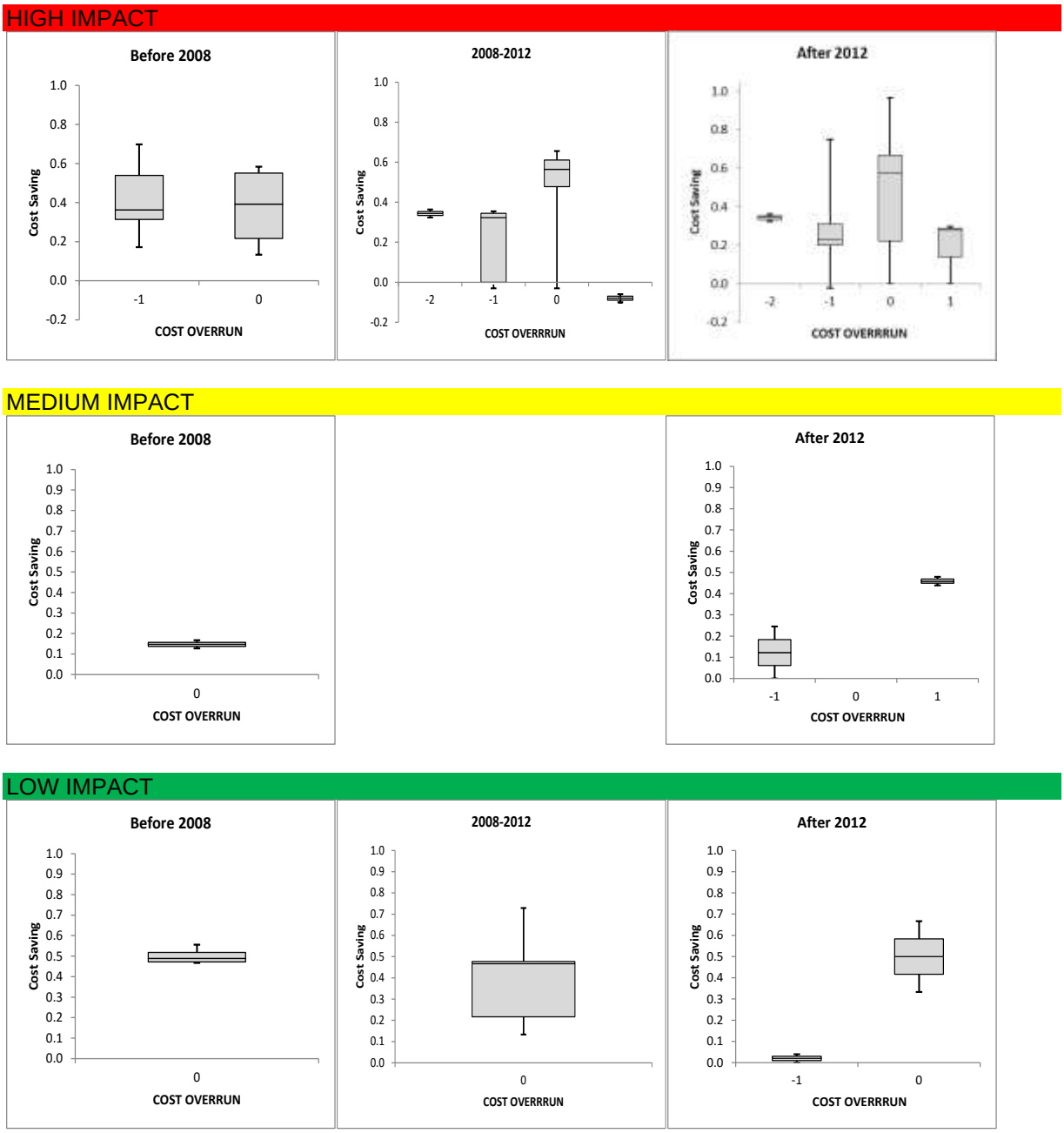

Figure 4.2: Impact of Cost savings (CSI) indicator on COST OVERRUN

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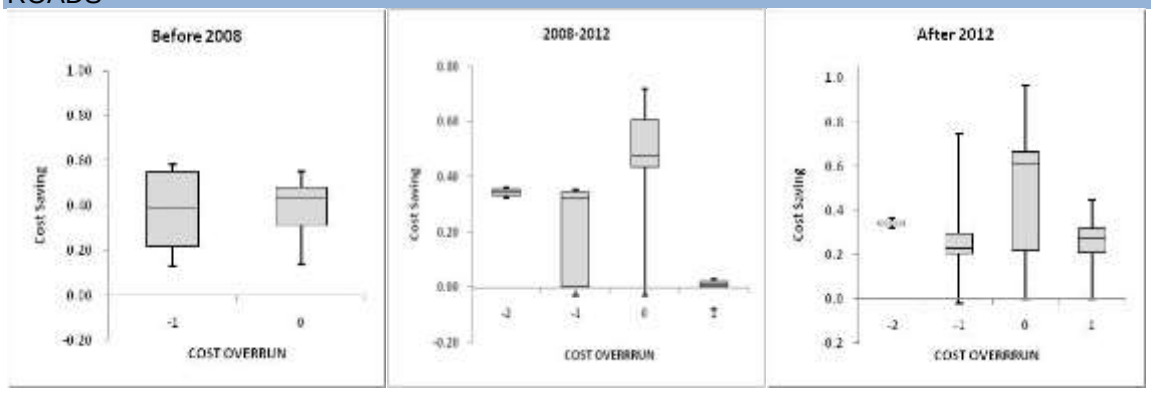

BRIDGE/TUNNEL

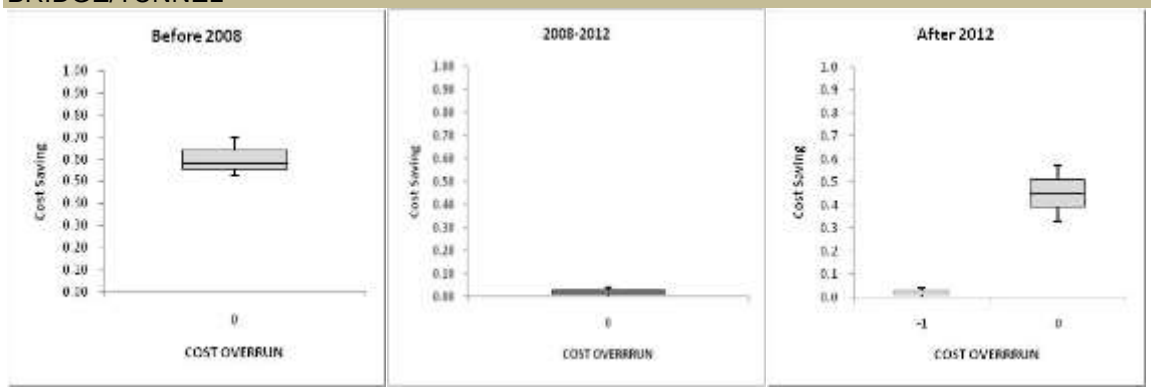

Figure 4.3: Impact of Cost savings (CSI) indicator on COST OVERRUN for road and bridge&tunnel projects

Figure 4.4 presents the impact of FSI on COST OVERRUN. For High impact cluster there is general trend towards higher values of FSI for better performing projects in all periods. However, the trend is reversed for outcomes “0” and “-1” which means that this trend is quite weak.

For Medium and High impact clusters different outcomes are available only for snapshots after the crisis. However the trends in these two clusters don’t coincide. While for Medium impact cluster there is no substantial difference between FSI for two different outcomes, for Low impact cluster it appears that lower values o FSI indicator after the crisis are related to projects performing in line.

Similarly, for Bridge&tunnel projects the FSI indicator is lower for projects performing in line compared to projects with COST OVERRUN, while for road projects there is general, but weak trend, of higher values of FSI for better performing projects. During and after the crisis, there is an increase in Cost saving Indicator, for project performed under cost. Reason behind the trend may be found in the increase in the capability to construct or to operate, dictated by the more demanding market.

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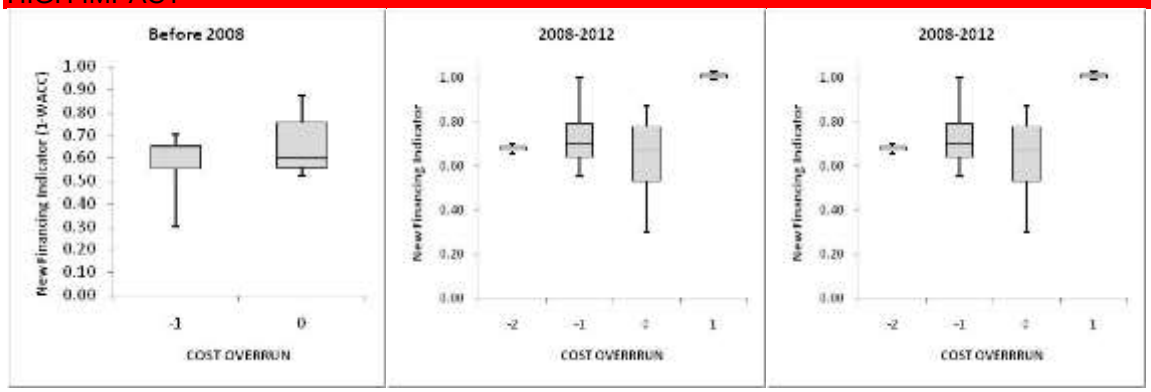
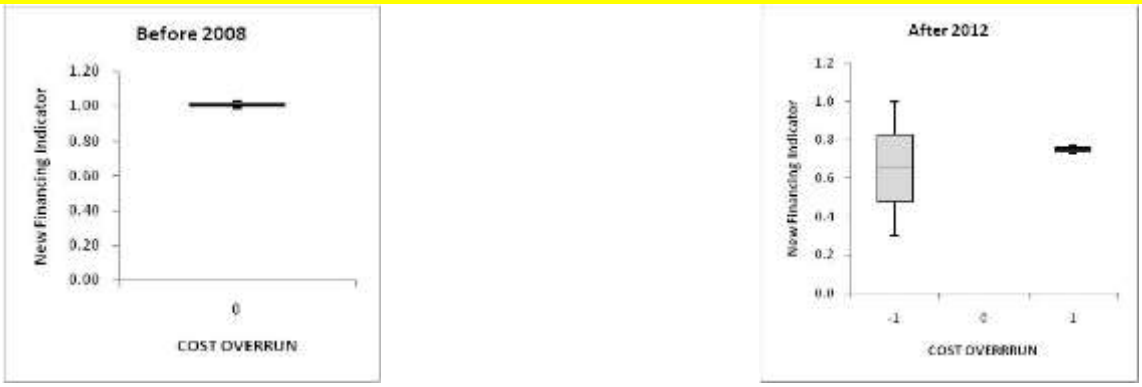
HIGH IMPACT



MEDIUM IMPACT



LOW IMPACT

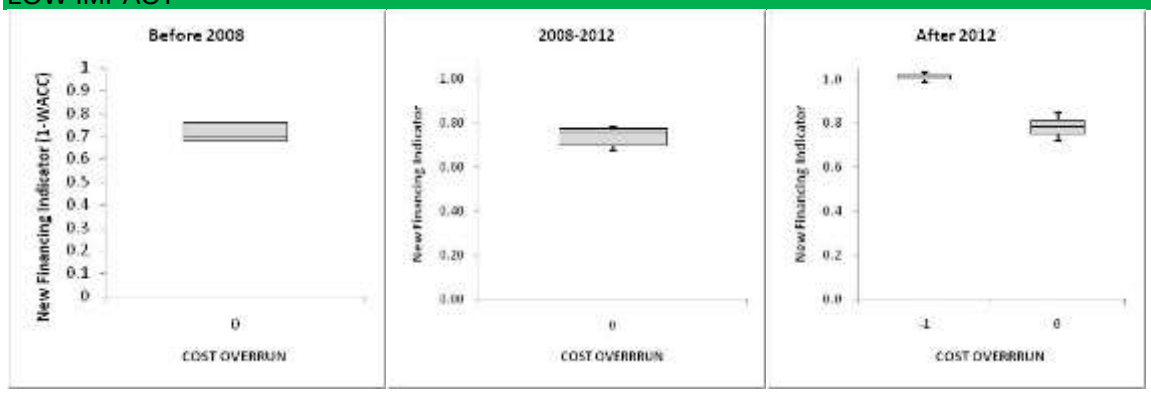


Figure 4.4: Impact of New financing scheme (FSI) indicator on COST OVERRUN

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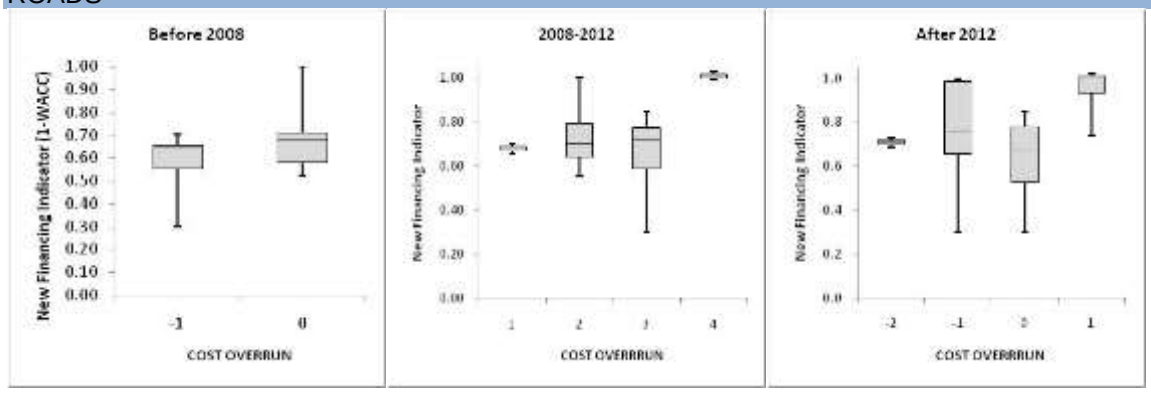

BRIDGE/TUNNEL

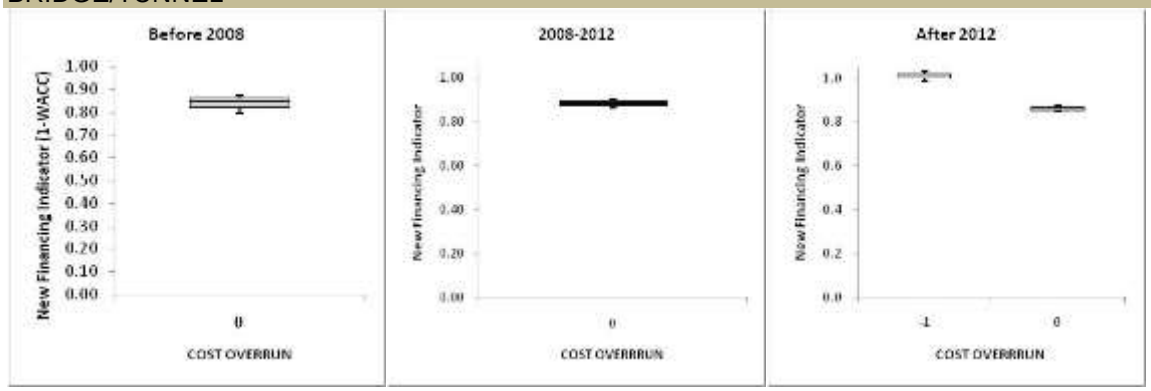

Figure 4.5: Impact of FSI indicator on COST OVERRUN for road and bridge&tunnel projects

No clear trend can be observed on the impact of FSI on TIME OVERRUN, for High and Medium impact clusters, as presented in Figure 4.6. In the Low impact cluster the values of FSI before and during the crisis were relatively similar for projects performing in line or above expectations, while for snapshots after the crisis, the FSI is lower for better performing projects.

For road projects no trend can be observed, while for bridge&tunnel projects slightly lower values of FSI are related to better performing projects after the crisis.

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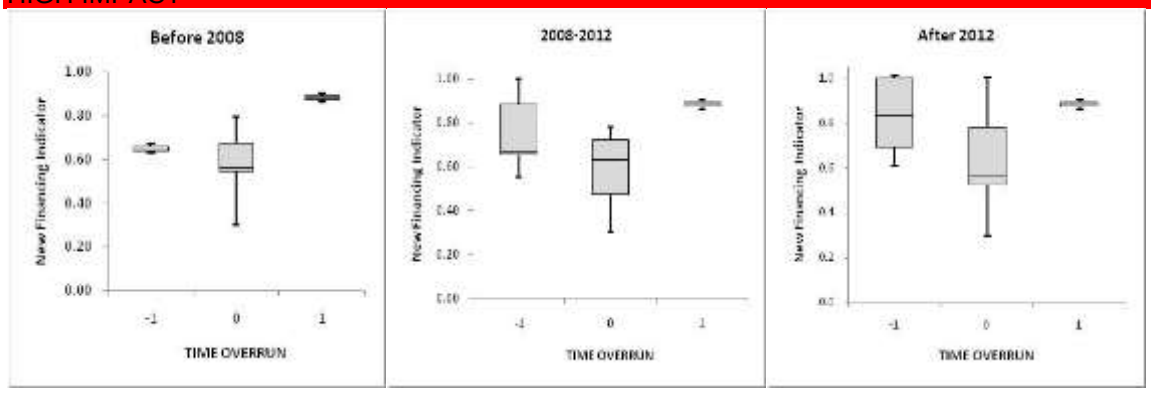
HIGH IMPACT



MEDIUM IMPACT

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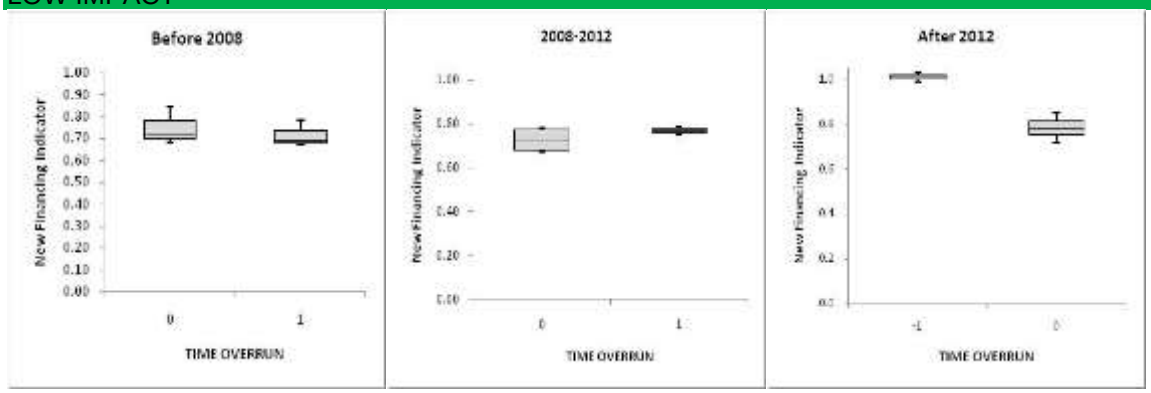

Figure 4.6: Impact of FSI on TIME OVERRUN

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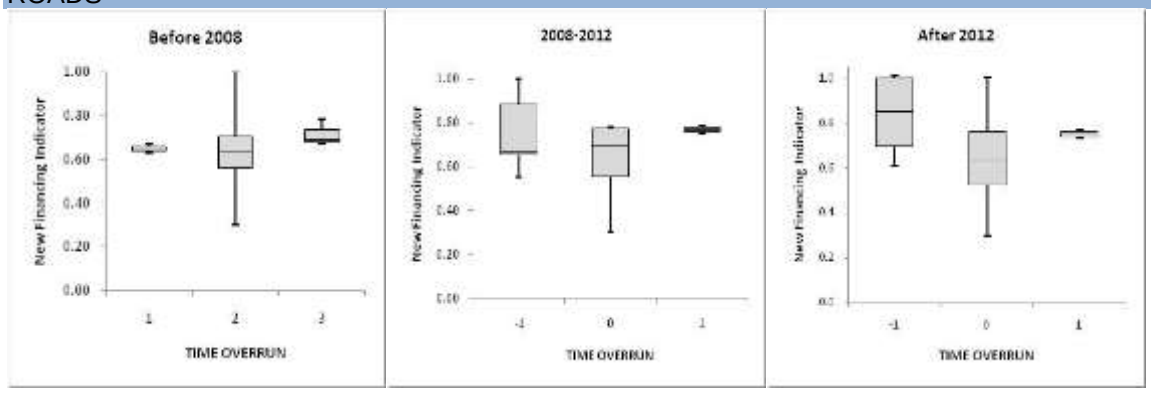

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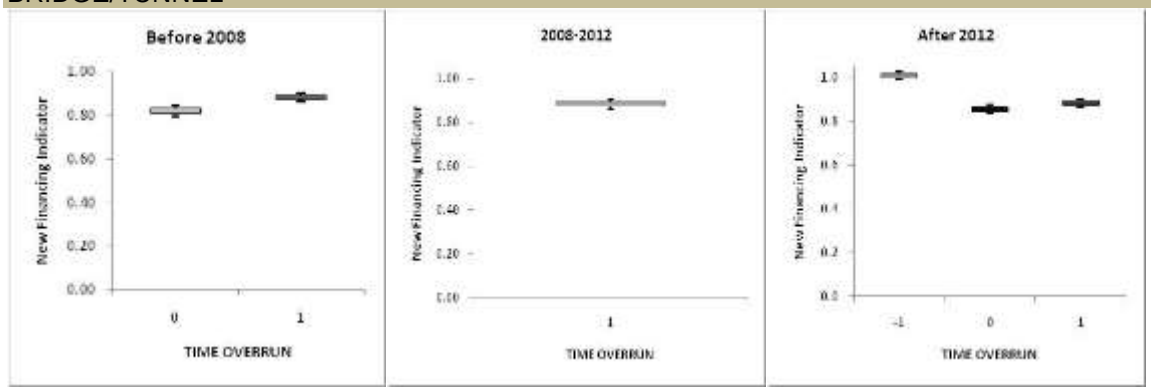

Figure 4.7: Impact of FSI on TIME OVERRUN for road and bridge&tunnel projects

No clear trend in the FSI can be observed for high or low impact clusters regarding the traffic outcome, as presented in Figure 4.8. For medium impact cluster the FSI after the crisis is lower for better performing projects.

Similarly, no trend can be observed for FSI regarding the road projects, while for bridge&tunnel projects it appears that FSI indicator is slightly higher after the crisis for better performing projects (Figure 4.9), indicating higher participation of public funds in financing of projects.

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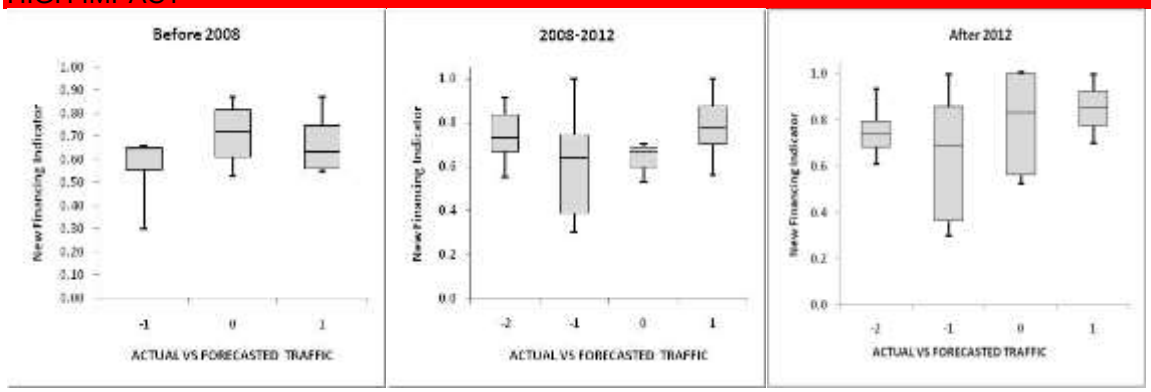
HIGH IMPACT



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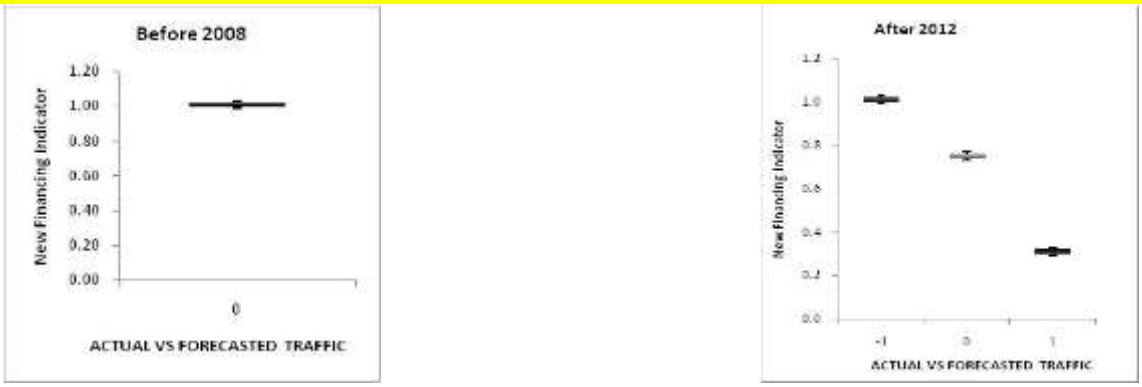

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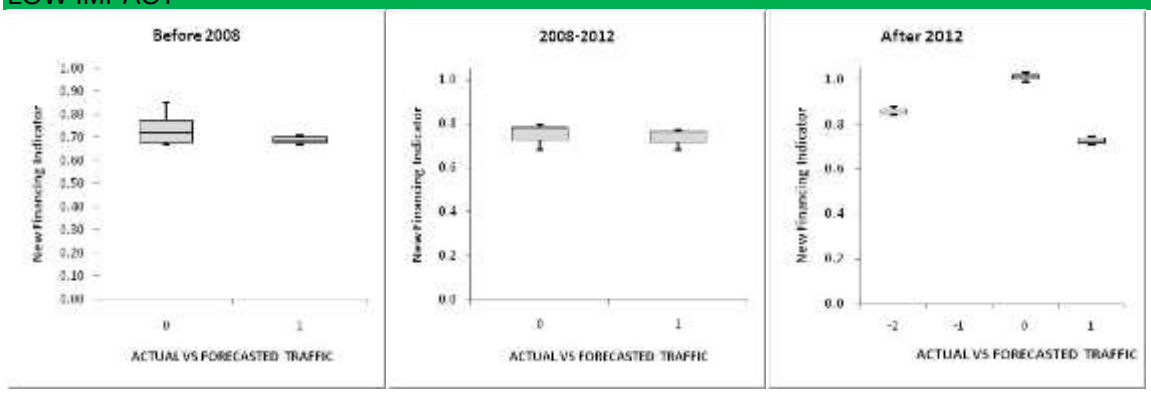

Figure 4.8: Impact of FSI on ACTUAL vs FORECASTED TRAFFIC

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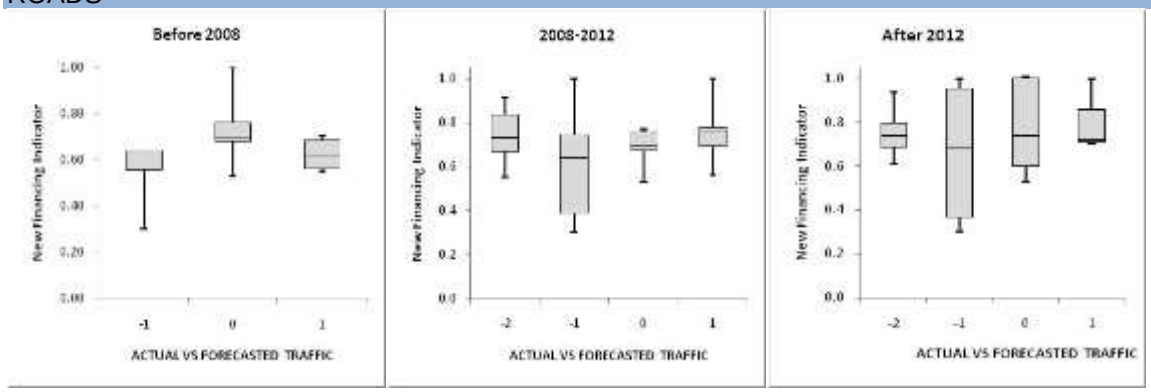

BRIDGE/TUNNEL

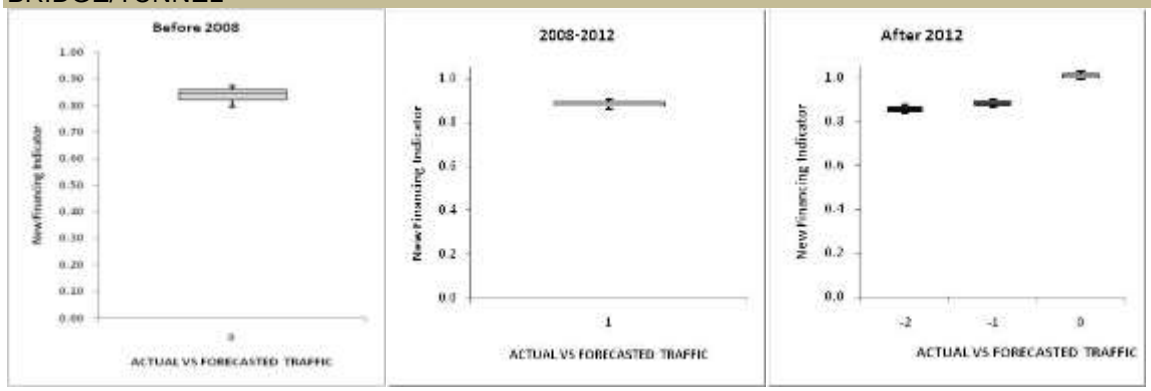

Figure 4.9: Impact of FSI on ACTUAL vs FORECASTED TRAFFIC for road and bridge&tunnel projects

The RRI appears to be lower during or after the crisis for low and high impact clusters, as presented in Figure 4.10. However, again, no clear trend can be identified, except for medium cluster, where the value of RRI is higher for project performing above expectations.

No trends can be observed for road and bridge&tunnel projects (Figure 4.11).

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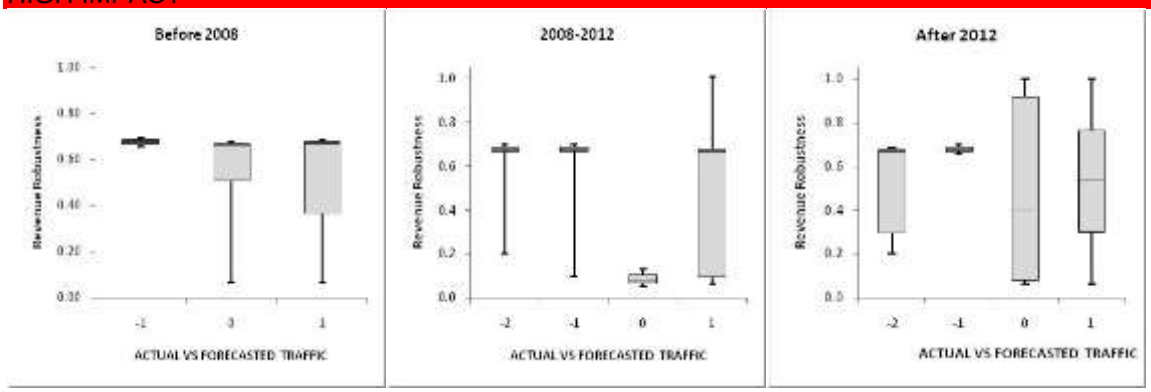
HIGH IMPACT



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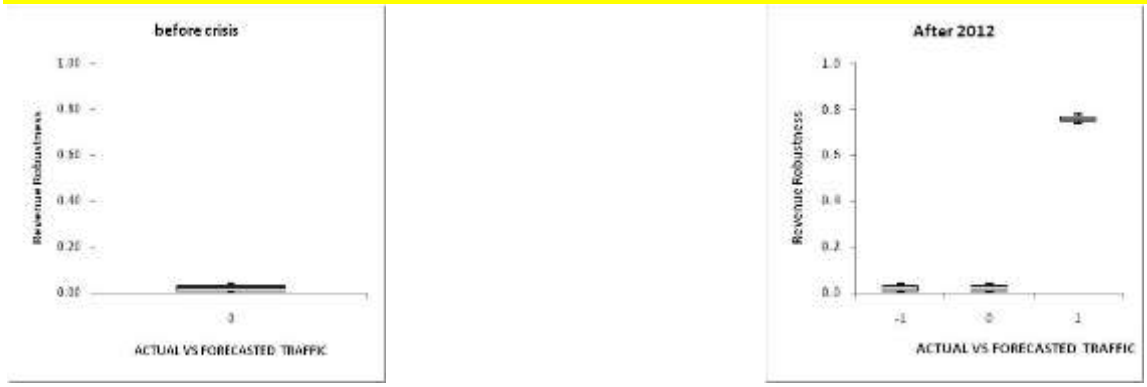

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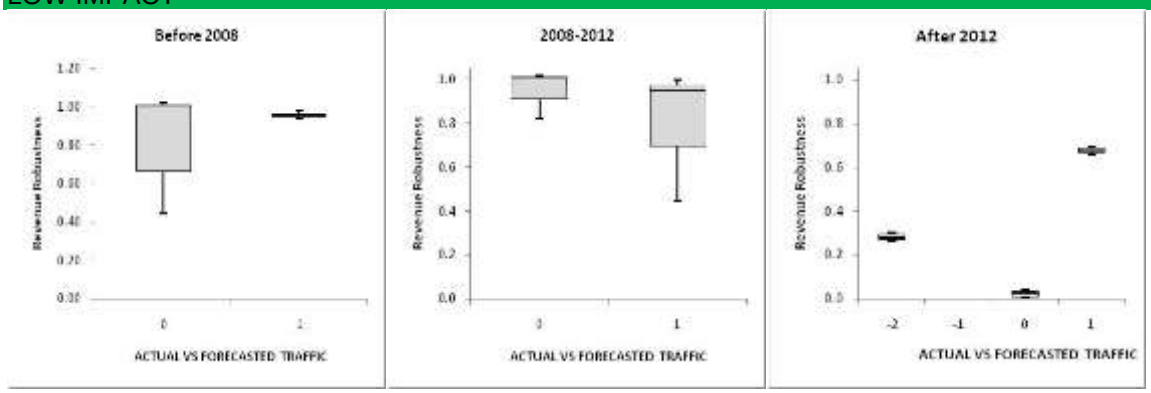

Figure 4.10: Impact of RRI on ACTUAL vs FORECASTED TRAFFIC

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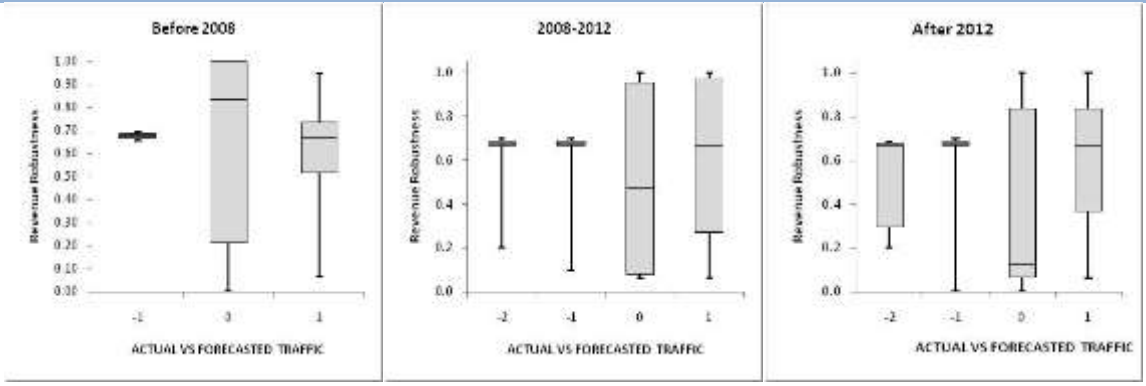

BRIDGE/TUNNEL

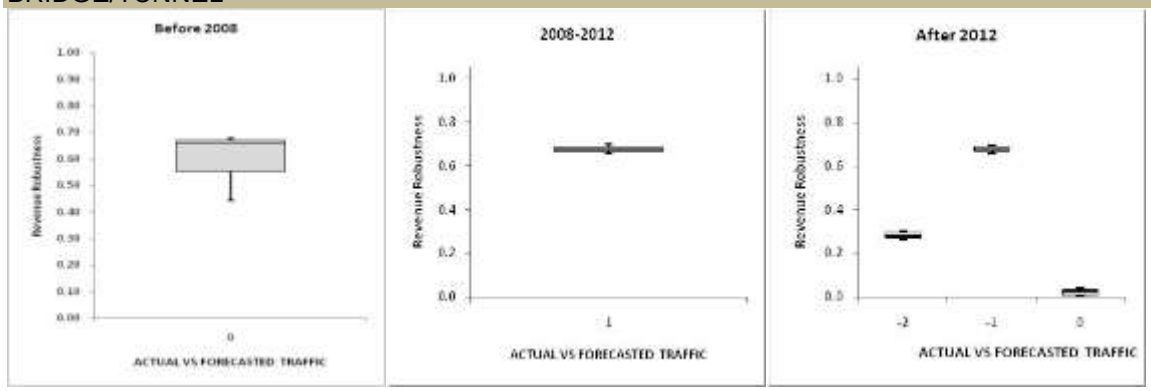

Figure 4.11: Impact of RRI on ACTUAL vs FORECASTED TRAFFIC for road and bridge&tunnel projects

The values the RAI in High impact cluster are generally higher after the crisis, especially for well performing project (Figure 4.12). The trend is opposite for Medium cluster countries, where well performing projects have lower values of RAI. For Low impact countries there is no trend.

For road projects it is not possible to observe trend, while for bridge&tunnel projects the values of RAI are generally higher for better performing projects.

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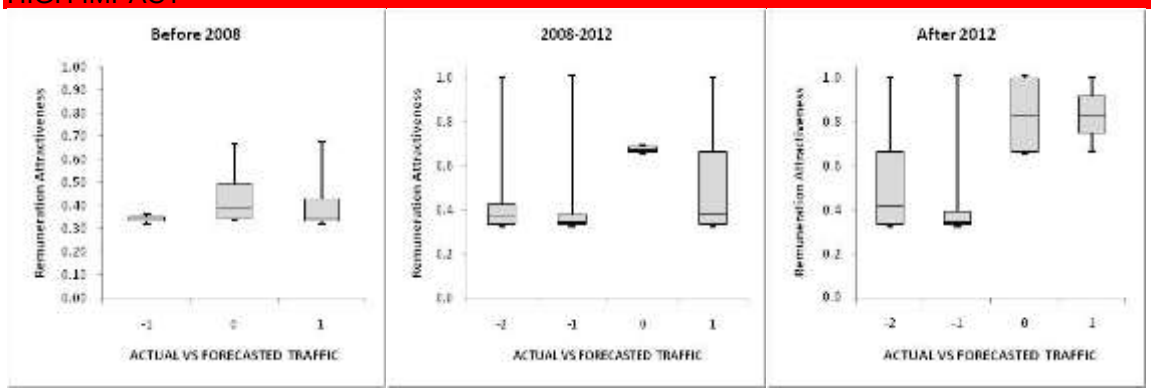

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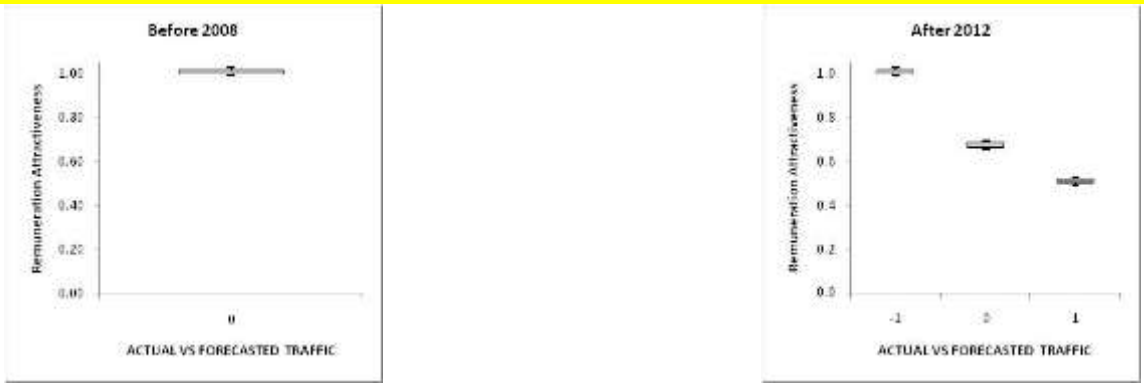

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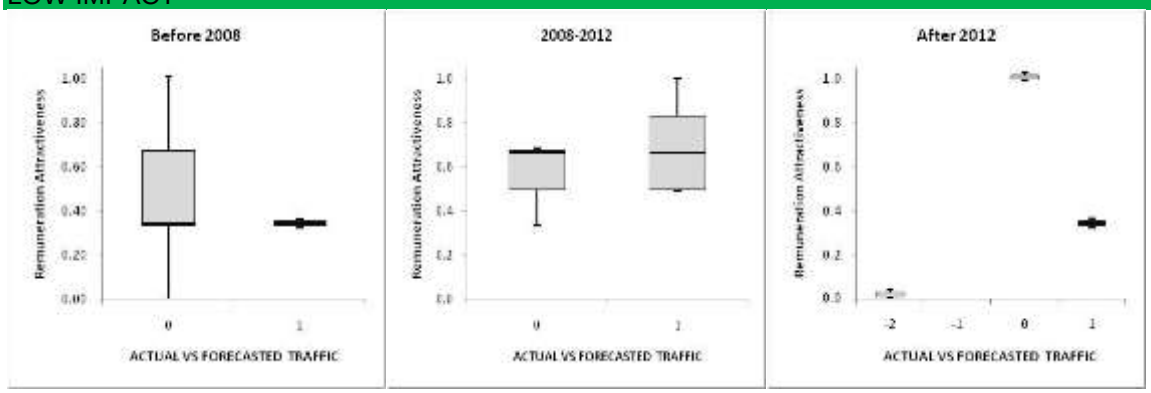

Figure 4.12: Impact of RAI on ACTUAL vs FORECASTED TRAFFIC

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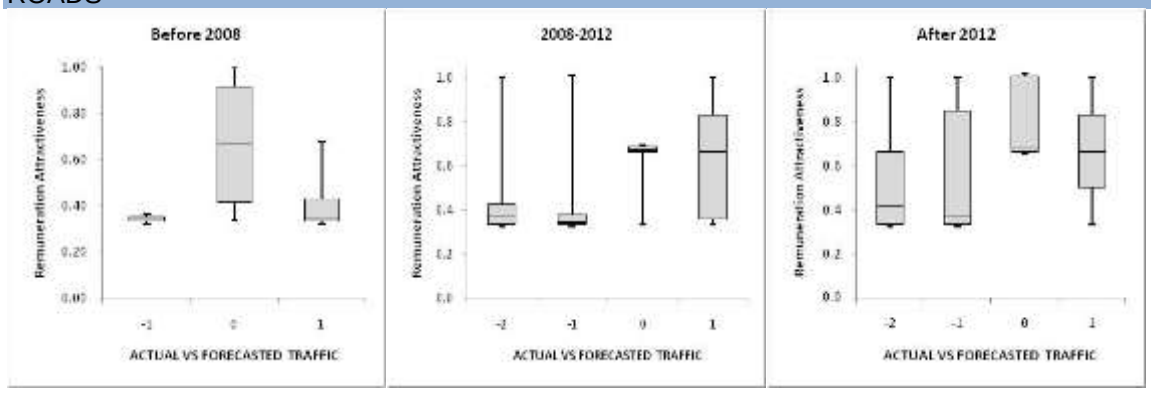

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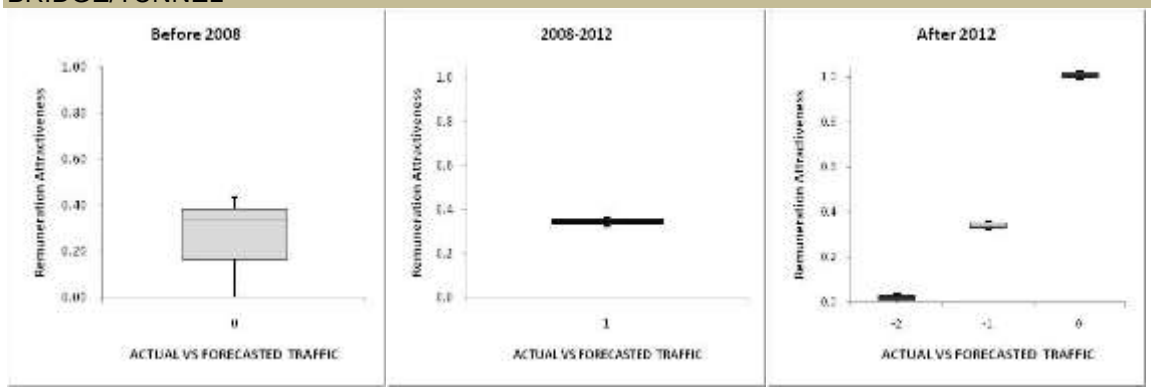

Figure 4.13: Impact of RAI on ACTUAL vs FORECASTED TRAFFIC for road and bridge&tunnel projects

On the other hand, RAI takes higher values during and after the crisis for projects performing under or over traffic projections. The reason for that may be explained by caution of private partners choosing projects with lower risk.

4.3 Conclusion

This section presented some general trends of CSI, FSI, RRI and RAI indicators versus cost, time and traffic outcomes of projects in the BENEFIT database, for periods before, during and after the crisis, and for three clusters of countries regarding crisis impact.

In many cases it was not possible to identify clear trends, primarily due to limited number of cases and snapshots available, especially when subdivided by clusters.

Based on the presented analysis it is clear that analysis of individual indicators is not sufficient to explain trends in project performance, and that combination of indicators should be assessed in order to better model the impact of different indicators on project performance. The Fuzzy Set Qualitative Comparative Analysis, Importance and Econometric analysis, presented in Chapters 5, 6, and 7, respectively, identify the combinations of indicators with crucial impact on project performance.

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5 Fuzzy Set Qualitative Comparative Analysis

5.1 Introduction

The methodology applied in this section is explained in the section 'Fuzzy Set Qualitative Comparative Analysis: methodological and theoretical notes' (Annex 2 to this chapter).. Readers are recommended to read that first, in order to understand the way of working in this chapter. The calibration is explained in the Annex 1 of this chapter 'Method of calibration'.

The purpose of this report is to identify the factors that affect the performance of the transport infrastructure projects with respect to the crisis. A fuzzy set Qualitative Comparative analysis (fs QCA) is conducted for four outcomes: cost, time, traffic and revenues. Since in this deliverable 4.4, we examine the 'Effects of the Recent Economic and Financial Crisis', fs QCA analysis is conducted with respect to crisis. More particularly, two sub-samples are tested for the crisis analysis: 1) projects completed (inaugurated) before crisis and 2) projects completed after crisis. The year 2008 is the year that we use as the beginning of the crisis. In the table below, the exact number of projects and conditions used per outcome and per sample are presented. In the fs QCA, by 'conditions' we mean the variables/indicators that are used in the analysis.

Table 5.1: Number of projects and conditions used per outcome and per sample

	Cost-time	Max conds.	Traffic-revenues	Max conds.
Crisis completion	25 (AFTER)	6*	21 (AFTER)	5
Crisis completion	22 (BEFORE)	5	22 (BEFORE)	5

The typology indicators used are the following 8:

1. Institutional Context
2. Economic & Financial Context
3. Governance
4. Cost Saving
5. Remuneration Attractiveness
6. Revenue Robustness
7. Transport market efficiency and acceptability
8. Financing Scheme (NEW)

The indicators IRA (Reliability & Availability indicator, Transport Mode Typology) and the Revenue Support indicator (Business Model Typology) are not included in the analysis because the variation of these indicators is <0.3. QCA does not allow us using indicators whose variation is less than 0.3.

We followed two steps to conduct this analysis: 1) initial analysis of the models, using the maximum number of conditions allowed and 2) simplification method based on which **only core conditions** are used for re-running the analysis, based on the more simple models created. These steps are presented as part A, and B throughout the report.

For the initial models in part A we had to pre-select the allowed number of conditions as we study restricted samples in order to reduce the number of conditions retained in our models and hypotheses. This is in particular the case in the following samples in this report: (a) analyses studying the sample of projects completed before crisis; (b) analyses studying the sample of projects completed after crisis. For the analyses on these two samples we had to pre-select the conditions we will test in the FsQCA

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models, as the size of these samples only allows to test five or six conditions (instead of the initial eight conditions we use in the models on the full sample).

In order to select these conditions to use in these restricted models, we use the following starting points:

a. As we study both the conditions that explain the presence as well as the absence of the outcome, we decided to use the same set of conditions for both the analyses of the presence and absence of the outcome. This is in line with other studies analysing both the conditions for presence and absence.
b. As our initial theoretical model (see previous WPs) contain all conditions (typology indicators) and does not make any prior assumptions about the relative importance of these conditions for presence or absence of the outcome, we had to develop an alternative method for selecting a more restricted set of conditions for the smaller samples we study.
c. This selection method is based on the relevance of individual conditions for the outcome in the involved sample. More specifically the selection is made based on the necessity consistency and necessity coverage of that condition (Bol and Lupi, 2013). The necessity consistency is the proportion of cases showing the condition and the outcome among the cases disclosing the outcome. The necessity coverage refers to the empirical importance of such a necessary condition, showing the proportion of cases showing the condition *and* the outcome among the cases showing the condition.
d. We selected the same set of relevant conditions for presence and absence, by taking those conditions which have the highest necessity consistency either in the necessity analysis for the presence of the outcome or the absence of the outcome. This implies that the selected condition is potentially relevant for explaining either the presence or the absence of the outcome. Selected conditions need to have a necessity consistency for presence or absence of the outcome of at least 0.75 or higher[17] Moreover, when ranking the conditions based on their necessity consistency, we checked whether their necessity coverage was not too low (below 0.33), with other words, we checked their empirical relevance.
e. Hence, depending on the number of conditions we could include in a certain model in relation with the sample size, we selected that number of conditions which showed the highest necessity consistency either in the necessity analysis of the presence or the absence of the condition and used that set of conditions in the sufficiency analysis for both presence and absence of the outcome.

In part B we further simplified solutions by including in a second set of analyses only the core conditions that were shown in the solution of the initial model, and leaving out the non-relevant and the peripheral conditions. As the core conditions are part of the simplest solution (i.e. parsimonious solution) of the initial model, we wanted to check if we could further simplify solutions by only including core conditions. If the results in the second set of analyses result in solutions with approx. equally high or higher sufficiency consistency and coverage and include more simple paths, we include them in the report and conclusions. Crucial is that readers should be aware that in this second set of analyses, the set of conditions that was used for the sufficiency analysis of the presence of outcome is not necessarily the same set of conditions that was used for the sufficiency analysis of the absence of the outcome. One should take this into account when comparing and interpreting results across these analyses. However, not all initial models can be simplified because either 1) there are no results from the initial analysis, or 2) only one condition is core.

The initial models that are used for testing the two samples of the projects completed before and after crisis are the following:

[17] Only when a condition has a necessity consistency of 0.90, a condition is considered to be a necessary condition for the outcome under consideration. However a somewhat lower necessity consistency still points at relevant conditions. Sometimes we even select conditions with necessity consistency <0.75 when consistencies are not high.

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Table 5.2: Initial models that are used for testing projects completed 'before & after crisis"

Models	Involved projects	Included conditions
Models for the presence and the absence of the 'on cost' outcome	Completion before crisis sample	Institutional context, Financial-economic context, Governance indicator, Remuneration attractiveness, Financing scheme
Models for the presence and the absence of the 'on cost' outcome	Completion after crisis sample	Institutional context, Financial-economic context, Governance indicator, Remuneration attractiveness, Transport market efficiency and acceptability, Financing scheme
Models for the presence and the absence of the 'on time' outcome	Completion before crisis sample	Institutional context, Financial-economic context, Governance, Remuneration attractiveness, Financing scheme
Models for the presence and the absence of the 'on time' outcome	Completion after crisis sample	Institutional context, Financial-economic context, Governance, Remuneration attractiveness, Transport market efficiency and acceptability and Financing scheme
Models for the presence and the absence of the 'on traffic' outcome	Completion before crisis sample	Institutional context, Financial-economic context, Governance, Remuneration attractiveness and Financing scheme
Models for the presence and the absence of the 'on traffic' outcome	Completion after crisis sample	Institutional context, Financial-economic context, Governance, Remuneration attractiveness and Financing scheme
Models for the presence and the absence of the 'on revenue' outcome	Completion before crisis sample	Financial-economic context, Governance indicator, Cost saving, Revenue robustness, Financing scheme.
Models for the presence and the absence of the 'on revenue' outcome	Completion after crisis sample	Institutional context, Financial-economic context, Governance indicator, Remuneration attractiveness, Financing scheme

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5.2 Analysis of the sample of projects completed before and after the crisis

5.2.1 1st Crisis Sub-sample: Projects completed before crisis

5.2.1.1 Cost analysis (22 cases - five conditions)

5.2.1.1.1 Part A: COST - FULL MODELS' ANALYSIS (using max. number of conditions)

For the cost outcome analysis with respect to the projects being completed before crisis, 22 projects are used and thus maximally five conditions. The five indicators used in the model are the five indicators which have the highest consistencies in the necessity control.

Necessity analysis

The necessity analysis is conducted for the eight conditions and is presented in Table 5.3. A high financing scheme showed to be necessary for projects being on cost (consistency: 0.94).

Table 5.3: Necessity analysis of the 'on cost' outcome for the crisis _before completion sample

Conditions	On Cost	
	Presence	Absence
High Institutional Context	**0.76** (0.71)	0.75 (0.45)
Low Institutional Context	0.40 (0.72)	0.50 (0.58)
High Economic & Financial Context	0.56 (0.66)	**0.71** (0.53)
Low Economic & Financial Context	0.60 (0.76)	0.55 (0.45)
High Governance	**0.80** (0.73)	0.72 (0.42)
Low Governance	0.37 (0.67)	0.54 (0.64)
High Cost Saving	0.70 (0.79)	0.59 (0.420
Low Cost Saving	0.49 (0.65)	0.70 (0.60)
High Remuneration Attractiveness	0.31 (0.65)	0.54 (0.72)
Low Remuneration Attractiveness	**0.87** (0.75)	0.74 (0.41)
High Revenue Robustness	0.61 (0.67)	0.70 (0.49)
Low Revenue Robustness	0.54 (0.74)	0.53 (0.47)
High Transport market efficiency and acceptability	0.51 (0.71)	0.52 (0.47)
Low Transport market efficiency and acceptability	0.62 (0.67)	0.68 (0.47)
High Financing Scheme (NEW)	0.94 (0.74)	0.72 (0.37)
Low Financing Scheme (NEW)	0.19 (0.52)	0.49 (0.84)

The typology conditions used for the 'cost' outcome analysis of the before crisis completion sample are: **1) the institutional context, 2) the financial-economic context, 3) the governance indicator, 4) the remuneration attractiveness and 5) the financing scheme**.

Sufficiency analysis

The solution of the on cost analysis shows that high institutional context and low financial-economic context, as core conditions, combined with high governance and high financing scheme can explain almost half of the projects to be 'on cost' (49%) (Table 5.4). The consistency was not very high but still satisfying (0.78).

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Table 5.4: Sufficiency analysis of projects being 'on cost' (cut off: 0.79)

Conditions	OUTCOME: presence of "on cost"
	Solution 1
Institutional Context	+
Financial-economic context	~
Governance	+
Remuneration Attractiveness	
Financing scheme (NEW)	+
Individual Consistency	0.78
Coverage (Raw)	0.49
Coverage (Unique)	0.49
Number of cases	5
Some relevant cases	**Port of Leixoes (0.65,0.8),** **Lusoponte Vasco da Gama Bridge (0.65,0.8),** **A22 motorway (0.59,0.8),** **A23 motorway (0.59,0.8),** **FERTAGUS Train (0.56,1)**
Overall Consistency/Coverage	(0.78/**0.49**)

Testing the absence of the on cost outcome shows that 45% of the projects being 'over cost' (and completed before crisis) can be explained by low financing scheme as a core condition and low remuneration attractiveness as a peripheral condition (Table 5.5). The consistency was also very high, 0.87.

Table 5.5: Sufficiency analysis of projects being 'on cost' (cut off: 0.79)

Conditions	OUTCOME: absence of 'on cost'
	Solution 1
Institutional Context	
Financial-economic context	
Governance	
Remuneration Attractiveness	~
Financing scheme (NEW)	~
Individual Consistency	**0.87**
Coverage (Raw)	0.45
Coverage (Unique)	0.45
Number of cases	1
Some relevant cases	**C-16 Terrasa Manresa toll motorway (0.75,1)**
Overall Consistency/Coverage	(0.87/**0.45**)

5.2.1.1.2 Part B: Simplification Method- Simplifying the Initial Full Models of cost with Only Core Condition

As mentioned on Table 5.4, we re-run the model using two conditions: institutional context and economic & financial context. Although the result was not quite satisfying where the consistency ratio slightly dropped from 0.78 to 0.76, however, the coverage slightly increases from 0.49 to 0.51 (Table 5.6). Thus, 51% of the projects being 'on cost' can be explained by high institutional context and low financial-economic setting as core conditions.

Since the solution formula of the over cost outcome contains only one core condition, the simplification model is not applied. Therefore, the solution formula for explaining the projects being over cost is illustrated in Table 5.5, above.

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Table 5.6: Sufficiency analysis of projects being 'on cost' (cut off: 0.76)

Conditions	OUTCOME: presence of 'on cost'
	Solution 1
Institutional Context	+
Financial-economic context	~
Individual Consistency	0.76
Coverage (Raw)	0.51
Coverage (Unique)	0.51
Number of cases	5
Some relevant cases	**Port of Leixoes (0.65,0.8),** **Lusoponte Vasco da Gama Bridge (0.65,0.8),** **A22 motorway (0.59,0.8),** **A23 motorway (0.59,0.8),** **FERTAGUS Train (0.56,1)**
Overall Consistency/Coverage	(0.76/**0.51**)

5.2.1.2 Time analysis (22 cases - five conditions)

5.2.1.2.1 Part A: TIME - FULL MODELS' ANALYSIS (using max. number of conditions)

Time outcome analysis for the projects being completed before crisis is conducted with the same number of cases and conditions as the cost outcome analysis (22 cases-maximum five conditions). The selection of these five conditions is made through the necessity control, by selecting the five conditions with the highest consistencies.

Necessity analysis

The necessity analysis is conducted for the eight conditions selected and is presented in Table 5.7. High financing scheme has a consistency at 0.896 for the projects being over time. Thus it is considered as necessary since it is very close to 0.90. However, no results were found for the absence of the 'on time' outcome.

Table 5.7: Necessity analysis of the 'on time' outcome for the before crisis completion-sample

Conditions	On Time	
	Presence	Absence
High Institutional Context	0.79 (0.85)	**0.83** (0.37)
Low Institutional Context	0.41 (0.86)	0.65 (0.56)
High Economic & Financial Context	0.59 (0.81)	**0.82** (0.46)
Low Economic & Financial Context	0.61 (0.89)	0.65 (0.39)
High Governance	**0.84** (0.89)	0.73 (0.32)
Low Governance	0.36 (0.77)	0.75 (0.65)
High Cost Saving	0.67 (0.87)	0.74 (0.40)
Low Cost Saving	0.54 (0.83)	0.77 (0.49)
High Remuneration Attractiveness	0.37 (0.88)	0.57 (0.56)
Low Remuneration Attractiveness	0.82 (0.82)	**0.88** (0.36)
High Revenue Robustness	0.67 (0.85)	0.72 (0.37)
Low Revenue Robustness	0.51 (0.81)	0.72 (0.47)
Transport market efficiency and acceptability	0.52 (0.85)	0.62 (0.42)
Transport market efficiency and acceptability	0.64 (0.81)	0.78 (0.40)
High Financing Scheme (NEW)	0.87 (0.80)	**0.896** (0.34)
Low Financing Scheme (NEW)	0.28 (0.87)	0.46 (0.59)

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The typology conditions used for the 'time' outcome analysis of the 'before crisis-completion' sample are: **1) the institutional context, 2) the financial-economic context, 3) the governance indicator, 4) the remuneration attractiveness and 5) the financing scheme**. The sample was composed of 22 projects, meaning that the maximum number of conditions that can be used in the analysis (excluding the outcome) are five (similarly for the cost analysis). The five conditions selected are the ones with consistency >0.75.

Sufficiency analysis

The analysis of the on time outcome gives very strong solutions (Table 5.8). The overall consistency of this solution is very high (0.90). The governance is core condition for both solution paths (solution 1a and 1b). The strongest solution (1st one) showed that 74% of the projects on time can be explained by high governance as a core condition and high financing scheme as a peripheral condition, with consistency 0.89.

Table 5.8: Sufficiency analysis of projects being 'on time' (cut off: 0.84)

Conditions	OUTCOME: presence of "on time"	
	Solution 1a	Solution 1b
Institutional Context		+
Financial-economic context		+
Governance	+	+
Remuneration Attractiveness		
Financing scheme (NEW)	+	
Individual Consistency	**0.89**	**0.86**
Coverage (Raw)	0.74	0.53
Coverage (Unique)	0.26	0.05
Number of cases	15	8
Some relevant cases	**Lusoponte Vasco da Gama Bridge (0.88,0.8), Port of Leixoes (0.84,0.8), Athens International Airport (0.79,0.8), FERTAGUS Train (0.78,0.8), Rion-Antirion Bridge (0.78,1), E4 Helsinki-Lahti (0.77,1), BNRR (M6 Toll) (0.72,0.8), A22 motorway (0.7,0.8), A23 motorway (0.7,0.8), Athens Ring Road (0.6,0.8), E39 Orkdalsvegen Public Road (0.6,0.8), M-45 (0.6,0.8), Herrentunnel Lübeck (0.6,0.8), Athens Tramway (0.57,0.8), A-19 Dishforth (0.54,0.8)**	**BNRR (M6 Toll) (0.73,0.8), E4 Helsinki-Lahti (0.64,1), A-19 Dishforth (0.63,0.8), C-16 Terrasa Manresa toll motorway (0.6,0.8), E39 Orkdalsvegen Public Road (0.6,0.8), M-45 (0.6,0.8), Herrentunnel Lübeck (0.6,0.8), Lyon's VeloV (0.56,0.8)**
Overall Consistency/Coverage	**(0.90/0.79)**	

No results are found for the absence of the time outcome because the consistency <0.75. Thus we can only identify the combinations of conditions affecting the projects on time and not the projects over time.

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5.2.1.2.2 Part B: Simplification Method- Simplifying the Initial Full Models of Time with Only Core Conditions

As shown in Table 5.7, the governance is a core condition for explaining the presence of the 'on time' outcome. Due to a limited number of core conditions (only governance) and also strong overall and individual coverages, we do not simplify the model.

5.2.1.3 Traffic analysis (22 cases - five conditions)

Traffic outcome analysis for the projects completed before the crisis is conducted with the same number of cases and conditions as the cost and time outcome analysis (22 cases - five conditions). The selection of these five conditions is made through the necessity control, by selecting the five conditions with the highest consistencies.

5.2.1.3.1 Part A: TRAFFIC - FULL MODELS' ANALYSIS (using max. number of conditions)

Necessity analysis

The necessity analysis is conducted for seven conditions and is presented in Table 5.9. It is conducted for seven instead of eight conditions because the initial models that are used for the full sample analysis of the traffic outcome were composed by seven conditions (all typology indicators apart from the transport market efficiency and acceptability) (Table 5.9). No condition is shown to be necessary for projects on or below traffic.

Table 5.9: Necessity analysis of the 'on traffic' outcome for the before crisis completion-sample

Conditions	On Traffic	
	Presence	Absence
High Institutional Context	**0.85** (0.61)	0.68 (0.59)
Low Institutional Context	0.44 (0.53)	0.56 (0.81)
High Economic & Financial Context	0.46 (0.69)	0.31 (0.56)
Low Economic & Financial Context	0.71 (0.46)	**0.83** (0.65)
High Governance	**0.80** (0.53)	0.75 (0.60)
Low Governance	0.40 (0.57)	0.41 (0.71)
High Cost Saving	0.70 (0.66)	0.52 (0.58)
Low Cost Saving	0.55 (0.49)	0.69 (0.74)
High Remuneration Attractiveness	0.55 (0.69)	0.43 (0.65)
Low Remuneration Attractiveness	0.73 (0.52)	**0.80** (0.68)
High Revenue Robustness	0.72 (0.57)	0.63 (0.60)
Low Revenue Robustness	0.50 (0.53)	0.54 (0.70)
High Financing Scheme (NEW)	0.82 (0.49)	**0.84** (0.61)
Low Financing Scheme (NEW)	0.35 (0.65)	0.30 (0.66)

The typology conditions used for the 'traffic' outcome analysis of the before crisis-completion sample are: **1) the institutional context, 2) the financial-economic context, 3) the governance indicator, 4) the remuneration attractiveness and 5) the financing scheme**. The conditions selected are the ones with the highest consistencies >0.75 in the necessity control, thus cost saving and revenue robustness are excluded.

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Sufficiency analysis

No results are found for the presence of the traffic outcome, because the raw consistency did not pass the threshold cut off consistency equal to 0.75. This means that we cannot identify the factors affecting the projects being on traffic.

Testing the absence of the 'on traffic' outcome shows that 60% of the projects being below traffic can be explained by low remuneration attractiveness and low financial economic context which are combined with low institutional context as core condition (solution 1) or low financing scheme as core condition (solution 2) (Table 5.10). The strongest path (1st solution) showed that low institutional context as a core condition and low financial-economic context and low remuneration attractiveness as peripheral conditions can affect 54% of the projects below traffic. The consistency ratio is 0.83.

Table 5.10: Sufficiency analysis of projects being 'below traffic' (cut off: 0.80)

Conditions	OUTCOME: absence of 'on traffic'	
	Solution 1	Solution 2
Institutional Context	~	
Financial-economic context	~	~
Governance		
Remuneration Attractiveness	~	~
Financing scheme (NEW)		~
Individual Consistency	**0.83**	0.79
Coverage (Raw)	0.54	0.27
Coverage (Unique)	0.33	0.06
Number of cases	4	1
Some relevant cases	**Athens Ring Road (0.72,0.67), Rion-Antirion Bridge (0.72,0.67), Athens Tramway (0.71,1), Athens International Airport (0.65,0.67)**	**C-16 Terrasa Manresa toll motorway (0.75,0.67)**
Overall Consistency/Coverage	**(0.82/0.60)**	

5.2.1.3.2 Part B: Simplification Method- Simplifying the Initial Full Models of Traffic with Only Core Condition

A solution is found only for the absence of the 'on traffic' outcome, so a simplified model is created only for testing the absence of the 'on traffic' outcome. When simplifying the model by using only core conditions, namely institutional context and financing scheme, the new model gives a more simple solution formula (Table 5.11). In summary, 56% of the projects being below traffic can be explained by low institutional context and consistency ratio equal to 0.81.

Table 5.11: Sufficiency analysis of projects being 'below traffic' (cut off: 0.82)

Conditions	OUTCOME: absence of "on traffic"
	Solution 1
Institutional Context	~
Financing scheme (NEW)	
Individual Consistency	**0.81**
Coverage (Raw)	0.56
Coverage (Unique)	0.56
Number of cases	4
Some relevant cases	**Athens International Airport (0.72,0.67), Athens Ring Road (0.72,0.67), Athens Tramway (0.72,1), Rion-Antirion Bridge (0.72,0.67)**
Overall Consistency/Coverage	**(0.81/0.56)**

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5.2.1.4 Revenue analysis (after A23 change) (22 cases - five conditions)

Revenue analysis is also conducted for 22 cases and maximally five conditions, as it was also done for the analysis of the other outcomes.

5.2.1.4.1 Part A: REVENUES - FULL MODELS' ANALYSIS (using max. number of conditions)

Necessity analysis

The necessity analysis is conducted for seven conditions and is presented in Table 5.12. The necessity control is conducted for seven instead of eight conditions because the initial models used for the full sample analysis of the revenues outcome were composed by seven conditions (all typology indicators apart from the transport market efficiency and acceptability). The condition 'high financing scheme' is shown to be necessary for projects being below revenues (consistency: 0.94).

Table 5.12: Necessity analysis of the 'on revenues' outcome for the completion before crisis sample

Conditions	On Revenues	
	Presence	Absence
High Institutional Context	0.73 (0.82)	0.76 (0.37)
Low Institutional Context	0.43 (0.81)	0.62 (0.490
High Economic & Financial Context	0.36 (0.84)	0.40 (0.41)
Low Economic & Financial Context	0.75 (0.75)	**0.84** (0.36)
High Governance	0.77 (0.79)	**0.83** (0.36)
Low Governance	0.38 (0.84)	0.51 (0.49)
High Cost Saving	0.63 (0.90)	0.53 (0.33)
Low Cost Saving	0.53 (0.72)	**0.85** (0.50)
High Remuneration Attractiveness	0.40 (0.77)	0.64 (0.54)
Low Remuneration Attractiveness	0.76 (0.83)	0.72 (0.34)
High Revenue Robustness	0.74 (0.90)	0.55 (0.29)
Low Revenue Robustness	0.42 (0.68)	**0.80** (0.56)
High Financing Scheme (NEW)	0.80 (0.74)	0.94 (0.37)
Low Financing Scheme (NEW)	0.32 (0.93)	0.34 (0.42)

The typology conditions used for the 'revenues' outcome analysis of the initial sample are: **1) the financial-economic context, 2) the governance indicator, 3) the cost saving, 4) the revenue robustness and 5) the financing scheme**. The conditions selected are the five conditions with the highest consistencies >0.75 in the necessity control.

The 'on-revenues' outcome analysis gives a very strong overall consistency/coverage (0.89/0.82). The strongest solution path in terms of consistency and coverage is the second solution. 62 % of the projects on revenues can be explained by high revenue robustness as a core condition combined with high governance.

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Table 5.13: Sufficiency analysis of projects being 'on revenues' (cut off: 0.82)

Conditions	OUTCOME: presence of 'on revenues'		
	Solution 1a	Solution 1b	Solution 2
Financial-economic context			
Governance		+	+
Cost saving			+
Revenue robustness	+	+	
Financing scheme (NEW)	+		+
Individual Consistency	0.88	0.90	0.89
Coverage (Raw)	0.60	0.62	0.54
Coverage (Unique)	0.09	0.12	0.11
Number of cases	12	10	8
Some relevant cases	**Athens International Airport (0.79,0.8), E4 Helsinki-Lahti (0.77,1), E39 Orkdalsvegen Public Road (0.75,1), Eje Aeropuerto (M-12) Motorway (0.75,0.8), Radial 2 Toll Motorway (0.75,0.8), Port of Agaete (0.75,1), Port of Leixoes (0.75,0.8), Port of Sines Terminal XXI (0.75,0.8), Rion-Antirion Bridge (0.75,0.8), Lusoponte Vasco da Gama Bridge (0.74,0.8), Athens Ring Road (0.6,0.8)**	**E4 Helsinki-Lahti (0.84,1), Lyon's VeloV (0.84,1), Athens International Airport (0.79,0.8), Athens Ring Road (0.75,0.8), BNRR (M6 Toll) (0.75,0.8), Port of Leixoes (0.75,0.8), Rion-Antirion Bridge (0.75,0.8), Lusoponte Vasco da Gama Bridge (0.74,0.8), C-16 Terrasa Manresa toll motorway (0.6,0.8), E39 Orkdalsvegen Public Road (0.6,1)**	**Lusoponte Vasco da Gama Bridge (0.78,0.8), Rion-Antirion Bridge (0.77,0.8), Port of Leixoes (0.73,0.8), FERTAGUS Train (0.7,0.8), E4 Helsinki-Lahti (0.66,1), Athens Ring Road (0.6,0.8), E39 Orkdalsvegen Public Road (0.6,1), A-19 Dishforth (0.54,0.8)**
Overall Consistency/Coverage	(0.89/0.82)		

No results are found for the absence of the 'on revenues' outcome for the sample of cases completed before crisis because the consistency of the only solution path was <0.75. This means that we cannot identify the conditions affecting the projects below revenues.

5.2.1.4.2 Part B: Simplification Method- Simplifying the Initial Full Models of Revenues with only Core Condition

A simplified model is proposed only for the presence of the outcome because no solutions were found for the absence. The simplification model of the 'on revenues' outcome is composed by two conditions:

1. **Cost saving**
2. **Revenue robustness**

The new model's solutions are simpler and have a higher overall coverage (0.87) compared with the ones of the initial model (Table 5.14). The strongest solution path, which is the first one, had its raw

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coverage increased from 0.60 to 0.74, meaning high revenue robustness can explain 74% of the projects being on revenues, with a consistency equal to 0.90.

Table 5.14: Sufficiency analysis of projects being 'on revenues' (cut off: 0.84)

Conditions	OUTCOME: presence of 'on revenues'	
	Solution 1	Solution 2
Cost saving		+
Revenue robustness	+	
Individual Consistency	0.90	0.90
Coverage (Raw)	0.74	0.63
Coverage (Unique)	0.24	0.13
Number of cases	15	9
Some relevant cases	**E4 Helsinki-Lahti (0.97,1), Lyon's VeloV (0.84,1), Athens International Airport (0.79,0.8), Athens Ring Road (0.75,0.8), BNRR (M6 Toll) (0.75,0.8), C-16 Terrasa Manresa toll motorway (0.75,0.8), E39 Orkdalsvegen Public Road (0.75,1), Eje Aeropuerto (M-12) Motorway (0.75,0.8), Radial 2 Toll Motorway (0.75,0.8), Port of Agaete (0.75,1), Port of Leixoes (0.75,0.8), Port of Sines Terminal XXI (0.75,0.8), Rion-Antirion Bridge (0.75,0.8), Lusoponte Vasco da Gama Bridge (0.74,0.8),**	**A-19 Dishforth (0.84,0.8), E39 Orkdalsvegen Public Road (0.84,1), BNRR (M6 Toll) (0.8,0.8), Lusoponte Vasco da Gama Bridge (0.78,0.8), Rion-Antirion Bridge (0.77,0.8), Port of Leixoes (0.73,0.8), FERTAGUS Train (0.7,0.8), E4 Helsinki-Lahti (0.66,1), Athens Ring Road (0.62,0.8)**
Overall Consistency/Coverage	**(0.89/0.87)**	

No results are found for the absence of the "on revenues" outcome for the crisis sample of cases completed before crisis because the consistency of the only solution path was <0.75. Thus, a simplified model was tested only for the presence of the 'on revenues' outcome.

5.2.2 2nd Crisis Sub-sample: Projects completed after crisis

The fs QCA analysis is also conducted for the sample of cases completed after crisis; the number of cases used was 25 for the cost and time outcomes (max. six conditions) and 21 for the traffic and revenue outcomes (max. five conditions).

5.2.2.1 Cost analysis (25 cases - six conditions)

5.2.2.1.1 Part A: COST - FULL MODELS' ANALYSIS (using max. number of conditions)

Necessity analysis

The necessity analysis is conducted for the eight conditions selected and is presented in Table 5.15. High financing scheme condition has a consistency very close to 0.90 (0.89) for the absence of the 'on cost' outcome and thus it is considered necessary.

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Table 5.15: Necessity analysis of the 'on cost' outcome for the crisis _after completion sample

Conditions	On Cost	
	Presence	Absence
High Institutional Context	**0.78** (0.78)	0.59 (0.39)
Low Institutional Context	0.40 (0.59)	0.68 (0.67)
High Economic & Financial Context	0.60 (0.82)	0.47 (0.43)
Low Economic & Financial Context	0.59 (0.62)	**0.81** (0.57)
High Governance	**0.80** (0.75)	0.67 (0.42)
Low Governance	0.60 (0.67)	0.60 (0.67)
High Cost Saving	0.55 (0.48)	0.74 (0.70)
Low Cost Saving	0.60 (0.67)	0.69 (0.51)
High Remuneration Attractiveness	**0.74** (0.70)	0.73 (0.46)
Low Remuneration Attractiveness	0.42 (0.70)	0.52 (0.57)
High Revenue Robustness	0.67 (0.67)	0.73 (0.49)
Low Revenue Robustness	0.50 (0.74)	0.51 (0.50)
High Transport market efficiency and acceptability	0.44 (0.74)	0.46 (0.51)
Low Transport market efficiency and acceptability	0.70 (0.66)	**0.76** (0.48)
High Financing Scheme (NEW)	0.86 (0.65)	**0.89** (0.45)
Low Financing Scheme (NEW)	0.28 (0.79)	0.32 (0.59)

The typology conditions used for the 'cost' outcome analysis of the crisis completion sample are: **1) the institutional context, 2) the financial-economic context, 3) the governance indicator, 4) the remuneration attractiveness, 5) the transport market efficiency and acceptability 6) the financing scheme**. These conditions are the conditions with the highest consistencies in the necessity control, showing that these ones could affect more significantly the cost outcome. All of them had a consistency >0.75 apart from remuneration attractiveness which had a consistency equal to 0.74.

Sufficiency analysis

The sufficiency analysis for the projects on cost showed that 56% of the projects on cost can be explained by high institutional context and high financial economic context as core conditions combined with high financing scheme as a peripheral condition (Table 5.16). The consistency of the solution path is equal to 0.85.

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Table 5.16: Sufficiency analysis of projects being 'on cost' (cut off: 0.83)

Conditions	OUTCOME: presence of 'on cost'
	Solution 1
Institutional Context	+
Financial-economic context	+
Governance	
Remuneration Attractiveness	
Transport market efficiency and acceptability	
Financing scheme (NEW)	+
Individual Consistency	0.85
Coverage (Raw)	0.56
Coverage (Unique)	0.56
Number of cases	9
Some relevant cases	**E18 Muurla-Lohja (0.86,0.8),** **Larnaca and Paphos International Airports (0.72,0.8),** **Lyon's tramway T4 (0.62,0.8),** **A5 Maribor Pince motorway (0.59,1),** **MST-Metro Sul do Tejo (0.56,0.8),** **Reims tramway (0.56,0.8),** **Central PT Depot of city of Pilsen (0.56,0.8),** **M-80 (Haggs) (0.55,0.8),** **Modlin Regional Airport (0.53,0.8)**
Overall Consistency/Coverage	(0.85/**0.56**)

The sufficiency analysis of the 'over cost' outcome showed that 41% of the projects over cost can be explained by low institutional context, low remuneration attractiveness and high financing scheme as core conditions combined with low financial-economic context as a peripheral condition. The consistency is quite high, 0.85.

Table 5.17: Sufficiency analysis of projects being 'over cost' (cut off: 0.91)

Conditions	OUTCOME: absence of 'on cost'
	Solution 1
Institutional Context	~
Financial-economic context	~
Governance	
Remuneration Attractiveness	~
Transport market efficiency and acceptability	
Financing scheme (NEW)	+
Individual Consistency	**0.85**
Coverage (Raw)	0.41
Coverage (Unique)	0.41
Number of cases	1
Some relevant cases	**Moreas Motorway (0.66, 1)**
Overall Consistency/Coverage	(0.85 /0.41)

5.2.2.1.2 Part B: Simplification Method- Simplifying the Initial Full Models of cost with Only Core Condition

As shown in Table 5.16 above, we can re-run the model using two core conditions, being institutional context and financial-economic context, for explaining the presence of the 'on cost' outcome. The new model results in a solution path as strong as the solution of the initial model in terms of consistency.

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Coverage slightly increases from 0.56 to 0.57. This means that 57% of the cases being on cost can be explained by the combination of high institutional context and high financial-economic context as core conditions. The consistency ratio remains stable, equal to 0.85.

Table 5.18: Sufficiency analysis of projects being 'on cost' (cut off: 0.85)

Conditions	OUTCOME: presence of 'on cost'
	Solution 1
Institutional Context	+
Financial-economic context	+
Individual Consistency	0.85
Coverage (Raw)	0.57
Coverage (Unique)	0.57
Number of cases	9
Some relevant cases	**E18 Muurla-Lohja (0.91,0.8),** **Larnaca and Paphos International Airports (0.72,0.8),** **Lyon's tramway T4 (0.62,0.8),** **A5 Maribor Pince motorway (0.59,1),** **M-80 (Haggs) (0.56,0.8),** **MST-Metro Sul do Tejo (0.56,0.8),** **Reims tramway (0.56,0.8),** **Central PT Depot of city of Pilsen (0.56,0.8),** **Modlin Regional Airport (0.53,0.8)**
Overall Consistency/Coverage	**(0.85/0.57)**

The initial model for the 'over cost' outcome analysis is simplified by selecting the three core conditions:

1. **Institutional Context**
2. **Remuneration attractiveness**
3. **Financing scheme**

The new model tested for the absence of the "on cost" outcome that uses three core conditions, gives a path with a lower consistency from the initial model (0.83 instead of 0.85). However the coverage was the same, at 0.41. 41% of the projects over cost can be explained by low institutional context and low remuneration attractiveness and high financing scheme as core conditions.

Table 5.19: Sufficiency analysis of projects being 'over cost' (cut off: 0.83)

Conditions	OUTCOME: absence of 'on cost'
	Solution 1
Institutional Context	~
Remuneration Attractiveness	~
Financing scheme (NEW)	+
Individual Consistency	**0.83**
Coverage (Raw)	0.41
Coverage (Unique)	0.41
Number of cases	2
Some relevant cases	**Moreas Motorway (0.66,1)**
Overall Consistency/Coverage	(0.83/0.41)

5.2.2.2 Time analysis (25 cases - six conditions)

The time analysis is conducted for the same number of cases and conditions as the cost analysis (25 cases - max. six conditions).

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5.2.2.2.1 Part A: TIME - FULL MODELS' ANALYSIS (using max. number of conditions)

Necessity analysis

The necessity analysis is conducted for the eight conditions and is presented in Table 5.20. No condition is shown to be necessary for projects to be on time or over time.

Table 5.20: Necessity analysis of the 'on cost' outcome for the crisis-after completion sample

Conditions	On Time	
	Presence	Absence
High Institutional Context	**0.86** (0.54)	0.53 (0.55)
Low Institutional Context	0.29 (0.27)	0.56 (0.87)
High Economic & Financial Context	0.65 (0.57)	0.39 (0.56)
Low Economic & Financial Context	0.50 (0.33)	**0.70** (0.77)
High Governance	**0.86** (0.51)	0.60 (0.59)
Low Governance	0.30 (0.31)	0.50 (0.85)
High Cost Saving	0.64 (0.52)	0.44 (0.59)
Low Cost Saving	0.49 (0.35)	0.64 (0.75)
High Remuneration Attractiveness	0.69 (0.41)	**0.70** (0.68)
Low Remuneration Attractiveness	0.46 (0.48)	0.40 (0.68)
High Revenue Robustness	0.63 (0.40)	0.66 (0.69)
Low Revenue Robustness	0.51 (0.47)	0.43 (0.66)
Transport market efficiency and acceptability	0.41 (0.42)	0.40 (0.69)
Transport market efficiency and acceptability	**0.71** (0.41)	0.67 (0.65)
High Financing Scheme (NEW)	**0.84** (0.40)	0.82 (0.65)
Low Financing Scheme (NEW)	0.27 (0.47)	0.25 (0.73)

The typology conditions used for the 'time' outcome analysis of the crisis-completion sample are: **1) the institutional context, 2) the financial-economic context, 3) the governance indicator, 4) the remuneration attractiveness, 5) the transport market efficiency and acceptability and 6) the financing scheme**. The six conditions selected out of the eight are the conditions with the highest consistencies, even though not all of them have consistency >0.75.

Sufficiency analysis

No results are found for the presence of the time outcome because the consistency did not pass the threshold cut off consistency of 0.75. This means that we cannot identify which conditions affect the projects on time. The results of the absence of the outcome are presented in table below 21.

The results show four solution paths with two core conditions, being institutional context and governance. The strongest solution, which is the 1st one, showed that 46% of the projects being over time can be explained by a low institutional context combined with a low transport market efficiency and acceptability. The consistency is equal to 0.87.

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Table 5.21: Sufficiency analysis of projects being 'over time' (cut off: 0.77)

Conditions	OUTCOME: absence of 'on time'			
	Solution 1a	Solution 1b	Solution 2a	Solution 2b
Institutional Context	~	~		
Financial-economic context		~		~
Governance			~	~
Remuneration Attractiveness		~	~	~
Transport market efficiency and acceptability	~		~	
Financing scheme (NEW)				~
Individual Consistency	**0.87**	**0.82**	**0.81**	**0.75**
Coverage (Raw)	0.46	0.29	0.19	0.19
Coverage (Unique)	0.27	0.04	0.02	0.01
Number of cases	4	2	1	2
Some relevant cases	**Belgrade By-pass Project. Section A: Batajnica-Dobanovci (0.9,1), Motorway E-75. Section Donji Neradovac - Srpska kuca (0.88,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.81,1), Warsaw's Metro II-nd line (0.59,1)**	**Piraeus Container Terminal (0.67,1), Moreas Motorway (0.66,1)**	**Modlin Regional Airport (0.6,1)**	**Barcelona Europe South Terminal (0.6,1)**
Overall Consistency/Coverage	(0.85/0.59)			

5.2.2.2.2 Part B: Simplification Method- Simplifying the Initial Full Models of Time with Only Core Condition

No results are found for the presence of the time outcome, thus a simplified model is created only for the absence of the outcome.

Although, the overall coverage/consistency of the new model's results is almost the same with the overall coverage/consistency of the initial model, the solution paths taken individually seem more robust in terms of coverage, in terms of composition since they are simpler and slightly in terms of consistency (Table 5.22). The first solution, which is the strongest one, shows that low institutional context as core condition can explain 56% of the projects over time.

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Table 5.22: Sufficiency analysis of projects being 'over time' (cut off: 0.80)

Conditions	OUTCOME: absence of 'on time'	
	Solution 1	Solution 2
Institutional Context	~	
Governance		~
Individual Consistency	**0.87**	**0.85**
Coverage (Raw)	0.56	0.50
Coverage (Unique)	0.11	0.04
Number of cases	6	6
Some relevant cases	**Belgrade By-pass Project. Section A: Batajnica-Dobanovci (0.9,1), Motorway E-75. Section Donji Neradovac - Srpska kuca (0.88,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.88,1), Moreas Motorway (0.72,1), Piraeus Container Terminal (0.67,1), Warsaw's Metro II-nd line (0.59,1)**	**Motorway E-75. Section Donji Neradovac - Srpska kuca (0.89,1), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.89,1), Belgrade By-pass Project. Section A: Batajnica-Dobanovci (0.78,1), Modlin Regional Airport (0.6,1), Barcelona Europe South Terminal (0.6,1)**
Overall Consistency/Coverage	(0.84/0.60)	

5.2.2.3 Traffic analysis (21 cases - five conditions)

For the traffic analysis for the projects being completed after crisis. 21 cases and maximally five conditions could be used.

5.2.2.3.1 Part A: TRAFFIC - FULL MODELS' ANALYSIS (using max. number of conditions)

Necessity analysis

The necessity analysis is conducted for seven conditions and is presented in Table 5.23. A high financing scheme is shown to be necessary for projects to be below traffic (consistency: 0.95).

The typology conditions used for the 'traffic' outcome analysis of the crisis-completion sample are: **1) the institutional context, 2) the financial-economic context, 3) the governance indicator, 4) the remuneration attractiveness and 5) the financing scheme**. The sample was composed of 21 projects, meaning that the maximum number of conditions that can be used in the analysis (excluding the outcome) are five (Table 5.24**Error! Reference source not found.**). The conditions selected are the ones with the highest consistencies in the necessity control, thus cost saving and revenue robustness are excluded.

Sufficiency analysis

The most significant configurations for explaining the presence of the 'on traffic' outcome shows that 64% of the projects on traffic were explained by high institutional context, high governance and high remuneration attractiveness as core conditions, combined with high financing scheme as peripheral condition, with consistency at 0.84.

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Table 5.23: Necessity analysis of the 'on traffic' outcome for the crisis_after completion sample

Conditions	On Traffic	
	Presence	Absence
High Institutional Context[18]	**0.78** (0.73)	0.68 (0.51)
Low Institutional Context	0.49 (0.66)	0.65 (0.70)
High Economic & Financial Context	0.50 (0.83)	0.44 (0.58)
Low Economic & Financial Context	0.75 (0.63)	**0.87** (0.58)
High Governance	**0.80** (0.70)	0.73 (0.51)
Low Governance	0.44 (0.67)	0.58 (0.70)
High Cost Saving	0.70 (0.71)	0.69 (0.56)
Low Cost Saving	0.56 (0.69)	0.64 (0.63)
High Remuneration Attractiveness	**0.82** (0.73)	0.70 (0.50)
Low Remuneration Attractiveness	0.44 (0.65)	0.62 (0.73)
High Revenue Robustness	0.70 (0.69)	0.69 (0.54)
Low Revenue Robustness	0.53 (0.68)	0.61 (0.62)
High Financing Scheme (NEW)	0.89 (0.62)	**0.95** (0.53)
Low Financing Scheme (NEW)	0.32 (0.89)	0.32 (0.70)

Table 5.24: Sufficiency analysis of projects being 'on traffic' (cut off: 0.77)

Conditions	OUTCOME: presence of 'on traffic'	
	Solution 1	Solution 2
Institutional Context		+
Financial-economic context		
Governance	~	+
Remuneration Attractiveness	~	+
Financing scheme (NEW)		+
Individual Consistency	0.78	0.84
Coverage (Raw)	0.31	0.64
Coverage (Unique)	0.05	0.39
Number of cases	3	9
Some relevant cases	**Piraeus Container Terminal (0.6,1)**	**E18 Muurla-Lohja (0.75,0.67), M-25 Orbital (0.75,0.67), Via-Invest Zaventem (0.75,0.67), Brabo 1 (0.75,0.67), Lyon's tramway T4 (0.72,1), Central PT Depot of city of Pilsen (0.56,0.67), M-80 (Haggs) (0.55,0.67), A5 Maribor Pince motorway (0.53,1)**
Overall Consistency/Coverage	(0.79/**0.70**)	

The 'absence of the on traffic outcome' shows that 51% of the projects below traffic are explained by low remuneration attractiveness and a high financing scheme as core conditions, combined with a low financial-economic context as peripheral condition, with consistency 0.79.

[18] In bold, we indicate the six conditions selected for our model because of their high consistencies.

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Table 5.25: Sufficiency analysis of projects being 'below traffic' (cut off: 0.81)

Conditions	OUTCOME: absence of 'on traffic'		
	Solution 1a	Solution 1b	Solution 2
Institutional Context			+
Financial-economic context	~		
Governance		~	~
Remuneration Attractiveness	~	~	~
Financing scheme (NEW)	+	+	
Individual Consistency	**0.79**	0.86	0.85
Coverage (Raw)	0.51	0.37	0.38
Coverage (Unique)	0.17	0.01	0.02
Number of cases	4	1	2
Some relevant cases	**Larnaca and Paphos International Airports (0.75,0.67), Moreas Motorway (0.66,0.67), MST-Metro Sul do Tejo (0.52,1)**	**Modlin Regional Airport (0.6,1)**	**Barcelona Europe South Terminal (0.6,0.67), Modlin Regional Airport (0.53,1)**
Overall Consistency/Coverage	(0.80/0.56)		

5.2.2.3.2 Part B: Simplification Method- Simplifying the Initial Full Models of Traffic with Only Core Condition

The core conditions for explaining projects 'on traffic' are the institutional context, governance and remuneration attractiveness. We then re-run the model using those three conditions:

1. **Institutional Context**
2. **Governance**
3. **Remuneration attractiveness**

Although, the simplified solution has a slightly decreased overall coverage compared to the initial one (initial: 0.70, simplified: 0.68), the solution consistency increased from 0.79 to 0.84. A high institutional context and high remuneration attractiveness as core conditions, combined with high governance as a peripheral condition can explain 68% of the projects completed after crisis and 'on traffic'.

Table 5.26: Sufficiency analysis of projects being 'on traffic' (cut off: 0.88)

Conditions	OUTCOME: presence of 'on traffic'
	Solution 1
Institutional Context	+
Governance	+
Remuneration attractiveness	+
Individual Consistency	0.84
Coverage (Raw)	0.68
Coverage (Unique)	0.68
Number of cases	10
Some relevant cases	**E18 Muurla-Lohja (0.75,0.67), M-80 (Haggs) (0.75,0.67), M-25 Orbital (0.75,0.67), Via-Invest Zaventem (0.75,0.67), Liefkenshoek Rail Link (0.75,0.67), Brabo 1 (0.75,0.67), Lyon's tramway T4 (0.72,1), Reims tramway (0.72,0.33), Central PT Depot of city of Pilsen (0.56,0.67), A5 Maribor Pince motorway (0.53,1)**
Overall Consistency/Coverage	(0.84/0.68)

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The simplification of the below traffic outcome is composed by three conditions:

1. **Institutional Context**
2. **Remuneration attractiveness**
3. **Financing scheme**

Although the overall coverage decreases from 0.56 to 0.51, the overall consistency increased (initial: 0.80 simplified: 0.84). The simplified solution for the absence of the 'on traffic' outcome shows that low institutional context and low remuneration attractiveness and high financing scheme as core conditions, explain 43% of the projects being below traffic, with consistency ratio at 0.89.

Table 5.27: Sufficiency analysis of projects being 'below traffic' (cut off: 0.79)

Conditions	OUTCOME: absence of 'on traffic'	
	Solution 1	Solution 2
Institutional context	+	~
Remuneration Attractiveness		~
Financing Scheme (NEW)	~	+
Individual Consistency	**0.80**	0.89
Coverage (Raw)	0.32	0.43
Coverage (Unique)	0.08	0.19
Number of cases	2	1
Some relevant cases	**Barcelona Europe South Terminal (0.6,0.67)**	**Moreas Motorway (0.66,0.67)**
Overall Consistency/Coverage	(0.84/**0.51**)	

5.2.2.4 Revenue analysis (21 cases - five conditions)

5.2.2.4.1 Part A: REVENUES - FULL MODELS' ANALYSIS (using max. number of conditions)

Necessity analysis

The necessity analysis is conducted for seven conditions and is presented in Table 5.28. It is conducted for six instead of eight conditions because the initial models used for the full sample analysis of the traffic outcome were composed by seven conditions (all typology indicators apart from the transport market efficiency and acceptability). The condition 'high financing scheme' showed to be necessary for projects below revenues (consistency: 0.95).

The typology conditions used for the 'revenues' outcome analysis of the initial sample are: **1) the institutional context, 2) the financial-economic context, 3) the governance indicator, 4) the remuneration attractiveness and 5) the financing scheme.** The conditions selected are the five conditions with the highest consistencies in the necessity control (not all of them have a consistency >0.75).

Sufficiency analysis

The second solution path is the strongest in terms of consistency and coverage (Table 5.29). This path shows that high institutional context and high governance as core conditions combined with high financing scheme can affect the 65% of the projects being on revenues. The consistency is at 0.80.

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Table 5.28: Necessity analysis of the 'on revenues' outcome for the crisis _after completion sample

Conditions	On Revenues	
	Presence	Absence
High Institutional Context	**0.73** (0.80)	0.61 (0.36)
Low Institutional Context	0.42 (0.66)	0.66 (0.57)
High Economic & Financial Context	0.42 (0.80)	0.44 (0.45)
Low Economic & Financial Context	0.71 (0.70)	**0.81** (0.43)
High Governance	0.73 (0.75)	**0.74** (0.41)
Low Governance	0.42 (0.75)	0.55 (0.53)
High Cost Saving	0.62 (0.73)	0.68 (0.44)
Low Cost Saving	0.53 (0.75)	0.58 (0.45)
High Remuneration Attractiveness	**0.74** (0.77)	0.69 (0.39)
Low Remuneration Attractiveness	0.41 (0.71)	0.58 (0.55)
High Revenue Robustness	0.69 (0.79)	0.58 (0.36)
Low Revenue Robustness	0.44 (0.66)	0.66 (0.53)
High Financing Scheme (NEW)	0.85 (0.69)	0.95 (0.42)
Low Financing Scheme (NEW)	0.28 (0.91)	0.30 (0.53)

Table 5.29: Sufficiency analysis of projects being 'on revenues' (cut off: 0.76)

Conditions	OUTCOME: presence of 'on revenues'	
	Solution 1	Solution 2
Institutional Context		+
Financial-economic context	~	
Governance	~	+
Remuneration Attractiveness		
Financing scheme (NEW)		+
Individual Consistency	0.76	0.80
Coverage (Raw)	0.42	0.65
Coverage (Unique)	0.14	0.37
Number of cases	5	13
Some relevant cases	**Motorway E-75. Section Donji Neradovac - Srpska kuca (0.89,0.8), Motorway E-75. Section Horgos-Novi Sad (2nd phase) (0.89, 0.8), Barcelona Europe South Terminal (0.6,0.8), Piraeus Container Terminal (0.6,1)**	**E18 Muurla-Lohja (0.84,0.8), Via-Invest Zaventem (0.78,0.8), Metrolink LRT. Manchester (0.78,1), Brabo 1 (0.78,0.8), M-25 Orbital (0.75,0.8), Lyon's tramway T4 (0.72,1), Larnaca and Paphos International Airports (0.67,0.8), Metro de Malaga (0.6,0.8), Central PT Depot of city of Pilsen (0.56,0.8), M-80 (Haggs) (0.55,0.8), A5 Maribor Pince motorway (0.53,1)**
Overall Consistency/Coverage	(0.78/0.79)	

No results are found for the absence of the 'on revenues' outcome (in truth table, consistency <0.75). This means that we cannot explain the projects being below revenues.

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5.2.2.4.2 Part B: Simplification Method- Simplifying the Initial Full Models of Revenues with Only Core Condition

A simplified model is proposed only for the presence of the outcome because no solutions are found for the absence. The full sample for the "on revenues" outcome analysis is simplified by using the three core conditions of the initial solutions:

1. **Institutional Context**
2. **Financial-Economic Context**
3. **Governance**

The new model that is tested results in two solution paths with overall consistency and coverage at 0.81 and 0.72, respectively. These solutions are stronger in terms of consistency and simplicity in its composition than the initial ones (Table 5.30). The most significant solution showed that 70% of the projects on revenues are explained by high institutional context and high governance as core conditions. The consistency of this solution is at 0.81.

Table 5.30: Sufficiency analysis of projects 'on revenues' (cut off: 0.79)

Conditions	OUTCOME: presence of 'on revenues'	
	Solution 1	Solution 2
Institutional Context	+	+
Financial-economic context	~	
Governance		+
Individual Consistency	0.78	0.81
Coverage (Raw)	0.50	0.70
Coverage (Unique)	0.02	0.22
Number of cases	5	14
Some relevant cases	**Larnaca and Paphos International Airports (0.67,0.8), Metro de Malaga (0.62,0.8), Barcelona Europe South Terminal (0.62,0.8), A5 Maribor Pince motorway (0.53,1)**	**E18 Muurla-Lohja (0.84,0.8),M-25 Orbital (0.84,0.8), M-80 (Haggs) (0.78,0.8), Via-Invest Zaventem (0.78,0.8), Liefkenshoek Rail Link (0.78,0.8), Metrolink LRT. Manchester (0.78,1), Brabo 1 (0.78,0.8), Lyon's tramway T4 (0.72,1), Larnaca and Paphos International Airports (0.67,0.8), Metro de Malaga (0.6,0.8), Central PT Depot of city of Pilsen (0.56,0.8), A5 Maribor Pince motorway (0.53,1)**
Overall Consistency/Coverage	(0.81/**0.72**)	

No results are found for the absence of the "on revenues" outcome (in truth table, consistency <0.75).

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5.3 Conclusions

In the conclusions, the strongest solution paths of the initial or simplified models' analysis are presented.

On Cost

The analysis (**initial or simplified models' analysis**) of the two crisis samples regarding the 'on cost' outcome (both presence and absence) results in the following **findings**:

- **Regarding the completion before crisis sample (22 cases):**
  - The necessity control shows that **high financing scheme** is a necessary condition for the presence of the 'on cost' outcome. This means that high financing scheme will almost always appear in the solution paths of the 'on cost' outcome analysis. High financing scheme means that the transport infrastructure projects are heavily subsidised by the public sector or that they are purely public. This shows that public projects that were completed before the crisis had more chances to be on budget than the PPPs.
  - The simplified analysis showed that **high Institutional context and low financial economic context as core conditions** combined are sufficient conditions that can explain 51% of the projects being on cost, with consistency 0.76. This means that a good institutional context, combined with bad economic conditions of the country where the project is located, explain 51% of the projects completed before the crisis that were on cost. These findings do not match our expectations, since we would expect a high financial economic context to explain the projects being on cost, especially before the crisis. However, this solution shows that even if the macro-economic figures in a country are not very increased, a significant share of projects can still be on cost.
- **Regarding the completion after crisis sample (25 cases):**
  - No condition was found necessary for the presence of the 'on cost' outcome.
    - 57% of the projects completed after crisis in our sample, which are 'on cost or below cost' have a **good institutional context and a good financial-economic context** as core conditions. The consistency is considered high (0.85), meaning that the explanatory value of this solution is quite strong.
    - A good institutional context also appeared as a core condition for the before crisis sample, showing the importance of having good political capacity, support and policies, good legal and regulatory framework and good public sector capacity for being on cost. It is interesting that the financial – economic context appears only in the projects that are completed after crisis, pointing out the importance of having good macro-economic figures and good growth competitiveness index in order to be on cost (simplified analysis).

Over Cost

- **Regarding the completion before crisis sample (22 cases):**
  - No condition is found necessary for the absence of the "on cost" outcome.
  - **Low financing scheme as a core condition** <u>and low remuneration attractiveness as peripheral condition</u> explains 45% of the projects over budget (initial analysis). The consistency of this solution can be considered high (87%). This means that PPPs and projects, whose remuneration scheme is less attractive for the investors, explain almost half of the projects that were completed before crisis and were over budget. These results are consistent with the on cost results which showed the opposite (public projects are on cost) regarding the financing scheme indicator.

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- **Regarding the completion after crisis sample (25 cases):**
  - The necessity control shows that **high financing scheme** is considered a necessary condition for the **absence of the 'on cost"' outcome (consistency=0.89)**. This means that high financing scheme will almost always appear in the solution paths of the 'over cost' outcome analysis. High financing scheme means that the transport infrastructure projects are heavily subsidised by the public sector or that they are pure public. This shows that public projects that were completed after the crisis had more chances to be over budget than the PPPs. It is interesting to observe that we found the opposite result for the projects completed before crisis; it was found that public projects have more chances to be on cost.
  - 41% of the projects completed after crisis are explained by **low institutional context, low remuneration attractiveness and high financing scheme as core conditions** (simplified analysis). It is observed that institutional context also appears in the on cost analysis with a high value, thus acting consistently, since here in the over cost analysis appears with a low value. Therefore it is shown that the institutional context affects projects that are completed after the crisis with regard to the achievement of the cost target. Low remuneration attractiveness not only appears as a core condition explaining the projects being over cost and completed after crisis but also the over cost projects which are completed before crisis, as presented above. Both times this condition is core. This confirms that when the projects' remuneration scheme is not very attractive for the investors, this will be one of the reasons for the projects to be over budget. This is logical if we consider that the remuneration scheme shows the money collected in order to compensate projects' costs. Thus, if the cost recovery is low, the projects are more likely to be over cost. Last but not least, the indicator 'high financing scheme' is also a core condition that explains the over cost path of this sample; indicating that public projects when dealing with a bad institutional and financial context, and a not very attractive remuneration scheme, will be over cost. The consistency of this path is quite high (85%). This demonstrates the high significance of this solution path.

On Time

The analysis (initial or simplified models' analysis) of the two crisis samples regarding the 'on time' outcome (both presence and absence) results in the following **findings**:

- **Regarding the completion before crisis sample (22 cases):**
  - No necessary condition is found for the presence of the on time outcome.
  - The strongest solution of the simplified model shows that **high governance as a core condition** combined with *high financing scheme* as a peripheral condition explain 74% of the projects being on or below time (consistency:0.89) (initial solution). This solution has a very strong explanatory value since it has one of the highest consistencies and coverages observed in the entire analysis conducted. This solution means that public projects with good contractual arrangements are on time. This solution is in accordance with the structure and logic behind the typology indicators. The governance indicator which refers to the contractual arrangements of transport infrastructure projects was expected to influence the time outcome because of the clauses often stated in the projects' contracts related to the date of project's completion. In the contracts e.g. there may be clauses referring to

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penalties that will be imposed in the case there is a delay in the completion of the infrastructure.

- It is also interesting to observe that high governance and high financing scheme also appear in the strongest solution of the "on cost" analysis of the projects completed before the crisis. Not only do they appear in this solution, but they are also core. **This confirms the literature reporting that cost and time are achieved in a similar way**.

- **Regarding the completion after crisis sample (25 cases):**
  - No condition is found as a necessary condition.
  - No results are found for the presence of the on-time outcome.

Over Time

The analysis (initial or simplified models' analysis) of the two crisis samples regarding the 'on time' outcome (both presence and absence) results in the following **findings**:

- **Regarding the completion before crisis sample (22 cases):**
  - The necessity control shows that **high financing scheme** is a necessary condition for the absence of the 'on time' outcome (consistency=0.896). However, the value of this finding is small because no solutions are found for the absence of the on time outcome (raw consistency <0.75).
  - No results are found for the absence of the on time outcome.
- **Regarding the completion after crisis sample (25 cases):**
  - No condition is found necessary for the absence of the "on time" outcome.
  - The strongest path of the simplified model shows that 56% of the projects over time (delayed) are explained by a **low institutional context as a core condition**, with a high consistency 0.87. This shows that the political stability in a country, the regulatory framework and the government effectiveness strongly affect the ability of the projects to be completed on time. Additionally, it is worth mentioning the second solution that was slightly less strong than the first one, which is explained above, which showed that 50% of the projects being over time are explained by a **low governance indicator as a core condition,** with a consistency of 0.85, which is high. This shows that half of the delayed projects had bad contractual arrangements. These findings match with the findings of the on-time analysis of the completion before crisis sample. In this analysis, we found that significant share of projects on time were explained by a high governance indicator, whereas in the overtime analysis of the completion after crisis sample, a significant share of projects over time are explained by a low governance indicator.

On Traffic

The analysis (initial or simplified models' analysis) of the three crisis samples regarding the 'on traffic' outcome (both presence and absence) results in the following **findings**:

- **Regarding the completion before crisis sample (22 cases):**
  - No condition is necessary for the presence of the 'on traffic' outcome.
  - No results are found for the presence of the on traffic outcome.
- **Regarding the completion after crisis sample (25 cases):**
  - No condition is necessary for the presence of the on traffic outcome.
  - 68% of the projects, which are completed after crisis and are on traffic, are explained by **high institutional context and high remuneration attractiveness as core conditions**, combined with high governance as a peripheral condition, with consistency

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0.84. This means that approximately two thirds of the projects on traffic are explained by a good legal and regulatory framework (regulations favouring transportation), by a high percentage of cost recovery (money that is collected through the remuneration schemes in order to cover projects' costs) and also by good contractual arrangements. Having a good contract cannot affect a project's traffic directly. However, it can ensure through specific clauses that e.g. the project will be delivered on time, or that the infrastructure will reach its highest possible availability to the users. Therefore, the above contribute to the achievement of the traffic target.

Below Traffic

The analysis (initial or simplified models' analysis) of the two crisis samples regarding the 'on traffic' outcome (both presence and absence) results in the following **findings**:

- **Regarding the completion before crisis sample (22 cases):**
  - No condition is necessary for the absence of the on traffic outcome.
  - Since no results are found for the presence of the 'on traffic' outcome, we can only explain the projects below traffic. The strongest solution path of the initial model shows that **low institutional context as a core condition combined** with low financial economic context and low remuneration attractiveness as peripheral conditions explain 54% of the projects being below traffic, with a consistency at 83%. The two first conditions compose the implementation context typology; this path shows that actual traffic is below the forecast traffic for almost half of the projects, when the regulatory framework of the country, where the infrastructure is located and the macro-economic figures are not good. For example, if the unemployment rate is high or the inflation increased, this could have an impact on the traffic; because the demand for using the infrastructure would be less. Also low remuneration attractiveness appears which is logical if we consider that projects being below the forecast traffic will collect less money from the remuneration schemes. Therefore, a smaller share of projects' costs will be recovered, thus making these remuneration schemes less attractive for the investors.

- **Regarding the completion after crisis sample (25 cases):**
  - The **necessity control** shows that a **high financing scheme** is a necessary condition for the absence of the 'on traffic' outcome (consistency: 0.95).This means that high financing scheme will almost always appear in the solution paths of the "over traffic" outcome analysis. A High financing scheme means that the transport infrastructure projects are heavily subsidised by the public sector or that they are purely public. This shows that public projects that were completed after crisis had more chances to be below traffic than the PPPs.
  - The strongest solution of the simplified analysis shows that 43% of the projects being below traffic are explained by **a low institutional context and low remuneration attractiveness and a high financing scheme as core conditions**, with consistency 0.43. This means that a significant share of the projects being below traffic, which are heavily subsidised by the public sector are explained by a bad institutional context and a small percentage of project's cost recovery through the remuneration schemes.
  - It is interesting to observe that institutional context and remuneration attractiveness also appear in the 'on traffic' analysis, with the opposite sign (positive), thus showing its importance for the achievement or non-achievement of the traffic target for the projects that are completed after crisis.

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- It is also interesting to observe that the above mentioned conditions, institutional context and remuneration attractiveness, appear also in the strongest solution of the 'below traffic' analysis of the other sample tested 'projects that are completed before crisis' (with the same sign, 'low'). Therefore, we can conclude that a bad institutional context and low remuneration attractiveness explain a significant share of projects that are completed both before and after the crisis.

On Revenues

The analysis (initial or simplified models' analysis) of the two crisis samples regarding the 'on revenues' outcome (both presence and absence) results in the following **findings**:

- **Regarding the completion before crisis sample (22 cases):**
  - No condition is necessary for the presence of the on revenue outcome.
  - The strongest path of the simplified model shows that 74% of the projects being on revenues are explained by **high revenue robustness as a core condition**, with a very high consistency at 0.90. This is one of the highest consistencies found in the whole analysis. High revenue robustness means that the revenue streams are more robust and the ability to cover the project costs from the revenues generated by or for the project is higher and also the risk is lower. Thus a high revenue robustness indicator could explain projects with actual revenues equal to or exceeding the forecast ones.
- **Regarding the completion after crisis sample (25 cases):**
  - No condition is necessary for the presence of the on revenue outcome.
  - The strongest solution of the simplified model shows that 70% of the projects on revenues are explained by a **high institutional context and high governance as core conditions**, with consistency 0.81. The explanatory value of this solution path is very strong because of its very high coverage in combination with a quite high consistency. This means that more than two thirds of the projects on revenues are explained by a good regulatory framework and a good contract. Regulations favouring transportation or having political stability in the country where the infrastructure is located cannot affect directly the revenues but they can affect traffic. Thus, increased traffic means higher revenues. Similarly, good contractual arrangements cannot affect directly the revenues. However, contractual clauses, which are related to project revenues, can affect traffic and therefore the revenues; e.g. clauses with regard to the availability of the infrastructure or with regard to revenue risk allocation among partners.

Below Revenues

The analysis (initial or simplified models' analysis) of the two crisis samples regarding the 'on revenues' outcome (both presence and absence) results in the following **findings**:

- **Regarding the completion before crisis sample (22 cases):**
  - A high financing scheme is necessary condition for the absence of the 'on revenues' outcome (consistency: 0.94). However, this finding cannot be further examined because no results are found for the absence of the 'on revenues' outcome.
  - No results are found for the absence of the on revenues outcome.
- **Regarding the completion after crisis sample (25 cases):**
  - The necessity control shows that **high financing scheme** is a necessary condition for the absence of the 'on revenues' outcome (consistency: 0.95). However, the value of this finding is small because no solutions are found for the absence of the 'on revenue' outcome (raw consistency <0.75).
  - No results are found for the absence of the 'on revenues' outcome.

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ANNEX 1: METHOD OF CALIBRATION

The method of calibration is presented into two categories: outcomes and typology indicators. We distinguish four outcomes of interest namely cost, time, traffic and revenues. All outcomes are calibrated using indirect calibration. On cost, time and revenues, we calibrate the three value FsQCA being: (1) below budget (cost), ahead schedule (Time) and exceeding revenue forecasted (Revenues) – score 1; (2) On budget (Cost), on time (Time) and on revenues (Revenues) - score 0.8, and (3) over budget (Cost), delayed (Time) and below revenue forecasted (Revenue) - score 0.0. In addition, the on traffic outcome is calibrated using the four values FsQCA (see table A1).

The calibration method should be based on theory or empirical studies, not just on mathematical operation (Ragin, 2008; Rihoux & Ragin, 2009; Schneider & Wagemann, 2010; Schneider & Wagemann, 2012). Almost all typology indicators were built by The Benefit partners who include different sub indicators; for instance, the typology index for governance encompasses 10 sub indicators. Accordingly, no theoretical framework or empirical studies can be used as a reference. Given this, we use direct calibration for assigning specific values into set of memberships 'either fully in/more in than out or fully out/more out than in'. According to Ragin (2008), the direct method uses estimates of the log of the odds of full membership using the following formula: odds of membership = (degree of membership)/ (1- (degree of membership)). The fs-QCA software 2.5 has been used for the calculation of values employing direct calibration. We first define three important qualitative anchors to structure the calibration: the threshold for full membership, the threshold for full non-membership and the crossover point (see Ragin, 2000). As Ragin (2008) mentioned, the qualitative anchors are set up as: the threshold for full membership (0.95); the crossover point (0.5) and the threshold for full non-membership (0.05). In this context, we should be careful to set the threshold, because it differs in terms of the method of calculation. First, the typology indicators for 'institutional setting' and 'financial-economic setting', which we will call here 'type 1' indicators, are composed by different sub indicators relating to country features, for which the raw values are provided by international organisations, including the World Bank Governance Indicators (WGI), the OECD, the World Economic Forum (WEF). Second, the other indices (i.e. governance, cost saving, revenue support, remuneration attractiveness, revenue robustness, transport market efficiency & acceptability, and financing scheme) are calculated by an aggregation of a number of sub indicators, using several data collections such as: secondary data, questionnaire, interview, and other sources. These other indicators are referred to here as 'type 2'.

The direct calibration for the 'type 1' indicators encompasses 'institutional setting' and 'financial-economic setting'. First, we reviewed the institutional setting for 26 European countries from 1996 to 2013. Due to incomplete data[19], the average value is 0.69 and the average maximum and minimum value are 0.85 (Denmark) and 0.39 (Serbia) respectively. However, when looking at value on specific countries as well as year of observation, the minimum value was to be found for Serbia in 2001 (0.29) and Denmark in 2004 (0,88) had the maximum value. Therefore, we set the thresholds for full membership, cross over point and non-full memberships as (a) 5 % percentile or threshold for non-membership= 0.40; (b) 50% percentile or cross over point = 0.65 and (c) 95% percentile or threshold for full membership= 0.90. Second and in a similar way, based on a review of the financial-economic setting index for 26 European countries from 2001 to 2014, taking into account incomplete data[20], we found that the average value was 0.61, and the average maximum and minimum value are 0.78 (Norway) and 0.39 (Serbia) respectively. We then determined the thresholds as: (a) 5% percentile or threshold for non-membership=0.40; (b) 50% percentile or cross over point= 0.60 and (c) 95% percentile or threshold for full membership= 0.80.

[19] Such countries have some missed values, for example: 4 countries with no liberalization of transport market index, Montenegro was only available for 2006-2013.
[20] There was some missing values for such countries: Serbia, Albania, Cyprus, Croatia, Denmark and Montenegro.

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The direct calibration for indicators of 'type 2' was used for the other 7 typology indicators, referring to governance, cost saving, revenue support, remuneration attractiveness, revenue robustness, transport market efficiency & acceptability, and financing scheme. One might consider that all indicators do not have a specific reference; however, the theoretical maximum and minimum values can be employed as a reference. Out of 7 indicators, by exception of cost saving, the theoretical value of all indicators falls within the possible range between 0 (the lowest) and 1 (the highest). Accordingly, we specify the thresholds as: (a) 5% percentile or threshold for non-membership=0, 05; (b) 50% percentile or cross over point= 0.50 and (c) 95% percentile or threshold for full membership= 0.95. Unlike the other 6 typology indicators, the cost saving indicator has the theoretical minimum and maximum value of -0.333 (the lowest) and 1 (the highest) respectively. In this case, we set up the threshold as: (a) 5% percentile or threshold for non-membership=-0.2665; (b) 50% percentile or cross over point= 0.333 and (c) 95% percentile or threshold for full membership= 0.9335. Finally, as Rihoux & Ragin (2009) state, a condition/variable must vary across cases[21], so the final check for calibrated value should also be carried out. As a result, all indicators can be considered as having sufficient variation, except revenue support (see table A1).

Table A1.1. Method of Calibration of Outcomes and Typology Indicators

ITEMS	SCORING	METHOD		CALIBRATION
		TYPE	Scaling	CS/fs-QCA
1. OUTCOME				
• Cost	Below budget, On budget, Over budget	INDIRECT	Below budget	1
			On budget	0.8
			Over budget	0
• Time	Ahead schedule, On time, Delayed	INDIRECT	Ahead schedule	1
			On time	0.8
			Delayed	0
• Traffic (Actual vs forecasted)	Exceeding, as forecasted, below forecasted, far below forecasted	INDIRECT	Exceeding	1
			As forecasted	0.67
			Below forecasted	0.33
			Far below forecasted	0
• Revenue (Actual vs forecasted)	Exceeding, As forecasted, below forecasted	INDIRECT	Exceeding	1
			As forecasted	0.8
			Below forecasted	0
2. **TYPOLOGY INDICATORS**				
• Institutional setting	Index varies between 0 to 1 (Review index 26 C's from 1996 to 2013)	DIRECT	Threshold for full membership (0.95)	0.90
			Cross over point	0.65
			Threshold for non- full membership (0.05)	0.40
• Financial-economic setting	Index varies between 0 to 1 (Review index 26 C's from 2001 to 2014)	DIRECT	Threshold for full membership (0.95)	0.80
			Cross over point	0.60
			Threshold for non- full membership (0.05)	0.40
• IRA	Index varies between 0% to 100%	INDIRECT	IRA ≥ 90%	1
			80% ≤ IRA < 90%	0.8
			70% ≤ IRA < 80%	0.6
			60% ≤ IRA < 70%	0.4
			50% ≤ IRA < 60%	0.2
			IRA ≤ 50%	0

[21] As a general rule, variation should be guaranteed by having at least 30% cases are in either below 0,5 set of membership or above 0,5 set of membership.

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ITEMS	SCORING	METHOD		CALIBRATION
		TYPE	Scaling	CS/fs-QCA
• Overall Governance	Index varies between 0 to 1	DIRECT	Threshold for full membership (0.95)	0.95
			Cross over point	0.50
			Threshold for non- full membership (0.05)	0.05
• Cost Saving	Index varies between -0.333 to 1	DIRECT	Threshold for full membership (0.95)	0.9335
			Cross over point	0.333
			Threshold for non- full membership (0.05)	-0.2665
• Revenue Support	Index varies between -0.333 to 1	DIRECT	Threshold for full membership (0.95)	0.95
			Cross over point	0.5
			Threshold for non- full membership (0.05)	0.05
• Remuneration Attractiveness	Index varies between 0 to 1	DIRECT	Threshold for full membership (0.95)	0.95
			Cross over point	0.5
			Threshold for non- full membership (0.05)	0.05
• Revenue Robustness	Index varies between 0 to 1	DIRECT	Threshold for full membership (0.95)	0.95
			Cross over point	0.5
			Threshold for non- full membership (0.05)	0.05
• Transport market efficiency & acceptability	Index varies between 0 to 1	DIRECT	Threshold for full membership (0.95)	0.95
			Cross over point	0.5
			Threshold for non- full membership (0.05)	0.05
• Financing Scheme	Index varies between 0 to 1	DIRECT	Threshold for full membership (0.95)	0.95
			Cross over point	0.50
			Threshold for non- full membership (0.05)	0.05

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ANNEX 2: FUZZY SET QUALITATIVE COMPARATIVE ANALYSIS: METHODOLOGICAL AND THEORETICAL NOTES

Method description

Fuzzy set Qualitative Comparative analysis is a comparative method that offers a middle path between quantitative and qualitative methods (Ragin 2008, p71). It is called comparative because "it explores and finds similarities and differences in outcome across comparable cases by comparing configurations of conditions" (Ragin, 1987, 1994; 2000; 2003; Rihoux & Ragin, 2008; Rihoux, 2008, as cited in Marx & Dusa, 2011)[22]. The method identifies which conditions are necessary and sufficient to bring about a certain outcome. The method refers to the INUS conception of causality. X is a *necessary condition* for Y is to say that it is impossible to have Y without X. X is a sufficient condition for Y is to say that the presence of X guarantees the presence of Y (X → Y). QCA hence focuses strongly on how different conditions in combination interact to bring about a certain outcome. This is different from statistical methods, which focus on how explanatory variables independently affect the explained variable (dependent variable).

"FsQCA is a set-theoretic approach (Ragin 2000). Set-theoretic approaches describe causal complexity in terms of relationships between conditions (in frequentist methods: independent variables) and an outcome (in frequentist methods: dependent variable). The assessment of causal complexity in set-theoretic methods is based on a few assumptions:

i. Conjunctural causation; a condition will only have an effect in combination with other factors.
ii. Equifinality; an outcome can be elucidated by multiple, mutually non-exclusive (paths of) conditions.
iii. Causal asymmetry; the presence of the outcome may have different explanations than its absence" (quoted from Verhoest, Molenveld and Willems, 2014).

These listed assumptions are clearly different from statistical methods (Schneider and Wagemann 2012). In this kind of analysis, we are mainly interested in how different factors together, in interaction (that is, configurations of conditions), bring about a certain outcome.

There are three reasons/arguments why QCA is used. First, a fuzzy-set QCA is highly appropriate for analysing small N cases or intermediate N cases (around 40-50 cases). Previous research has pointed out the benefits of using (fs)QCA on a medium-sized dataset, compared to traditional regression analysis (Vis, 2012). But QCA is not useful in very small samples (e.g. less than 12 cases) (Fiss, 2008). Second, a QCA allows us to test hypotheses or existing theories. More specifically, the researchers aim at operationalizing theory or hypotheses as explicitly as possible by defining a series of conditions that should yield a particular outcome (Rihoux & Ragin, 2009). In this deliverable, we are mainly interested in analysing how the different typology conditions combine, as conditions for particular cases of infrastructure projects, in order to explain the presence of cost and time underrun as well as achieving traffic and revenue on or above forecasts ("success" indicators, called 'outcomes' in QCA). Third, QCA forces researchers to achieve conceptual clarity through the calibration procedure, in which cases are assigned to sets.

[22] According to Ragin (2008), fuzzy sets are at the same time qualitative and quantitative because they are case-oriented and variable-oriented. They are case-oriented because they focus on sets and set membership (qualitative states). Case-orientedness is about preserving the rich information about the complexity of the cases (configuration of case). Fuzzy sets are also condition-oriented, which refers to the comparison and the degree of membership of a case on a variable/condition. This aspect provides a basis for precise measurement, which is very important in quantitative research.

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The steps of FsQCA include: (1) the identification of the outcomes that we want to analyse and the selection of relevant conditions, of which the combination will have an impact on the outcome, 2) the calibration of values into sets, 3) the construction of a truth table[23], 4) the minimization of consistent configurations to form solution formula, and 5) the interpretation of solutions (Rihoux and Ragin, 2009). The selection of outcomes and conditions is made based on the research question and the in-depth knowledge of the cases and variables of the researcher, respectively. The maximum number of conditions that can be used depends on the number of the cases (see in Marx and Dusa, (2011).

The calibration, which is the most important step after the data gathering in the fuzzy-set QCA, refers to assigning specific membership scores to cases, on a scale from 0, meaning 'fully out of the set', to 1, meaning 'full membership in the set' (Verhoest et al, 2014). Fuzzy set QCA is not restricted to binary values [1 (membership in the set) or 0 (non-membership in the set)] like crisp set QCA is, which is the original version of the QCA (crisp-set QCA) (Vanelslander et al., 2015 and Rihoux & Ragin, 2009, chapter 5) but the values can be calibrated according to different "degrees of membership" in the fuzzy sets. For example, a four-value fuzzy set encompasses: fully in (1), more in than out (0.67), more out than in (0.33) and fully out (0) (Rihoux & Ragin, 2009). Calibration is also explained in the following lines.

In general, there are two ways of conducting calibration: direct and indirect. On the one hand, one might apply direct calibration by specifying the values of an interval scale that corresponds to three qualitative breakpoints (anchor points), structuring a fuzzy set: the full membership, full non-membership and the cross over point. On the other hand, using indirect calibration, the external standard used is the researcher's qualitative assessment of the degree to which cases with given scores on an interval scale are members of the target sets (Ragin, 2008). After defining the qualitative anchor points for each set (when cases are fully in a set (1), fully out (0), and the location of the crossover point (0.5)), then each case is given a score to each set that reflects the degree to which it is in or out. The identification of the anchor points and the assignment of cases to sets are based on previous theory or evidence (Schneider & Wagemann, 2010). In our analyses, all variables are transformed into fuzzy sets using the "direct" method of calibration (Ragin, 2008 and Vanelslander 2015).

As soon as the values are calibrated, the dataset can be uploaded in the Fs/QCA 2.5 software, which is used for the analysis. Then one can start to structure the truth table. The truth table is made by selecting the conditions/variables and the outcome to be examined. Fuzzy set analysis not only gives us the ability to examine which the combinations of conditions are, that lead to an outcome (for example in our research one of the outcomes is being 'on cost'), but also it allows us to examine which are the combinations/configurations that lead to "no outcome - absence of outcome" (e.g. not being 'on cost', i.e. having cost overrun). According to Schneider & Wagemann (2010) the presence and the absence of the outcome should always be dealt with, in two separate analyses.

The next step after structuring the truth table is minimizing the consistent configurations to form solution formula by using the "consistency cut-off". This cut-off actually refers to cutting off from the truth table the rows whose consistency is under the threshold we set. "The raw consistency column tells us how consistently a configuration is a subset of the outcome or in other words how it satisfies the set relation of sufficiency" (Legewie, 2013). This score determines whether a configuration of conditions consistently contributes to an outcome. The column for the outcome set is left blank, since it has to be coded based on the consistency scores. For example, if the consistency cut-off threshold

[23] Another step could be also added before the construction of the truth table. This step includes checking for necessary conditions (Rihoux & Ragin, 2009, p.110). A necessary condition is a condition, which should be present so as the outcome to occur but its presence does not guarantee the occurrence of the outcome. In general, a necessary condition is interpreted as a superset of the outcome, whereas a sufficient condition is interpreted as a subset of the outcome. The truth table is actually an analysis of sufficiency (Rihoux & Ragin, 2009, p.110).

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we select is 0.75, this means that in the blank column we will fill in the number 1 for all the rows whose raw consistency is greater than 0.75 and the number 0 for the ones with a raw consistency smaller than 0.75. In this way, we only keep for our calculations the combinations of conditions, which consistently contribute to the outcome. After the cut-off, we can continue the analysis either without specifying assumptions or with specifying the assumptions. So, we assume/decide under which circumstances a condition may contribute to the outcome (Legewie, 2013). After selecting the assumptions, we finally reach the final step of the fuzzy-set QCA analysis, which is the output of the truth table analysis. In the output of the truth table analysis, three solutions are presented: the parsimonious, the intermediate and the complex solution. It is recommended to use the intermediate solution for interpreting the QCA results, in case theoretical hypotheses are formulated. The **complex solution** does not make the above-mentioned simplifying assumptions. It takes all the rows from the truth table which were coded with the number 1 on the outcome and then applies some Boolean simplification so as to combine rows (Elliot, 2013). But if a larger number of causal conditions are included then, we will get rather complicated solutions (Elliot, 2013). The **parsimonious solution** uses any and all remainder[24] rows so as to simplify the solution. The parsimonious solution should only be used if we are certain that the assumptions made to create the solution are justified (Elliot, 2013). The **intermediate solution** only includes 'easy' assumptions when simplifying the solution. The software asks to specify these easy assumptions, when it calculates the intermediate solution; when one selects all causal conditions to be present, the software is instructed that one assumes that it is the presence of the causal conditions which leads to the outcome (Elliot, 2013). To sum up, the intermediate solution includes selected simplifying assumptions to reduce complexity but should not include assumptions, which might be inconsistent with the theoretical and/or empirical knowledge (Legewie, 2013). In all the three solutions, we can see the paths/combinations of conditions, which lead to the outcome.

The interpretation of the results is mainly based on the **consistency** and **coverage** values indicated in the solutions and combination of conditions in solution formula resulted in the outcome. Consistency shows the extent to which the solution path is consistent to reality or in other words the extent to which this solution path leads to the outcome. Hence, it assesses the degree to which a subset relation has been approximated. The higher the consistency of a solution path, the higher the chance you have that a case with such a path also shows the outcome. In the sufficiency analyses, consistency measures the degree to which a path is sufficient for the outcome to occur, indicating in which percentage of the cases this is the case. Some scientists consider a consistency of 0.75 as a satisfying consistency but others set an even higher and more strict threshold and accept only 0.85 or higher as a satisfying consistency. Low consistency is caused by including irrelevant conditions and/or missing crucial conditions, using inadequate values for the conditions, and miscalibrating the conditions or outcomes (Legewie, 2013)[25].

Coverage, by contrast, assesses the degree to which a cause or causal combination ''accounts for'' instances of an outcome. When there are several paths to the same outcome, the coverage of any given causal combination may be small. Thus, coverage gauges empirical relevance or importance. Coverage expresses the percentage of cases, which have a particular solution path. Coverage, hence, reports the proportion of membership in the outcome explained by the overall solution term, indicating the percentage of the cases for which that is the case. Thresholds are not so strict for the coverage as for the consistency. The other important step is to interpret each solution formula, which contains different combinations of conditions corresponding with the cases. We can differentiate between 'solution coverage' (indicating how much is covered by the solution term by all paths together); 'raw coverage' (indicating which share of the outcome is explained by a certain alternative path); and

[24] **Logical remainder**: In QCA, limited diversity is shown through the empty cells in the truth table, i.e., no cases that belong to these rows are contained in a data set. These empty rows are called "logical remainders." Being able to identify logical remainders and in this way making limited diversity visible is one of the strengths of QCA (Legewie, 2013).

[25] In the current analysis a necessity consistence of 0.90 has been used in order to avoid miscalibrations as the data set is very diverged.

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'unique coverage' (indicating which share of the outcome is exclusively explained by a certain alternative path).

Hence, Qualitative Comparative Analysis (QCA) deals with conditions or combinations of conditions, which will lead to certain outcomes. An important issue is how many conditions and cases are the most appropriate to be included in the model. Having a lot of conditions in the model increases the risk of having higher complexity. Thus, we have a high probability of finding contradictory cases. One of the most important parts of the QCA is to develop the truth table. The truth table tells us how many logically possible combinations of values on the causal variable (condition) we have, when the formula is 2n, meaning when doing the full model (say 7 conditions in our case), the number of possible combinations would be 2^7 or 128 possible combinations. In case of 5 conditions, there would be 32 possible combinations representing only 25% of the combinations, which we would have if we were using 7 conditions. In order to reduce the complexity, it is good to try to simplify the model from 7 conditions to a number as small as possible for explaining the outcome. This is the reason why in the results section a simplification model is applied, by redoing the analysis with only the core conditions stemming from the initial model. The core conditions refer to the conditions included in both the intermediate solution and the parsimonious solution and hence are the most relevant conditions to use to simplify our models, in search for the most simple and strong paths.

The contribution of the fs-QCA analysis will be important for the validation of the BENEFIT model because through this analysis we will identify which are the most important conditions or combinations of conditions that have an impact on the project infrastructure outcomes (cost, time traffic and revenues).

We will analyse both the necessity and sufficiency of conditions for outcomes to be present or absent. The outcomes selected for our analysis refer to four elements:

1) on cost: when this outcome is present, it means that a transport infrastructure project is on or below costs, while its absence implies that the project is over cost.
2) on time, when this outcome is present, it means that a transport infrastructure project is finalized on or before the planned time, while its absence implies that the project is over time.
3) on traffic: when this outcome is present, it means that actual traffic at the transport infrastructure is meeting or exceeding traffic forecasts, while its absence implies that actual traffic is below the forecasted level of traffic.
4) on revenues: when this outcome is present, it means that actual revenues generated by the transport infrastructure are meeting or exceeding revenue forecasts, while its absence implies that actual revenues are below the forecasted level of revenues.

In case of all the typology conditions, the more their value come closer to the value of ‘1’, the more positively they affect the respective outcome and vice versa. The above does not apply for the financing scheme indicator; the more it comes closer to the value ‘1’, the more heavily the project is subsidized by the public sector.

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6 Importance Analysis

6.1 Importance Analysis (IA) Overview

This section provides a brief description of the approach adopted in this study to identify those relevant factors to project outcomes obtained before and during the European economic crisis for the cases considered in Benefit research project.

The literature provides a number of methods to determine critical variables from multidimensional phenomena, as are the factors under study. Ansten and Vaurio (1992) and Aven and Nøkland (2010) provide guidance on this matter. We advocate an approach in which, the dominance of a factor is a function of its probability of occurrence, and each factor uncertainty (variability of the factor) influence on the output variables, that in this particular case, represent outcomes in a project. In this proposed approach, the analysis framework used here deployed Bayesian Networks (BN) in combination with Sensitivity Analysis (SA).

BNs organize the body of knowledge in any given area by mapping out cause-and-effect relationships among key variables and encoding them with numbers that represent the extent to which one variable is likely to affect another (Henriksen et al, 2008). BNs are essentially a tool for modelling the relationships between variables, and for capturing the uncertainty in the dependencies between these variables using conditional probabilities (van der Gaag, 1996). These conditional probabilities can be learnt under certain conditions from small data sets as shown by Onisko, Druzdzel and Wasyluk (2001). The developed Bayesian Networks models were evaluated using traditional tests reported by Anderson et al. (2004) and Lee and Moore (2014). Such tests include independence tests to check marginal and conditional independence among factors in the models, marginal log-likelihood estimation, which is a comparative measure and is used to assess the goodness of fit, and cross-validation to verify the capability prediction of the models developed. In this analysis, note that, the models developed include relationships of variables confirmed by rejection of the hypothesis of independence for each marginal and conditional relationship (using the cut-offs $p < 0:001$, $p<0.01$, and $p <0.05$ for different relationships). The choice of an optimal model is mainly done by the assessment of its marginal log-likelihood value in conjunction with the prediction accuracy estimated with the leave-one-out procedure reported by Lee and Moore (2014).

Sensitivity analysis is the study of how the uncertainty in the output of a mathematical model or system (whether numerical or otherwise) can be apportioned to the various sources of uncertainty in its inputs (Saltelli et al, 2008). Sensitivity analysis is an ideal method to evaluate models (Borgonovo and Plischke, 2016).

In a BN, a SA could be carried out using an empirical approach—by altering each of the variables and observing the related changes in the posterior probabilities of the output. In the standard approaches to sensitivity analysis, one variable is altered from the original set of input variables and the sensitivity value related to the remaining input variables then calculated and compared with those of other subsets of input variables (Deng, 2010). In our study, Borgonovo's (2006) measure is used as a sensitivity indicator. This is an alternative approach that examines the global response of a model's output by looking at the whole output distribution changes while assessing the influence of uncertainty (Borgonovo, 2006). Borgonovo's measure was tested in Borgonovo (2006) and in Borgonovo et al. (2011) with numerical and analytical tests showing reliable results in terms of ranking relevant factors according to their influence on output uncertainty.

The Borgonovo sensitivity analysis renders rankings that can be represented by tornado graphs as shown in the Figure 6.1. A tornado graph presents those factors that have the largest normalized

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effects on the occurrence of an output factor in a model. In a tornado graph, the numbers on the upper horizontal axis (δ) indicate the estimated value of Borgonovo's importance measure. A relatively high value of Borgonovo's importance measure indicates that the output variable uncertainty is highly sensitive to the involved variable with this importance measure. If the measure is relatively low, the output will be fairly insensitive to the associated factor. In a tornado graph, factors are ordered according to their importance measure. In total, this analysis helps discard irrelevant variables to a given output variable

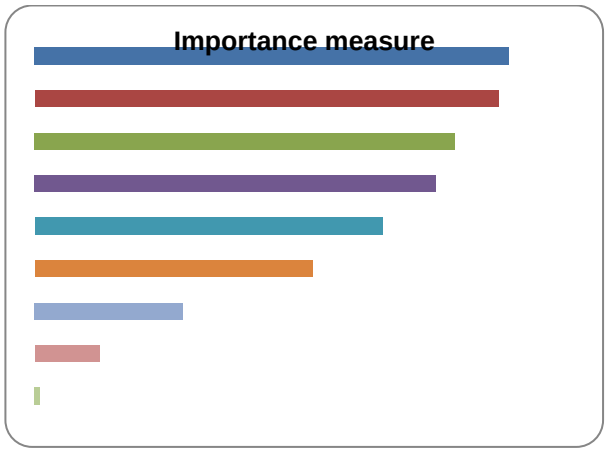

Figure 6.1: Ranking of factors and their impact on the occurrence of a given output variable

6.2 Modelling and analysis of the matching framework model overview

The variables in the matching framework model were described D3.1. The case study projects where the data were obtained from are described in **D4.2, Annex A.1,** and their records, called here "snapshot" data, on **D4.2, Annex A.2**. As shown below in Figure 6.2, the proposed analysis consisted of determining the most relevant variables linked to a set of predefined output variables. The set of predefined variables in the model under scrutiny in Figure 6.2 are labelled as 'cost', 'time', 'traffic', and 'revenue'. More details about the variables considered for this analysis are provided later in this report. The models analysed considered some plausible interactions among input factors. These interactions were identified by means of independence tests as described in the precedent section.

Table 6.1 shows how variables were discretized. Given the size of the data set (up to 118 records), it is only possible to discretize the variables into three or two degrees of freedom. Using a higher number of classes or degrees of freedom will reduce the number of records for each class, and accordingly, the reliability of the inferences and conclusions of the analysis cannot be guaranteed.

Note that the modelling approach is capable of dealing with non-parametric variables. This means that the analysis carried out is not constrained by any assumption of normality or any particular probability distribution assumption. This has been discussed by Anderson et al. (2004).

A number of analyses were run with data sets with different sizes as shown in Table 6.2.

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Table 6.1: Variables and their discretization

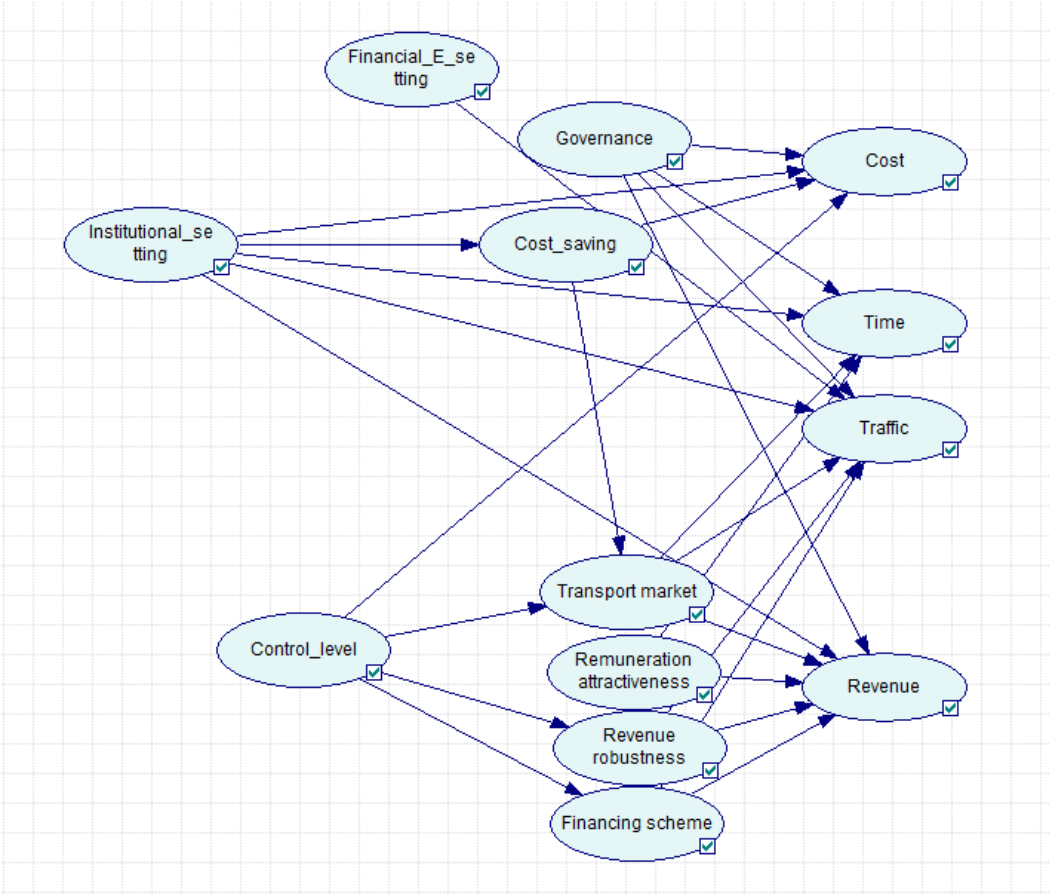

Figure 6.2: Structure of most optimal model found so far

Unfortunately, more analyses with different and smaller data sets cannot be carried out. Such additional analyses would not provide accurate results. Our approach is constrained by the size of the data sets. According to Onisko, Druzdzel and Wasyluk (2001) tests, the number of records to be used for the Analysis of Importance should be bigger than 50 records. The remaining data subsets available, representing subsamples of the total sample of infrastructure projects contain less than 50 records.

Table 6.3 depicts metrics of the analyses developed. These metrics provide information on the quality of the modelling.

The minimal percentage of correct diagnoses obtained was 59.24% (Analysis #5). In terms of goodness of fit, which is measured by each model's marginal log-likelihood (column 3), we did not obtained significant differences among similar datasets. Thus the models analysed are pretty equivalent in terms of goodness of fit to the data. The most optimal dataset is the one composed by the records associated with projects completed after crisis.

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Table 6.1: Variables and their discretization

Type	Variable	Degrees of freedom*
Input variables	Institutional setting	a_more_than_073
		between_067_073
		c_less_than_067
	Financial Economic setting	a_more_than_063
		between_050_063
		c_less_than_050
	Availability/Reliability (IRA)[a]	a_more_than_075
		between 056 and 075
		c_below_056
	Governance	a_more_than_069
		between_056_069
		c_less_than_056
	Cost saving	a_more_than_047
		between_018_047
		c_less_than_018
	Level of control[b]	a_more_than_073
		between_045_073
		c_less_than_045
	Revenues[c]	a_more_than_010
		between_006_010
		c_less_than_006
	Remuneration attractiveness	a_more_than_067
		between_033_067
		c_less_than_033
	Revenue robustness	a_more_than_067
		between_057_067
		c_less_than_057
	Transport market efficiency & acceptability	a_more_than_044
		between_022_044
		c_less_than_022
	Financing scheme	a_more_than_091
		between_070_091
		c_less_than_070
Output variables	Cost Overrun	a_cost_underrun[d]
		b_cost_overrun
	Time Overrun	a_time_underrun[e]
		b_time_overrun
	Actual vs Forecasted Traffic	a_forecast_as_expected[f]
		b_below_forecast[g]
	Revenue vs Forecasted Revenue	a_forecast_as_expected[h]
		b_below_forecast[i]

Notes: * Classes are determined using the 33th and 67th percentiles values of each variable data set.

[a] variable available in the data set but not used here because of its insignificance to the project outcomes as shown earlier in Task 4.1 reports

[b] variable available in the data set used in the present analysis which is subcomponent of the former variable 'revenue support'

[c] variable available in the data set used in the present analysis which is subcomponent of the former variable 'revenue support'

[d] cost underrun class includes values associated with costs on budget

[e] time underrun class includes values associated with time to completion as planned

[f] the class includes values associated with actual traffic exceeding forecasts

[g] the class includes values associated with actual traffic far below expectations

[h] the class includes values associated with actual revenue exceeding forecasts

[i] the class include values associated with actual revenue far below expectations

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Table 6.2: Analyses conducted and the respective dataset deployed

#	Description	Data size*/number of project cases	Objective of the analysis "Identification of factors relevant to …"
1	All the records available & projects awarded before crisis (2008)	90/36	Cost
2			Time
3		83/33	Traffic
4			Revenue
5	All the records available & projects completed before crisis (2008)	54/25	Cost
6			Time
7		59/22	Traffic
8			Revenue
9	All the records available & projects completed after crisis (2008)	59/22	Cost
10			Time
11		45/21	Traffic
12			Revenue
13	All the records available & projects awarded after crisis (2008)	28/15**	Cost
14			Time
15		18/10**	Traffic
16			Revenue

* Each data set size excludes records (snapshots) at award time.
** Data sets not analysed due to their small size

Table 6.3: Metrics of the analyses developed

#(1)	Description(2)	Marginal log-likelihood (3)	Average diagnostic accuracy (4)	Objective of the analysis(5) "Identification of factors relevant to …"
1	All the records available & projects awarded before crisis (2008) M1	-855	72.77%	Cost
2		-855	83.33%	Time
3		-803	79.06%	Traffic
4		-803	87.21%	Revenue
5	All the records available & projects completed before crisis (2008) M2	-524	59.24%	Cost
6		-524	62.96%	Time
7		-532	71.18%	Traffic
8		-532	84.75%	Revenue
9	All the records available & projects completed after crisis (2008) M3	-532	84.75%	Cost
10		-532	93.22%	Time
11		-425	80.00%	Traffic
12		-425	95.55%	Revenue

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6.3 Results and discussion

In the Table 6.4 and Table 6.5 results are presented per outcome and sample tested. The tornado graphs present those factors that have the largest normalized effects on the occurrence of an outcome in the modelling framework. In the graphs, the numbers on the upper horizontal axis indicate the estimated value of Borgonovo's importance measure. A relatively high value of Borgonovo's importance measure indicates that the output variable (outcome) uncertainty is highly sensitive to the analized variable. If the measure is relatively low, the output will be fairly insensitive to the associated factor. In a tornado graph, factors are ordered according to their importance measure.

The results report variables, which are independent of particular outcomes (output variables), as well as others that are not relevant. It is noted that the models developed include relationships of variables confirmed by rejection of the hypothesis of independence for each marginal and conditional relationship (using the cut offs $p < 0:001$, $p<0.01$, and $p <0.05$ for different relationships). The relevance of a given variable is given by the sensitivity analysis performed. An importance value threshold of 0.05 has been adopted as suggested by one used by Plischke, Borgonovo and Smith (2013).

6.3.1 Funding and Financing of Transport Infrastructure - Lessons Learned

All typology indicators representing respective aggregated factors (see BENEFIT deliverables D3.1, D2.2, D2.3, D2.4 and D4.2) do not have the same influence on all outcomes. Notably, Cost and Time outcomes are related to the construction phase of a project, while traffic and revenues are prominent in operational performance. Some points of interest are discussed below per outcome.

6.3.1.1 Cost

Across all samples, the institutional setting, governance, level of control, and cost saving indicators appeared to be the most significant. Remarkably, cost saving variable relative ranking does not vary. This variable exhibits stability but has the lowest significance importance level in comparison with the other significant factors. It appears that no additional resilience action, represented here by other input variables, was deployed or was effective in the project cases analysed. This is possible to infer from the changes in the rankings between the 'completed before crisis' and 'completed after crisis' datasets. This comparison shows that no additional factor different from those relevant in the 'completed before crisis' dataset resulted to be important in the 'completed after crisis' dataset model. Conversely, the financial & economic setting, remuneration attractiveness, revenue robustness, transport market efficiency & acceptability, and financing scheme variables seem to be independent of cost variable across the different datasets analysed. Note however that, independence tests carried out, within the context of this analysis, have shown strong associations between institutional and financial-economic setting indicators, being the latter an input variable of institutional setting factor.

6.3.1.2 Time

The variables financial & economic setting, revenue robustness, and financing scheme appeared as independent of the Time outcome. Across the samples analysed, the variables cost saving and transport market efficiency & acceptability are not relevant. Meanwhile, the governance, institutional setting, remuneration attractiveness, and level of control revenue are typical factors relevant to time output variable.

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Table 6.4: Results obtained with respect to the Outcome: COST

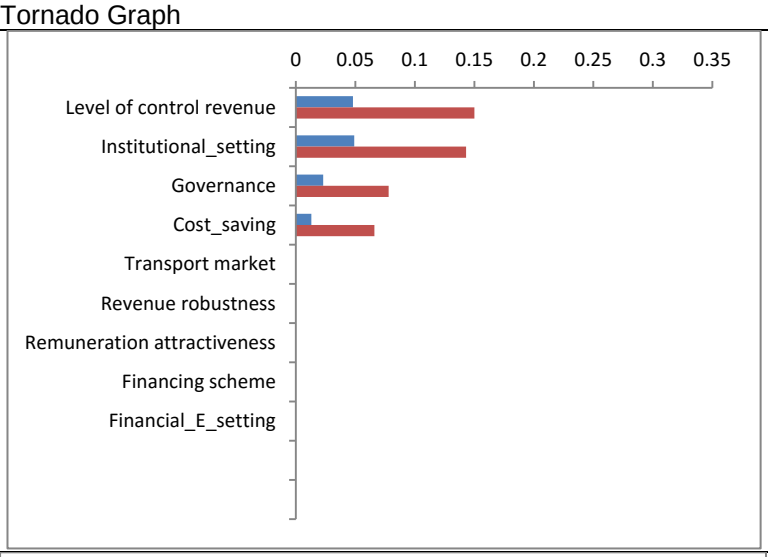
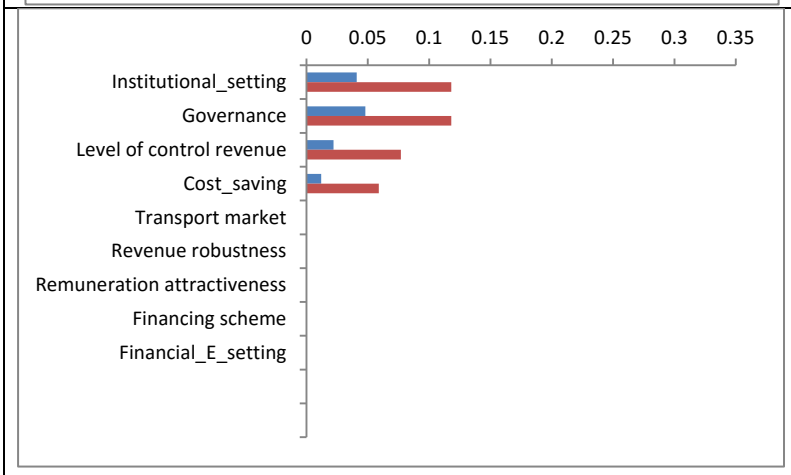
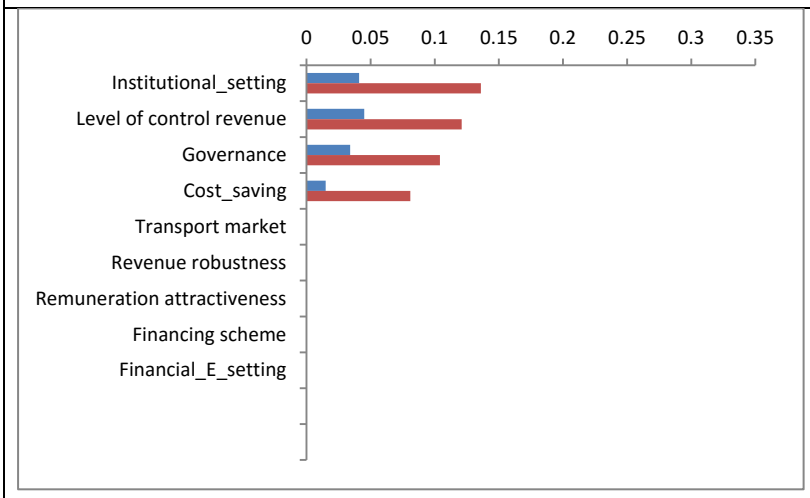
Tornado Graph	Sample
	Awarded before crisis Relevant Indicators: 1. Level of control revenue 2. Institutional_setting 3. Governance 4. Cost_saving Insignificant indicators (δ <0.05): Independent Indicators: 1. Transport market 2. Revenue robustness 3. Remuneration attractiveness 4. Financing scheme 5. Financial_E_setting
	Completed before crisis Relevant Indicators: 1. Institutional_setting 2. Governance 3. Level of control revenue 4. Cost_saving Insignificant indicators (δ <0.05): Independent Indicators: 1. Transport market 2. Revenue robustness 3. Remuneration attractiveness 4. Financing scheme 5. Financial_E_setting
	Completed after crisis Relevant Indicators: 1. Institutional_setting 2. Level of control revenue 3. Governance 4. Cost_saving Insignificant indicators (δ <0.05): Independent Indicators: 1. Transport market 2. Revenue robustness 3. Remuneration attractiveness 4. Financing scheme 5. Financial_E_setting

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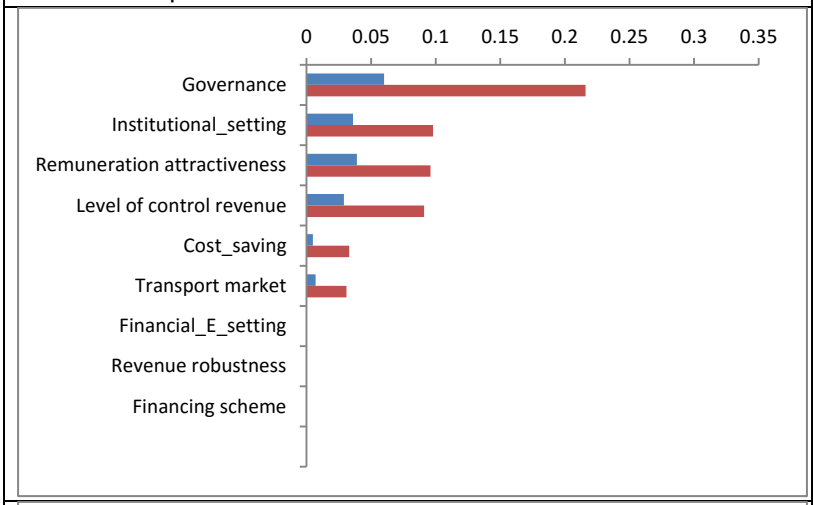
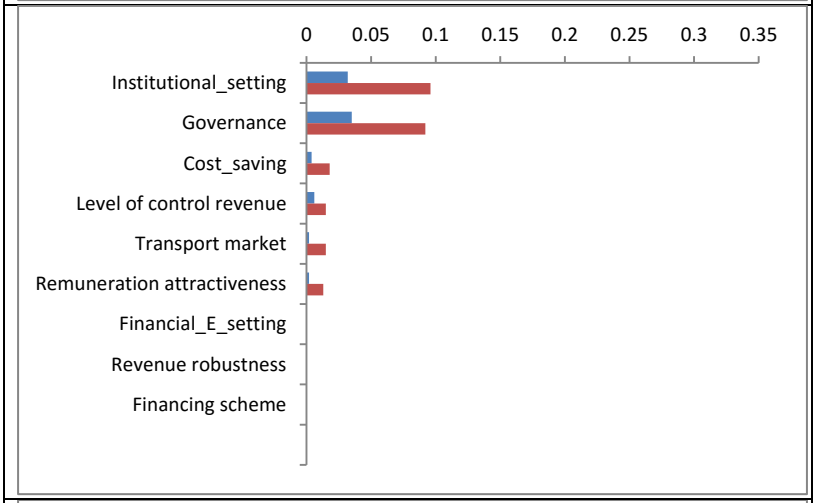
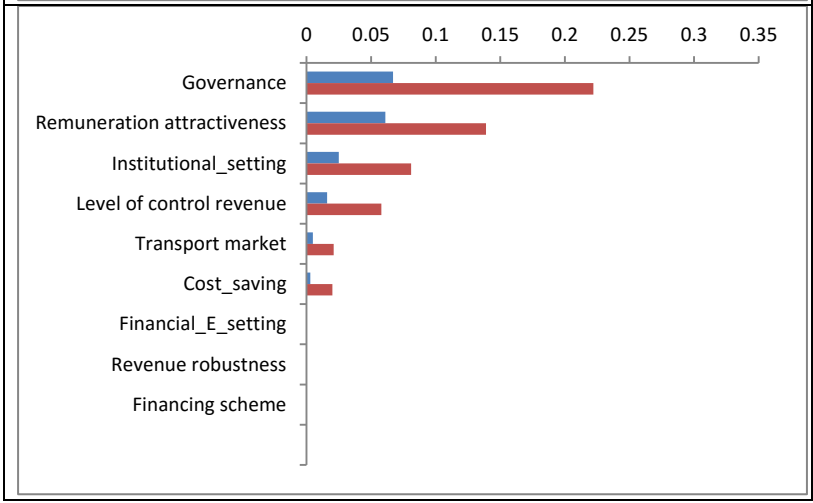
Table 6.5: Results obtained with respect to the Outcome: TIME

Tornado Graph	Sample
	Awarded before crisis Relevant Indicators: 1. Governance 2. Institutional_setting 3. Remuneration attractiveness 4. Level of control revenue Insignificant indicators (δ <0.05): 1. Cost_saving 2. Transport market Independent Indicators: 1. Financial_E_setting 2. Revenue robustness 3. Financing scheme
	Completed before crisis Relevant Indicators: 1. Institutional_setting 2. Governance Insignificant indicators (δ <0.05): 1. Cost_saving 2. Level of control revenue 3. Transport market 4. Remuneration attractiveness Independent Indicators: 1. Financial_E_setting 2. Revenue robustness 3. Financing scheme
	Completed after crisis Relevant Indicators: 1. Governance 2. Remuneration attractiveness 3. Institutional_setting 4. Level of control revenue Insignificant indicators (δ <0.05): 1. Transport market 2. Cost_saving Independent Indicators: 1. Financial_E_setting 2. Revenue robustness 3. Financing scheme

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Remarkably, the level of control variable stably ranks always at the lowest level of significance among the significant factors. In contrast with the cost output results, additional resilience actions were introduced to or successfully implemented in the project cases analysed during the economic crisis. This is possible to infer from the changes in the rankings between the 'completed before crisis' and 'completed after crisis' datasets. This comparison shows that both remuneration attractiveness and level of control revenue related management actions seem to be relevant in the model that considers 'completed after crisis' project cases, while these factors appear to be insignificant in the 'completed before crisis' dataset.

6.3.1.3 Traffic

According to our analysis all the input factors analysed resulted to be insignificant to explain changes in the variable traffic across cases. Further analyses showed that the variables associated with revenue robustness, transport market efficiency & acceptability, and financing scheme when set at medium and low values respectively produce positive outcomes in the output variable traffic. Likewise, it was detected that, low values of the variable associated with institutional setting yield high values for the output variable traffic.

6.3.1.4 Revenue

According to our analysis, level of control revenue variable, in two out of the three cases analysed, and remuneration attractiveness factor, in one instance, are significant factors to the revenue output variable. All the rest of input factors considered here resulted either to be insignificant to or independent of the variable revenue. Likewise, a number of analyses showed that the variables associated with revenue robustness, transport market efficiency & acceptability, and financing scheme when they are set at medium and low values respectively produce positive outcomes in the output variable revenue. Likewise it was detected that, low values of the variable associated with institutional setting yield high values for the output variable revenue.

6.3.2 Effects of Recent Economic and Financial Crisis – Lessons Learned

The study of findings with respect to the project outcomes in relation to the matching framework and the respective typology indicators based on this analysis suggests that many of the variables analysed are important, while to a different level for the various outcomes. Yet, most of the time, the variables associated with revenue robustness, transport market efficiency & acceptability, and financing scheme appeared to be insignificant to the outcome variables analysed here.

The results presented in this section, indicated that some resilience actions were implemented at some instances during crisis time in the projects analysed. This is the case of actions to meet project time expectations such as those related to remuneration attractiveness and level of control revenue variables which appeared to be important in the 'projects completed after crisis' models. On the other hand, the intensive implementation of actions leading to meet cost expectations in projects and related to governance, level of control, and cost saving seemed to be sufficiently robust to face the economic crisis. This because no other management action appeared to be significant to achieve project cost expectations during the crisis.

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Table 6.6: Results obtained with respect to the Outcome: TRAFFIC

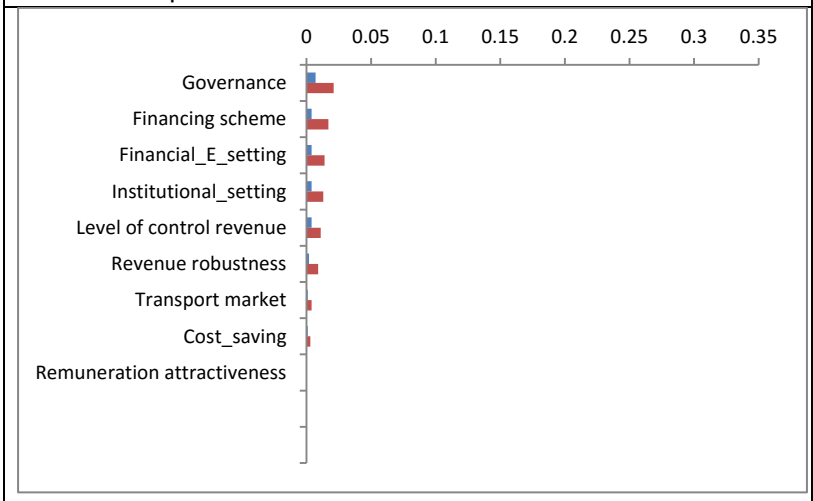
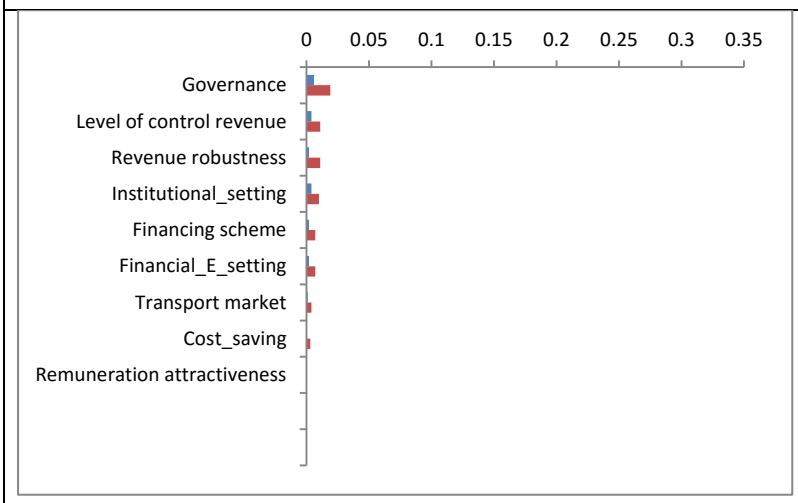
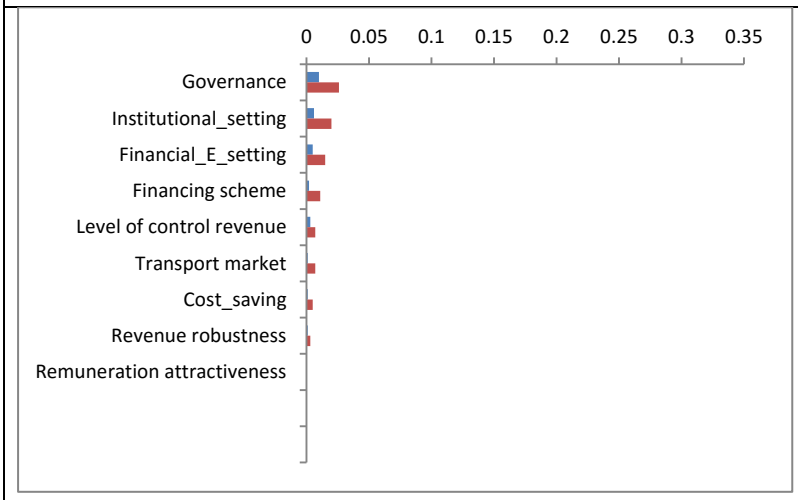
Tornado Graph	Sample
	Awarded before crisis Relevant Indicators: Insignificant indicators (δ <0.05): 1. Governance 2. Financing scheme 3. Financial_E_setting 4. Institutional_setting 5. Level of control revenue 6. Revenue robustness 7. Transport market 8. Cost_saving Independent Indicators: 1. Remuneration attractiveness
	Completed before crisis Relevant Indicators: Insignificant indicators (δ <0.05): 1. Governance 2. Level of control revenue 3. Revenue robustness 4. Institutional_setting 5. Financing scheme 6. Financial_E_setting 7. Transport market 8. Cost_saving Independent Indicators: 1. Remuneration attractiveness
	Completed after crisis Relevant Indicators: Insignificant indicators (δ <0.05): 1. Governance 2. Institutional_setting 3. Financial_E_setting 4. Financing scheme 5. Level of control revenue 6. Transport market 7. Cost_saving 8. Revenue robustness Independent Indicators: 1. Remuneration attractiveness

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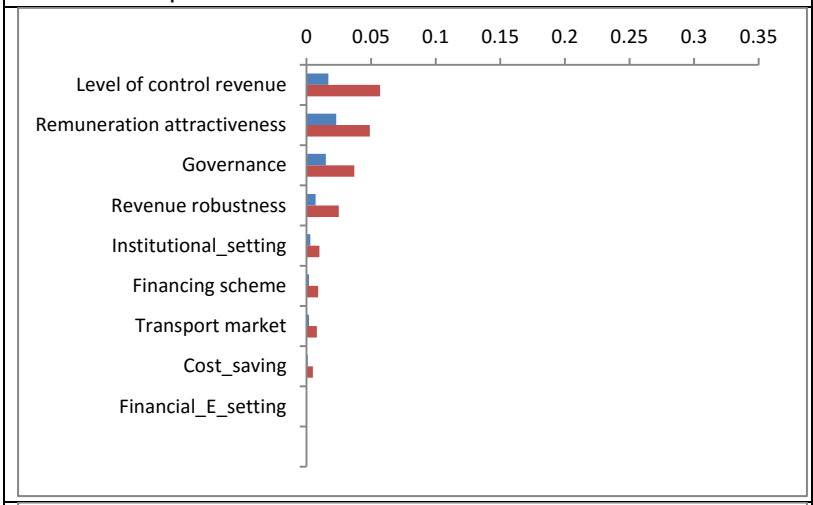
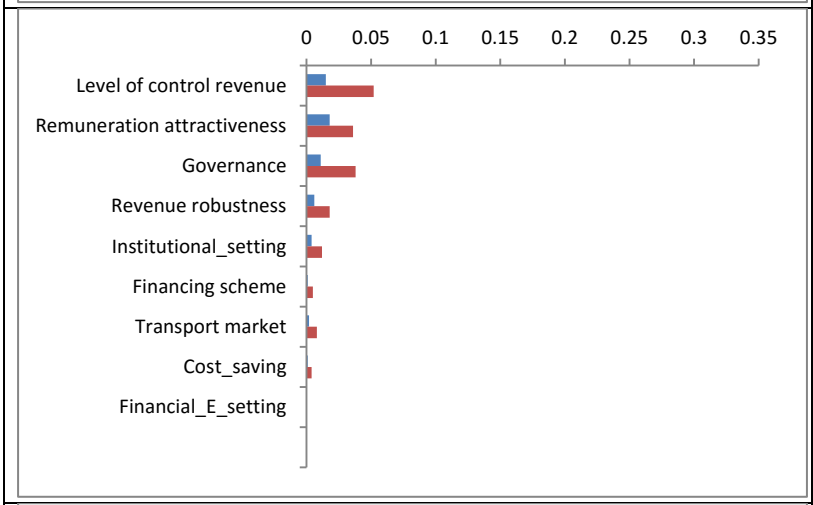
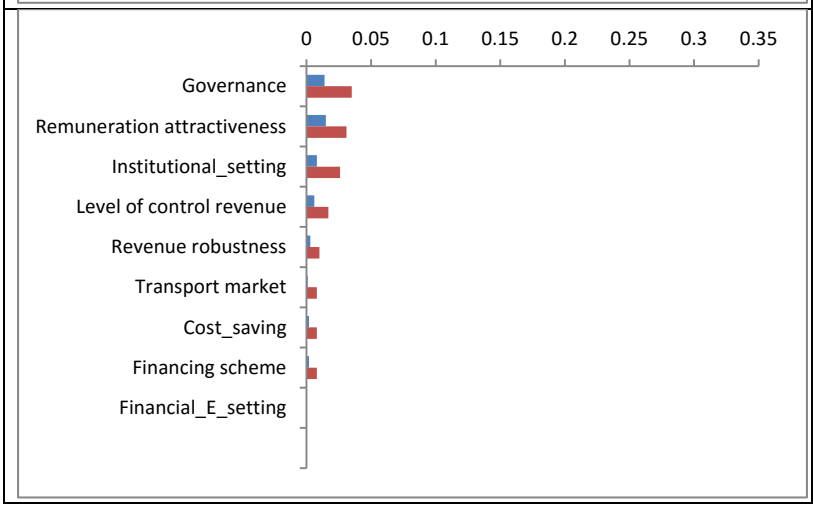
Table 6.7: Results obtained with respect to the Outcome: REVENUE

Tornado Graph	Sample
	Awarded before crisis Relevant Indicators: 1. Level of control revenue 2. Remuneration attractiveness Insignificant indicators (δ <0.05): 1. Governance 2. Revenue robustness 3. Institutional_setting 4. Financing scheme 5. Transport market 6. Cost_saving Independent Indicators: 1. Financial_E_setting
	Completed before crisis Relevant Indicators: 1. Level of control revenue Insignificant indicators (δ <0.05): 1. Remuneration attractiveness 2. Governance 3. Revenue robustness 4. Institutional setting 5. Financing scheme 6. Transport market 7. Cost_saving Independent Indicators: 1. Financial_E_setting
	Completed after crisis Relevant Indicators: Insignificant indicators (δ <0.05): 1. Governance 2. Remuneration attractiveness 3. Institutional_setting 4. Level of control revenue 5. Revenue robustness 6. Transport market 7. Cost_saving 8. Financing scheme Independent Indicators: 1. Financial_E_setting

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7 Econometric Analysis

7.1 Introduction

The aim of this section is to provide some empirical evidence regarding the factors that explain the "success" of a transport infrastructure project. Such "success" is empirically approached by four variables: "cost underrun", "time underrun", "actual versus forecasted traffic" and "actual versus forecasted revenue". These variables take discrete values (binary outcomes), which implies the usage of a binary outcomes model (microeconometrics models). Among other aspects, these models treat the binary outcome like a probability. Two models are employed towards this aim: a *logistic* model and a bivariate *probit* model depending on the existence of correlation among the endogenous variables. Special attention is put on the effect of the economic crisis that began in 2007.

The discrete values of the four endogenous variables are as follows:

$$cost\ underrun \begin{cases} 1 \text{ if cost is below budget or on budget} \\ 0 \text{ if cost is over budget} \end{cases}$$

$$time\ underrun \begin{cases} 1 \text{ if time is ahead of schedule or on time} \\ 0 \text{ if time is delayed} \end{cases}$$

$$revenue \begin{cases} 1 \text{ if revenue is exceeding forecast or as forecasted} \\ 0 \text{ if revenue is below or far below forecasted} \end{cases}$$

$$traffic \begin{cases} 1 \text{ if traffic is exceeding forecast or as forecasted} \\ 0 \text{ if traffic is below forecasted} \end{cases}$$

7.2 Cost and time underrun

Table 7.1 shows the estimates of the bivariate model (cost and time underrun), variables such as "financial economic setting", "governance", "cost savings" and "revenue support" show a significant effect on the cost underrun equation whereas, in the time underrun equation, the significant variables are: "crisis", "ira", "governance" and "revenue robustness". The parameter "athrho" is positive and significant which implies that both endogenous variables are positively and significantly correlated.

Table 7.2 shows the marginal effect of the changes in the probability of the bivariate model. Project conducted during the economic crisis reduces the probability of finishing the project successfully (below budget or on budget and ahead of schedule or on time) by 17.9%. The financial-macroeconomic context (macroeconomic environment and financial market development) shows the highest effect on the probability. A marginal improvement in this variable improves the probability of finishing the project successfully by 56%. i.e., an improvement in the macroeconomic environment as well as the development of the financial market in which the project takes place provides the highest improvement in order to finish a project successfully (below budget or on budget and ahead of schedule or on time).

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Table 7.1: Cost and time underrun estimation (bivariate model)

	Log pseudolikelihood = -113.92	Observations 124
		Wald Chi2(20)= 52.43
		Prob Chi2=0.0001
	Coefficients	**Robust Std. Error**
Cost underrun:		
Crisis	-0.108	0.327
Financial-macroeconomic context	2.268**	0.997
Ira	0.018	0.986
Governance	0.292**	0.145
Cost savings	0.341**	0.159
Revenue support	0.443***	0.127
Remuneration attractiveness	0.074	0.151
Revenue robustness	0.119	0.134
Market efficiency	0.034	0.165
Financing scheme	0.086	0.143
Constant	0.750***	0.289
Time underrun:		
Crisis	-0.948***	0.326
Financial-macroeconomic context	1.370	0.864
Ira	0.240***	0.101
Governance	0.673***	0.187
Cost savings	-0.168	0.143
Revenue support	0.095	0.133
Remuneration attractiveness	-0.210	0.148
Revenue robustness	-0.256*	0.154
Market efficiency	0.050	0.165
Financing scheme	-0.042	0.142
Constant	1.128***	0.316
athrho	0.889***	0.229
rho	0.711	0.113

***p<0.01, **p<0.05, *p<0.1

The next variable in importance in term of change of the probability is the “governance” (governance indicator), a marginal improvements in issues related to the efficiency/ effectiveness of governance such as number of bidders, exploitation or revenue and financial risk allocation among others (governance variable), rises the probability of success of the project about 15.8%. Finally, marginal increases in the revenue support of the project (level of control, potential to secure revenues/demand and revenues from other transport activities) increases the probability of finishing successfully by 8% approximately.

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Summarizing, variables such as crisis, financial-macroeconomic context and governance seems to be key to explain the success of a project. The three variables provide the highest changes in the probability. Marginal positive changes in these variables may imply sharp rises in the probability of success.

Table 7.2: Marginal effect

	dy/dx	Robust Std. Error
Crisis	-0.179**	0.084
Financial-macroeconomic context	0.560**	0.237
Ira	0.044*	0.025
Governance	0.158***	0.039
Cost savings	0.019	0.041
Revenue support	0.079**	0.033
Remuneration attractiveness	-0.025	0.040
Revenue robustness	-0.027	0.033
Market efficiency	0.013	0.038
Financing scheme	0.004	0.037

*** p<0.01, **p<0.05, *p<0.10

The following two models analyze both “cost underrun” and “time underrun” independently. As it was already shown in Table 7.1, there is a correlation between both variables. So, this new approach may get biased results, there is a correlation between both variables. So, this new approach may get biased results.

7.3 Cost underrun

According to Table 7.3**,** four variables are significant explaining the cost underrun: “financial economic setting”, “governance”, “cost savings” and “revenue support”. All of them show a positive sign. The economic crisis does not show a significant effect on the cost of a project.

Proceeding with marginal effect of some of the aforementioned variables (Table 7.4), a marginal improvement in the economic context in which a project is carried out rises the probability of finishing the project successfully (below budget or on budget and ahead of schedule or on time) by 54.2%. Similar to the bivariate model (Table 7.2), this variable shows a marginal effect above the rest of variables. In order to improve the performance of a project in term of cost, the financial economic context seems to be key. The second variable in importance seems to be “revenue support”, a marginal improvement in issues such as level of control, potential to secure revenues/demand and revenues from other transport activities, rises the probability of finishing the project below budget or on budget by 11.7%.

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Table 7.3: Cost underrun estimation (logistic model)

	Log pseudolikelihood = -63.766	Observations 124
		Wald Chi2(10)= 16.70
		Prob Chi2=0.0812
		Pseudo R2=0.197
	Coefficients	**Robust Std. Error**
Cost underrun:		
Crisis	-0.258	0.420
Financial-macroeconomic context	3.157*	1.888
Ira	0.060	0.264
Governance	0.485*	0.310
Cost savings	0.537**	0.281
Revenue support	0.686**	0.298
Remuneration attractiveness	0.212	0.307
Revenue robustness	0.089	0.333
Market efficiency	0.091	0.350
Financing scheme	0.115	0.328
Constant	1.240	0.462

*** p<0.01, **p<0.05, *p<0.10

Table 7.4: Marginal effect

	dy/dx	**Robust Std. Error**
Crisis	-0.044	0.071
Financial-macroeconomic context	0.542*	0.331
Ira	0.010	0.044
Governance	0.083*	0.047
Cost savings	0.092**	0.044
Revenue support	0.117***	0.047
Remuneration attractiveness	0.036	0.053
Revenue robustness	0.015	0.057
Market efficiency	0.015	0.060
Financing scheme	0.019	0.055

*** p<0.01, **p<0.05, *p<0.10

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7.4 Time underrun

Contrary to the cost, the financial macroeconomic context does not show a significant effect on the success of the project in term of time (ahead of schedule or on time) (Table 7.5). Nonetheless, the economic crisis provides a negative and significant impact in this regards. Continuing with Table 7.5, other two variables show significant effects: “ira” and “governance”.

Table 7.5: Time underrun estimation (logistic model)

	Log pseudolikelihood = -59.289	Observations 124
		Wald Chi2(10)= 29.97
		Prob Chi2=0.0009
		Pseudo R2=0.287
	Coefficients	**Robust Std. Error**
Time underrun:		
Crisis	-1.564***	0.521
Financial-macroeconomic context	2.426	1.795
Ira	0.450*	0.267
Governance	1.177***	0.455
Cost savings	-0.282	0.303
Revenue support	0.227	0.341
Remuneration attractiveness	-0.324	0.276
Revenue robustness	-0.471	0.372
Market efficiency	0.097	0.349
Financing scheme	-0.106	0.328
Constant	1.830***	0.563

*** p<0.01, **p<0.05, *p<0.10

Analyzing the marginal effect (Table 7.6), the economic crisis has an importance impact on the probability. The crisis reduces the probability of success of a project in term of time by 24.4%. The second variable in importance is the “governance” whereas the “ira” shows little effect in term of change of the probability. A slightly improvement in the governance of the project rise the probability of finishing ahead of schedule or on time by 18.3%.

7.5 Traffic

As in the case of the revenue, the economic crisis does not have a significant impact in order to explain the success in the traffic performance (Table 7.7). The significant variables explaining the traffic forecast are: “financial-macroeconomic context”, “IRA”, “revenue support”, “remuneration attractiveness” and “market efficiency and acceptability”.

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Table 7.6: Marginal effect

	dy/dx	Robust Std. Error
Crisis	-0.244***	0.090
Financial-macroeconomic context	0.378	0.259
Ira	0.070**	0.036
Governance	0.183***	0.057
Cost savings	-0.044	0.047
Revenue support	0.035	0.052
Remuneration attractiveness	-0.050	0.043
Revenue robustness	-0.073	0.055
Market efficiency	0.015	0.054
Financing scheme	-0.016	0.051

*** p<0.01, **p<0.05, *p<0.10

Table 7.7: Traffic estimation (logistic model)

	Log pseudolikelihood = -43.326	Observations 124
		Wald Chi2(10)= 64.63
		Prob Chi2=0.0000
		Pseudo R2=0.2525
	Coefficients	**Robust Std. Error**
Revenue:		
Crisis	-0.750	0.513
Financial-macroeconomic context	4.913**	2.117
Ira	0.377**	0.186
Governance	0.053	0.434
Cost savings	0.514	0.332
Revenue support	0.637*	0.373
Remuneration attractiveness	0.953***	0.334
Revenue robustness	0.480	0.369
Market efficiency	-0.598*	0.322
Financing scheme	0.106	0.325
Constant	1.667***	0.532

*** p<0.01, **p<0.05, *p<0.10

According the marginal effect (Table 7.8), the significant variables previously highlighted show a small effect in the probability except the “financial-macroeconomic context”. A marginal increase in such variable implies a rise in the probability of about 72.6%. On the contrary, a marginal increase in

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variables such as “remuneration attractiveness” provides a lower improvement in the probability of the traffic of 14%.

Table 7.8: Marginal effect

	dy/dx	Robust Std. Error
Crisis	-0.110	0.076
Financial-macroeconomic context	0.726***	0.290
Ira	0.055*	0.027
Governance	0.007	0.064
Cost savings	0.076*	0.045
Revenue support	0.094*	0.050
Remuneration attractiveness	0.140***	0.039
Revenue robustness	0.070	0.052
Market efficiency	-0.088**	0.046
Financing scheme	0.015	0.047

*** p<0.01, **p<0.05, *p<0.10

7.6 Revenue

Focused on Table 7.9**,** the variables that help to explain the revenue of a project are: “ira”, “remuneration attractiveness”, “revenue robustness” and “financing scheme”. On the other hand, the economic crisis does not seem to explain the performance of the revenue. Proceeding with the marginal effect (Table 7.10), the change in probability because of the aforementioned variables is small compared to the previous models. Moreover, and also compared to the previous models, the success of the revenue of a project seems to rest more on “micro” variables (those variables closer to the project) such as: “ira”, “remuneration attractiveness”, “revenue robustness” or “financing scheme”. For instance, a marginal increase in the “remuneration attractiveness” increases the probability of achieving the revenue forecasted by 9.6%.

7.7 Conclusion

The economic crisis seems to affect (negatively) the cost and time of the projects, but not the revenue and traffic. The “macro” variables (those more related with the general economic and financial context in which the projects take place such as the “crisis” or the “financial-economic context”) provide, on average, the highest effect on the probability of each model. On the contrary, the “micro” variables (those variables closer to the project such as “revenue support”, “remuneration attractiveness” or “revenue robustness”) provide the lowest effect on the probability.

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Table 7.9: Revenue estimation (logistic model)

	Log pseudolikelihood = -43.326	Observations 124
		Wald Chi2(10)= 64.63
		Prob Chi2=0.0000
		Pseudo R2=0.2525
	Coefficients	**Robust Std. Error**
Revenue:		
Crisis	-1.544	1.087
Financial-macroeconomic context	2.364	2.397
Ira	0.238*	0.141
Governance	-0.031	0.467
Cost savings	0.372	0.387
Revenue support	0.412	0.316
Remuneration attractiveness	0.897**	0.379
Revenue robustness	0.887***	0.333
Market efficiency	0.062	0.220
Financing scheme	-0.447*	0.262
Constant	3.641***	1.024

*** p<0.01, **p<0.05, *p<0.10

Table 7.10: Marginal effect

	dy/dx	**Robust Std. Error**
Crisis	-0.166	0.117
Financial-macroeconomic context	0.255	0.263
Ira	0.025*	0.014
Governance	-0.003	0.050
Cost savings	0.040	0.042
Revenue support	0.044	0.035
Remuneration attractiveness	0.096***	0.036
Revenue robustness	0.095***	0.036
Market efficiency	0.006	0.023
Financing scheme	-0.048*	0.028

*** p<0.01, **p<0.05, *p<0.10

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8 Trends in Remuneration Schemes Employed for PPP Projects and the Impact of the Crisis

8.1 European context

8.1.1 Introduction

Public budget constraints, the cost of debt, long-term fiscal policy and others reasons coupled with demanding infrastructure development programmes have created a serious gap in infrastructure investment, regardless of its importance to the economy. In response, governments shot solutions with governance models that include the private sector, widely known as Public Private Partnerships (PPPs). Between 1990 and 2009 more than 1300 PPP contracts were signed in the EU, representing a capital value of more than EUR 250 billion. The transport sector accounted for more than 50% of these contracts in value. However, while the PPP model seems quite suitable for the provision of transport infrastructure (Engel et al, 2010), PPPs have shown a number of limitations: the cost of PPP financing, transaction costs, tendering and bidding issues, their incomplete contract nature, lack of innovation, limits in bank financing and others (cfr. Meaney and Hope (2012); Martin et al, (2013); Hodge, G. and Greve, C. (2013 and 2007)). For revenue generating projects, revenue-related risks are significant in transport and reflect the uncertainty in predicted traffic volumes and the willingness of users to pay for services. The problem is further aggravated when the PPP revenue and remuneration scheme coincides. The economic crisis has furthered this problem and the private sector averts the revenue risk. In 2013, over 90% of the PPP transactions closed were authority-pay PPPs (e.g. availability payments, shadow tolls etc.) (EPEC, 2014).

The present section reviews these trends over time for the transport sector, especially with respect to the remuneration schemes employed at award or financial close and the impact post-crisis trends may have on:

- The potential to mobilise private financing
- The overall risk assumed by the public sector
- The potential of PPPs to contribute to government infrastructure programmes

When considering remuneration schemes, three basic schemes are investigated:

1. Real Tolls, by which users pay the concessioner directly for the use of the service
2. Shadow Tolls, by which the state compensates the concessioner per unit of service usage
3. Availability fees by which a periodic payment is made by the state to the concessioner based on service performance criteria.

Notably, variations and combinations of the above categorisation exist in practice. In the analysis that follows, the primary remuneration scheme is considered. In addition, based on the above definitions, remuneration schemes may be characterized as:

- Demand based when the remuneration is based on demand (real and shadow tolls) and
- Availability based

Again, depending on the origin of payment, remuneration schemes may be characterized as:

- User paid (real tolls) or
- Government paid (shadow tolls and availability fee)

It is also worth noting that, while in most cases the remuneration scheme coincides with the revenue scheme, these schemes may also differ. For example, configurations by which the service is user paid and, therefore, demand is also influenced by the usage price, and availability fees are the remuneration scheme. This is a situation where the demand risk is totally allocated to the public party.

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Depending on the infrastructure mode considered some schemes are dominant or better serve the specific mode. Airport and ports usually serve concessions and involve a usage payment to governments calculated on a flat basis and size of throughput, while users pay a tariff for use to the concessioner. Rail and urban transit often concern a commercial service which is subsidized (supported) by a government “availability fee”.

Roads, however, demonstrate a large range of remuneration schemes formulated around the principle three types described herewith.

Following an overview, the present contribution is focused on the trends of Road remuneration schemes employed over time, emphasizing on whether a shift has demonstrated following the credit crunch and the financial/economic crisis in Europe.

As these trends could not be identified through the BENEFIT database, a larger “proprietary list” of PPP projects was made available to the project, which formulated the basis for this analysis. The list only included project name, country and year of financial close, and therefore, the remuneration scheme had to be identified through independent research and investigation.

The proprietary list included 413 PPP projects with financial close between 1995 and 2015. Of the 413 projects listed, 186 were excluded as they concerned double registrations of the same project, or projects that were not defined as PPPs based on the BENEFIT definition. A number of projects were also omitted from the list as their remuneration scheme could not be reasonably confirmed. To the remaining 227 projects, 22 projects were added from the BENEFIT database, which were not present in the priority list. Further research lead to the addition of another 17 projects identified. Hence the total list of projects considered amounted to 266 projects in the period 1986 to 2015. The analysis that follows is, however, focused between 1995 and 2014, as few projects are registered outside this range. Table 8.1 illustrates the number of projects from each source per mode.

Road projects (bridge and tunnel road projects included) formulate the grand majority of this list and justify any further analysis to be conducted only on the road segment. As noted in Table 8.1, the original listing included 259 projects. 16 were removed as public funded projects, 4 as not being EU and 40 as being duplications of the same project. Another issue identified concerned the actual definition of PPP projects. In many cases (very common for Italian projects) the fact that the road authority had a private legal status (e.g. ANAS), was considered the basis for considering projects as PPPs. For this reason, the eight (8) Italian cases were excluded from the analysis. The remuneration scheme for another 14 road projects could not be confirmed.

Table 8.1: PPP projects considered

	Airports	*Ports*	*Rail*	*Roads*	*Urban Transit*	*Total*
Initial Listing	37	36	40	259	41	413
Not included	31	28	24	82	21	186
Used from the listing	6	8	16	177	20	227
Added from BENEFIT database	2	7	9	2	2	22
Added from other lists	0			14	3	17
Total	8	15	25	193	25	266

Notably, while 266 projects are a considerable number, they only represent a small share of the projects awarded and **findings should be considered with caution.**

This report includes a descriptive analysis of available data in terms of distributions over time. The descriptive analysis is followed by its preliminary interpretation with respect to the road sector. Conclusions and recommendations end this section.

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8.1.2 Overview

Between 1995 and 2014, the sample analysed includes 258 projects. Figure 8.1 illustrates their distribution over time. This 20-year period represents the period when PPPs became widely known and considered an alternative to public funding of infrastructure and, more so, transport infrastructure in the Europe and the EU. This period could be split into three sections: the period before the year 2000 which corresponds to the "piloting" of the PPP model of infrastructure delivery; the period between 2001 and 2007 as a maturing period and finally the period following the crisis.

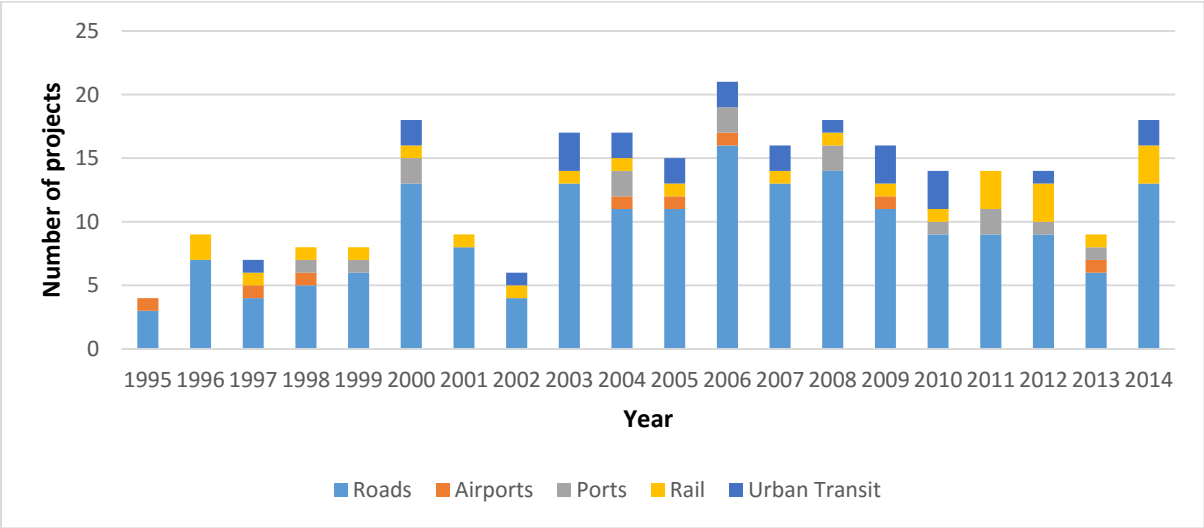

Figure 8.1: PPPs by Principle Mode per year of Financial Close in Europe
Source: Authors' compilation

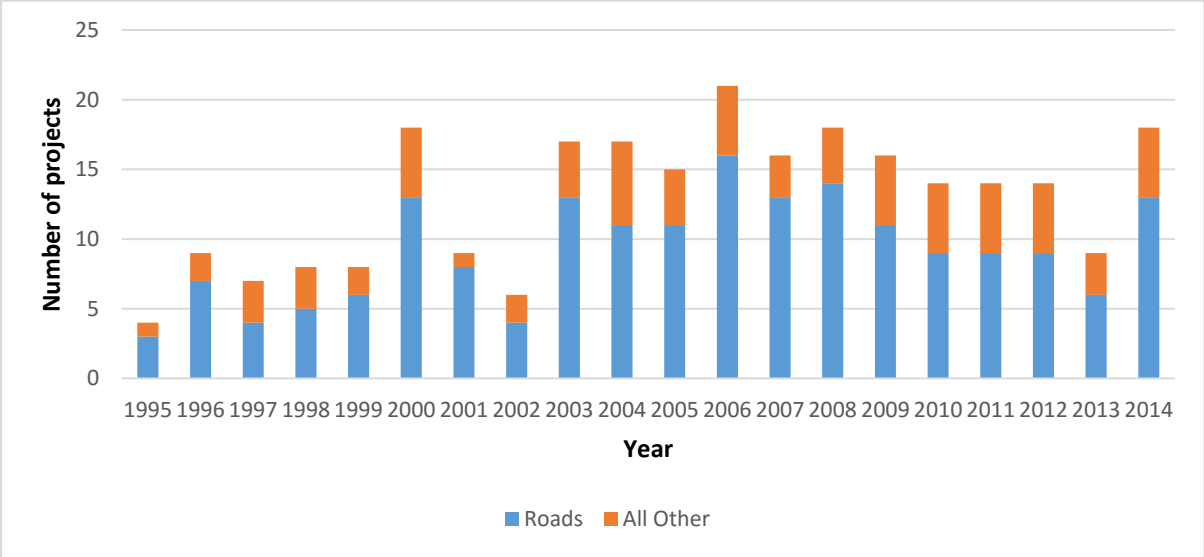

Figure 8.2: Road PPPs per year of Financial Close compared to all other modes
Source: Authors' compilation

Governments often selected this procurement mode in order to accelerate infrastructure development programmes which would not be feasible given public budgetary constraints. Evidently, road infrastructure was the most favoured, but also the most impacted by the economic crisis, as may be

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illustrated by the drop in the financial close of road projects following the 2008 year-mark. It is also interesting to note, that in the same period, following the economic crisis, other modes are viewed as more attractive for the procurement scheme (see Figure 8.2 for greater emphasis) or the risk appetite of the PPP market given the fact that other modes due to their structure favoured availability remuneration schemes. The strong shift to availability based remuneration schemes is very evident in Figure 8.3 with a definite switch from PPPs being typically demand based to typically availability based schemes. Notably, demand based remuneration schemes were more in line with the overall approach governments had for PPPs: sharing of risks (demand risk included) and relief of the public budget pursuing the user pays principle. The risk averseness of the PPP market following the economic crisis contests the initial approach.

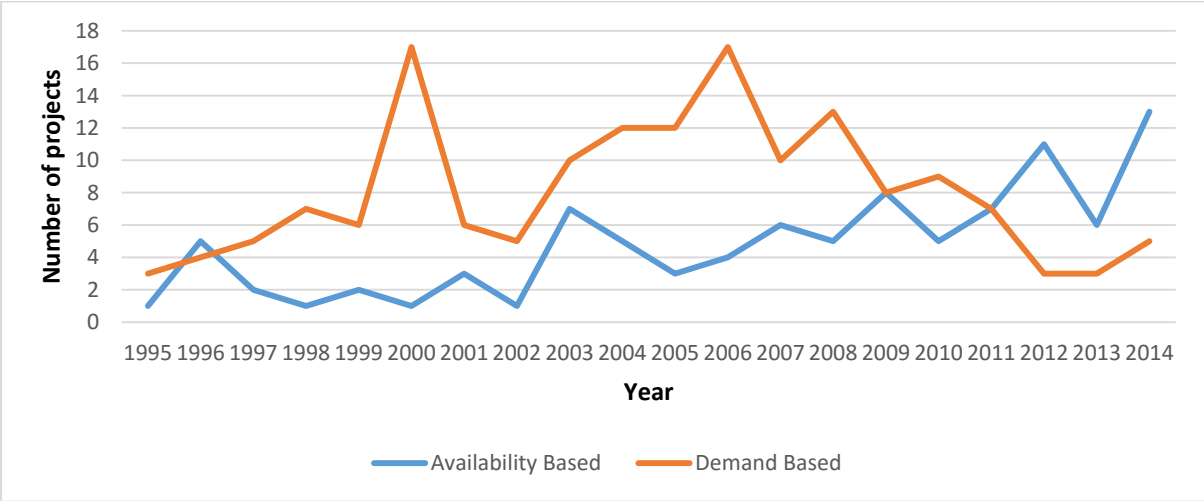

Figure 8.3: Availability vs Demand Based Remuneration Schemes over time (PPP Financial Close)
Source: Authors' compilation

A question stemming from Figure 8.3 is whether the shift in remuneration scheme preference is due to the greater share non-road sector projects are claiming in the PPP Market. Figure 8.4 and Figure 8.5 illustrate the response within the analysed sample.

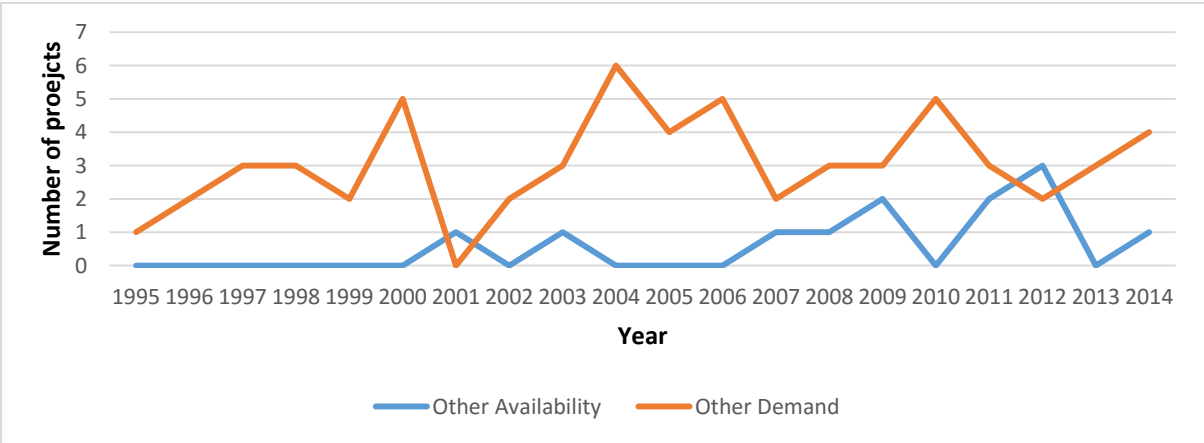

Figure 8.4: Availability vs Demand Based Remuneration Schemes over time (PPP Financial Close) of non-road projects
Source: Authors' compilation

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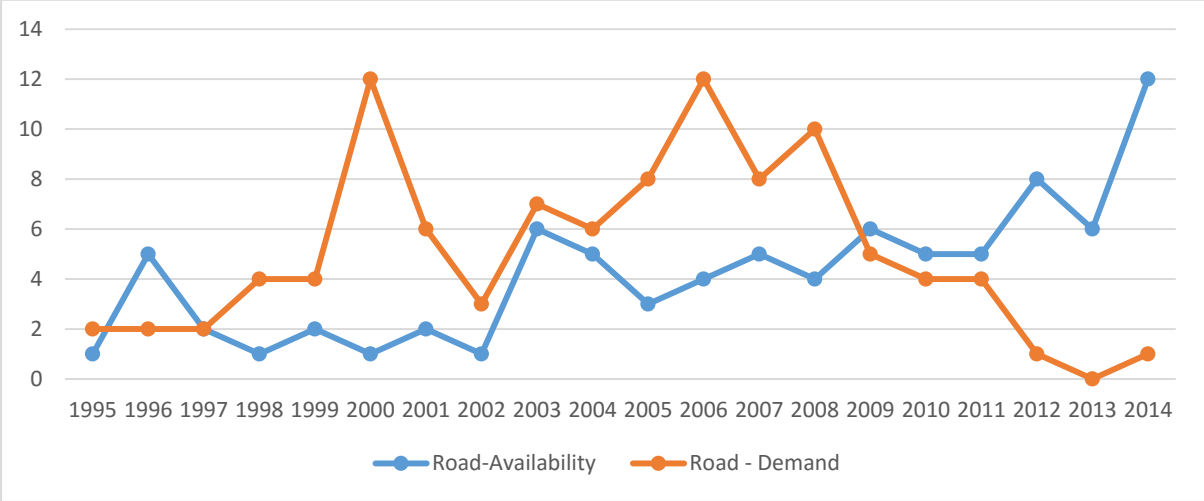

Figure 8.5: Availability vs Demand Based Remuneration Schemes over time (PPP Financial Close) of road projects
Source: Authors' compilation

While for non-road projects there seems to be no clear change in the adopted remuneration scheme (also considering the size of the sample), road projects may be seen to present a clear shift in preferred schemes.

Another point of interest are the countries (governments) adopting PPPs. Figure 8.6 presents the number of projects reaching financial close per country between 1994 and 2014. It is important to stress that Figure 8.6 concerns number of projects and not level of budget, which may present a totally different picture. It is interesting to note that nine (9) countries, in principle, contributed to the transport PPP market in Europe with Spain and the UK in the lead and the rest following far behind. Notably, half of these countries were significantly influenced by the economic crisis. It is also interesting to see how these nine countries contribute over the three (3) identified PPP periods.

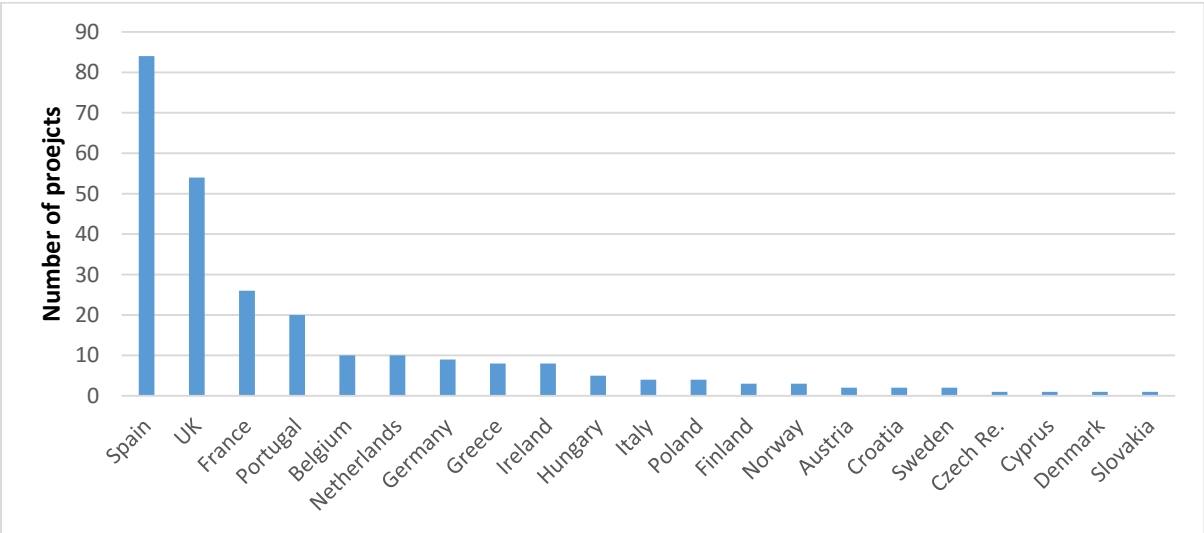

Figure 8.6: Number of projects reaching financial close per country between 1995 and 2014
Source: Authors' compilation

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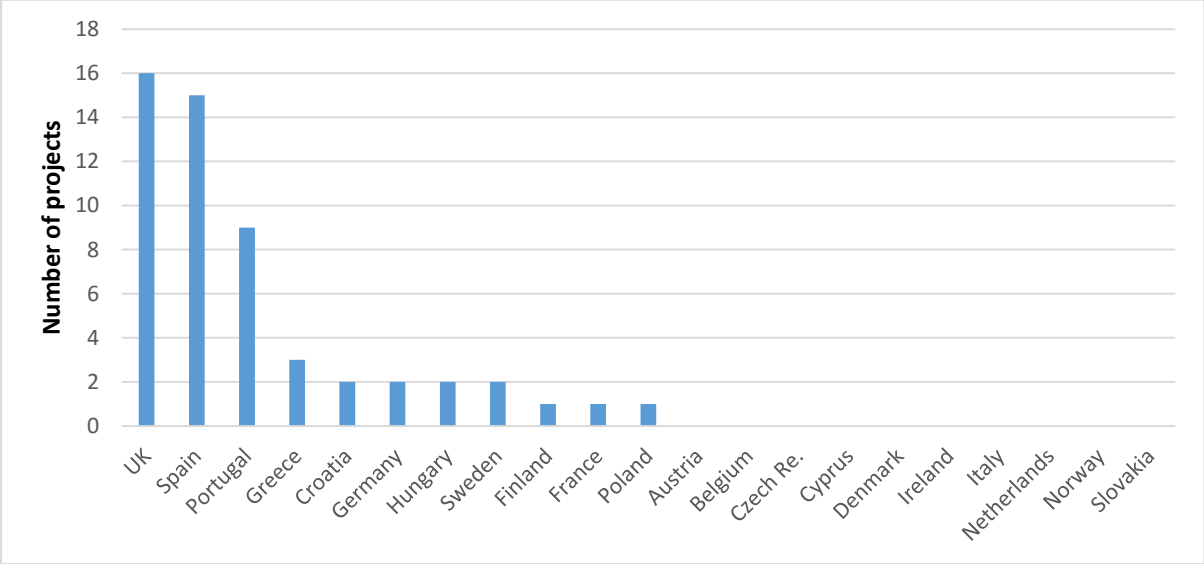

Figure 8.7: Number of projects reaching financial close per country between 1995 and 2000
Source: Authors' compilation

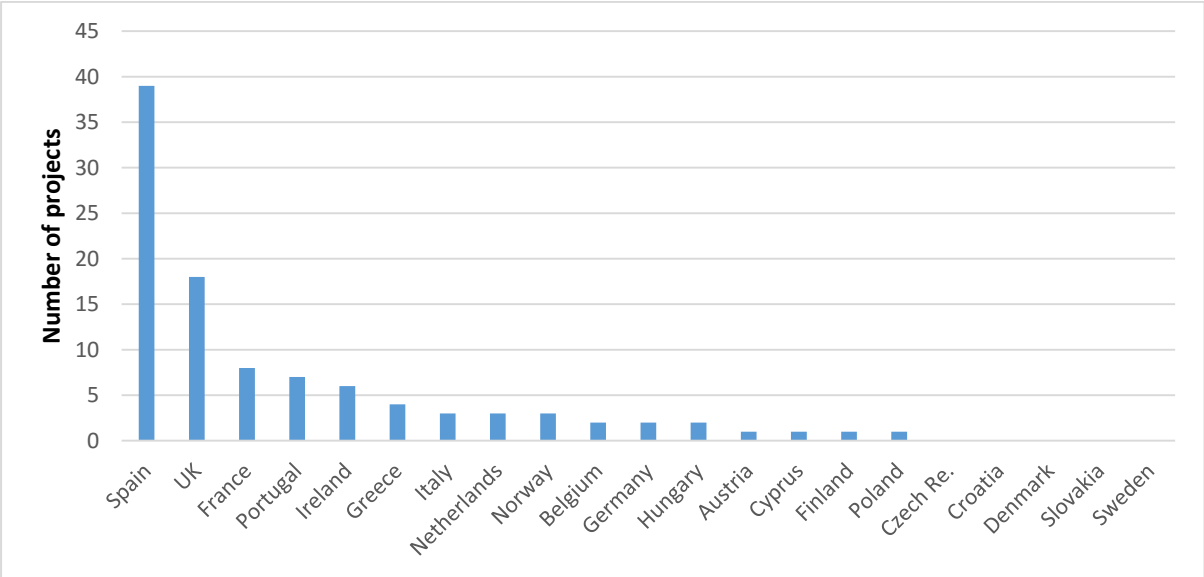

Figure 8.8: Number of projects reaching financial close per country between 2001 and 2007
Source: Authors' compilation

Spain, while slightly behind the UK in the first period (1995-2000) takes a definite lead in the second and, while, with reduced contribution in the third period continues to lead the PPP transport infrastructure market. What is interesting to note for the UK, is that despite the market changes, the UK sustains a stable pipeline of projects over the entire period.

Apart from the behaviour of the two leading countries, it is interesting to note the behaviour of the other countries over the three (3) periods. In the first period, Portugal is a country with considerable presence, especially given its size followed by Greece. It is worth noting, that Portugal had adopted a policy decision by which to accelerate the development of its transport infrastructure and close the

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infrastructure gap with the average of other OECD countries. Since the key goal of the Portuguese policy was development, the remuneration scheme adopted was in most cases shadow tolls and availability fees. In both cases, the government undertook the demand risk.

The second period is characterised by the continued presence of Portugal and Greece but also countries such as France with a long tradition in concessions, new entrants such as Ireland, Italy, the Netherlands, as well as countries deciding to experiment with the infrastructure procurement model such as Norway. In many ways, this development was expected given the need to improve infrastructure, the growing traffic demand and the relative positive experience acquired from PPPs (BENEFIT project, D4.3, Chapter 8).

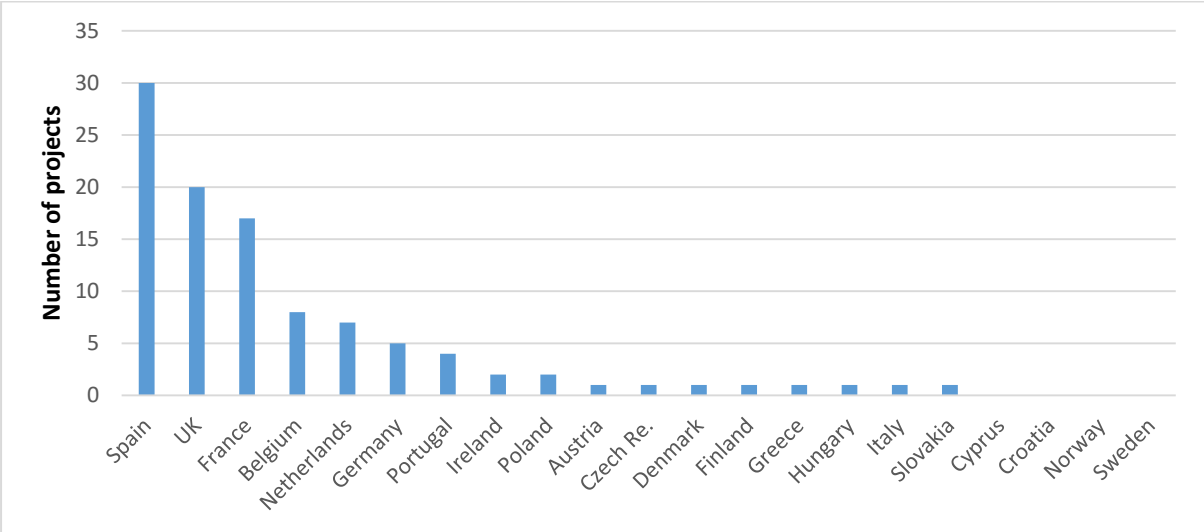

Figure 8.9: Number of projects reaching financial close per country between 2008 and 2014
Source: Authors' compilation

The third period is characterised by the rebound following the credit crunch. What is noticeable is the fact that the number of projects reaching financial close between in the second and third period are approximately the same. However, there is a considerable shift in governments' participation in the procurement scheme. While Spain and the UK continue to lead the market, new entrants seem to characterise the period, while countries active in the initial two periods have practically withdrawn.

In conclusion, stemming from the relatively limited sample of projects considered, it seems that following the economic crisis two major changes have taken place:

1. A shift from demand based remuneration schemes to availability based.
2. A significant change in the countries driving the PPP market and development in the transport sector.

8.1.3 Descriptive analysis

In Figure 8.10 toFigure 8.12, Remuneration schemes for road projects awarded between 1995 and 2014 for the EU is presented.

In terms of number of projects awarded per year, Road PPPs seem to pick up strongly as of 1999, reach a peak in 2007 and then drop due to the credit crunch and the financial crisis and show a strong re-bound in 2014.

When focusing on the remuneration schemes employed, it is evident that availability based and government based remuneration schemes dominate after 2007-2008.

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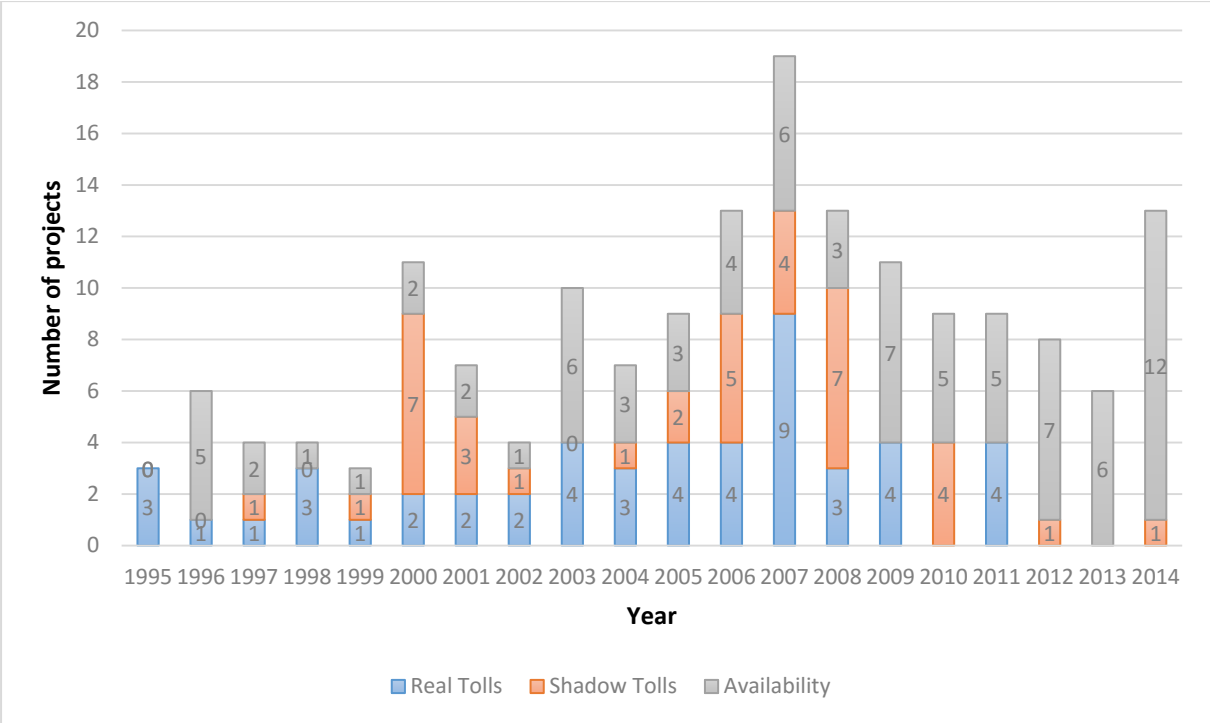

Figure 8.10: Remuneration Schemes (real toll, shadow toll, availability fee) per Year of Award/Financial Close for Road Projects (PPP projects in number of deals)
Source: Authors' compilation

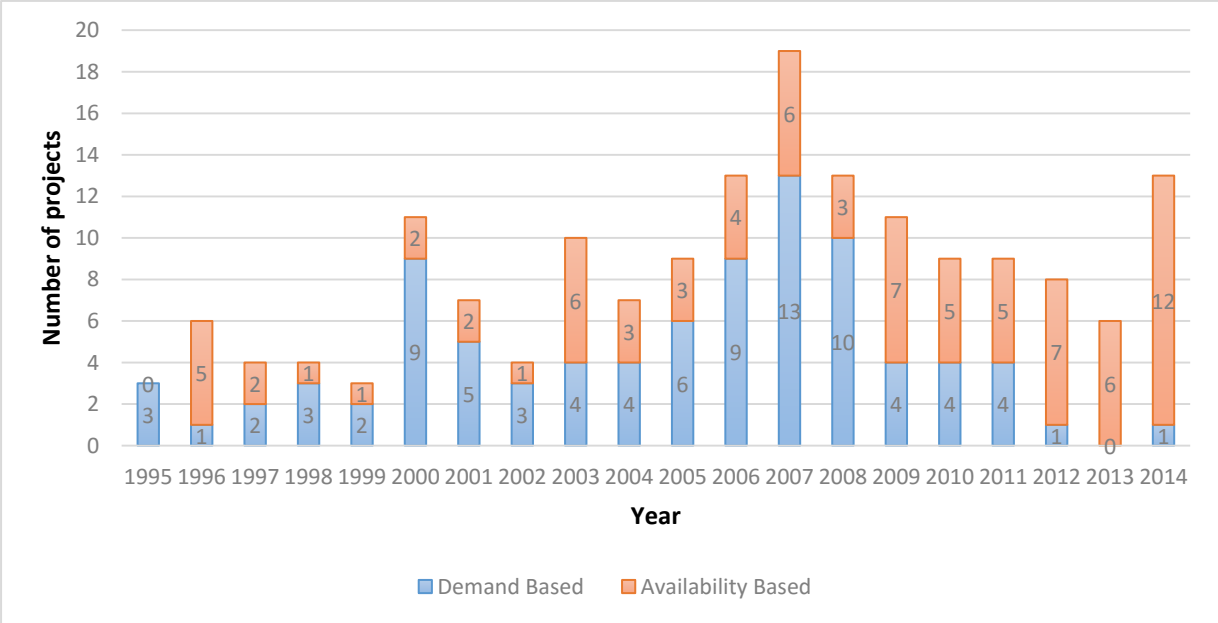

Figure 8.11: Remuneration Schemes (demand vs availability based) per Year of Award/Financial Close for Road Projects (PPP projects in number of deals)
Source: Authors' compilation

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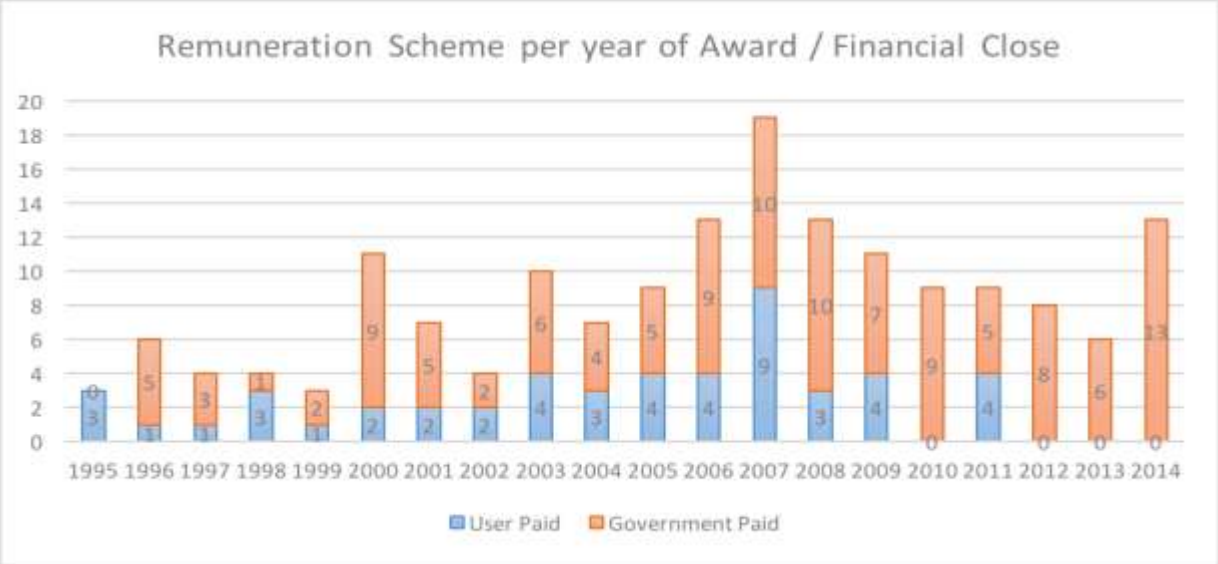

Figure 8.12: Remuneration Schemes (user vs government paid) per Year of Award/Financial Close for Road Projects (PPP projects in number of deals)
Source: Authors' compilation

When looking at country contribution over the entire period, 1995-2014, it is evident that Road PPP growth is concentrated on few lead countries (see Figure 8.13). Spain is clearly the country leading Road PPPs in the EU followed by the UK. Then, there is a second group of countries, which is led by France and followed by Portugal, Ireland, the Netherlands, Germany, Greece and Belgium. Other countries have small contributions.

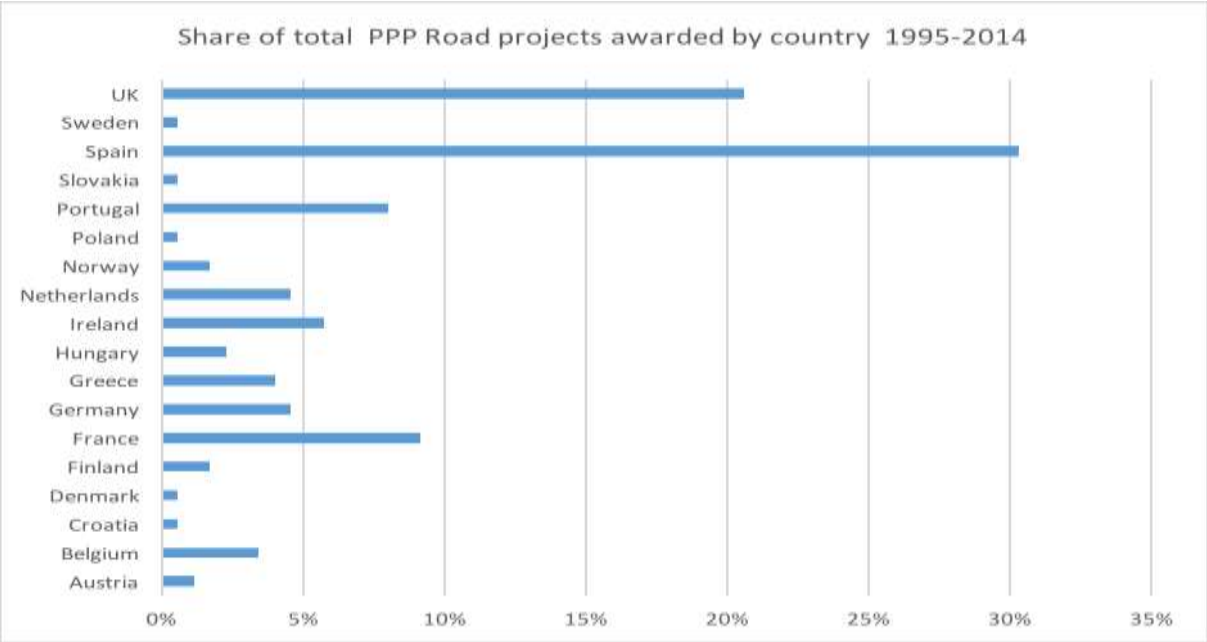

Figure 8.13: Share of total PPP Road projects awarded by country between 1995 and 2014 (PPP projects in number of deals)
Source: Authors' compilation

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Considering two distinct periods 2001 – 2007 (Figure 8.15) and then 2008 – 2014 (Figure 8.16), there is a noticeable shift in contributing countries. In the first period (2001-2007) 73 Road PPP projects were awarded, while in the second period (2008-2014) 70 projects. Hence, in the two periods an approximately equal number of projects were awarded. For reasons of completion, the first period (1995-2000) is also presented (Figure 8.14).

The overview of Figure 8.14 to Figure 8.16 shows shifts in contributions over time. In the first period (1995 – 2000), the UK has a lead role followed by Spain and Portugal, while Greece is present with 2 projects and Germany, Croatia and Finland are present with one project each. This period also includes the Sweden-Denmark joint venture PPP. In conclusion, this period is dominated by the UK, Spain and Portugal, while few other countries setup their first PPP Road deals. The Road PPP EU market is still relatively small.

The second period, characterized by growth of the Road PPP market, has a very different profile. More specifically, before 2008, economic crisis time-mark, the dominate country driving Road PPPs in the EU is Spain (36% of all project awarded in the period) and by far second the UK (18%). Other countries with a strong presence are Ireland (11%), Portugal (7%), and Greece (7%), followed by France (5%), Germany (4%) and Norway (4%). Hungary is also present in this period, as well as Belgium, the Netherlands and Finland. The later with one project each.

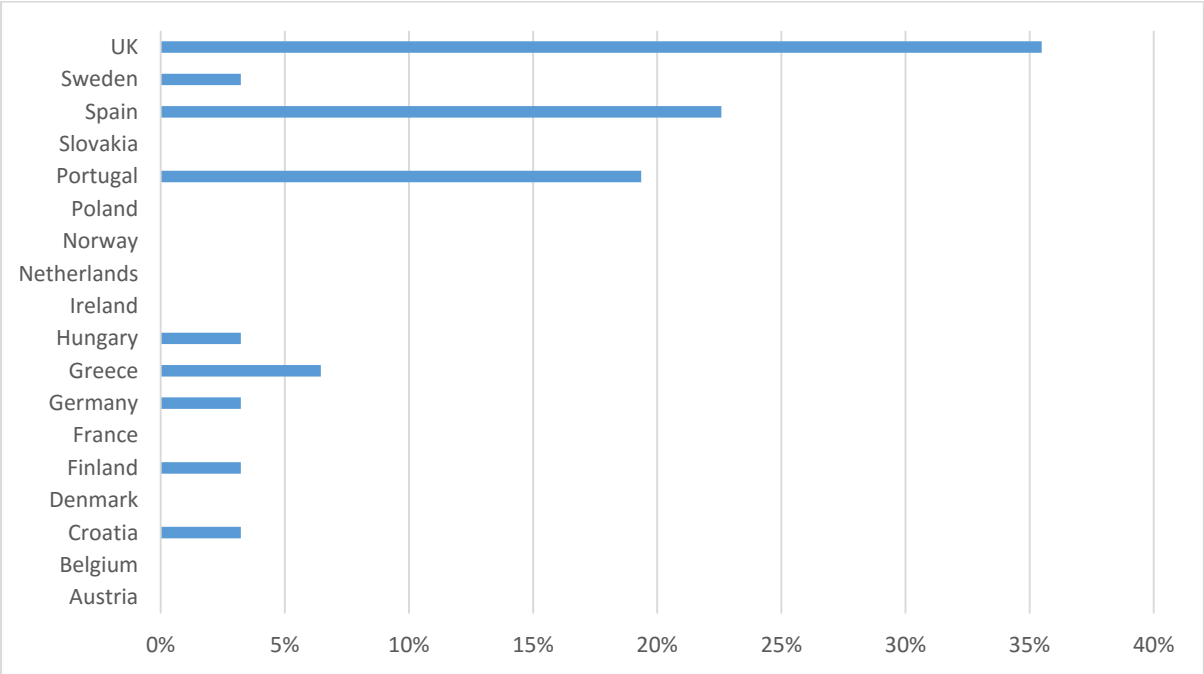

Figure 8.14: Share of total PPP Road projects awarded by country between 1995 and 2000 (PPP projects in number of deals)
Source: Authors' compilation

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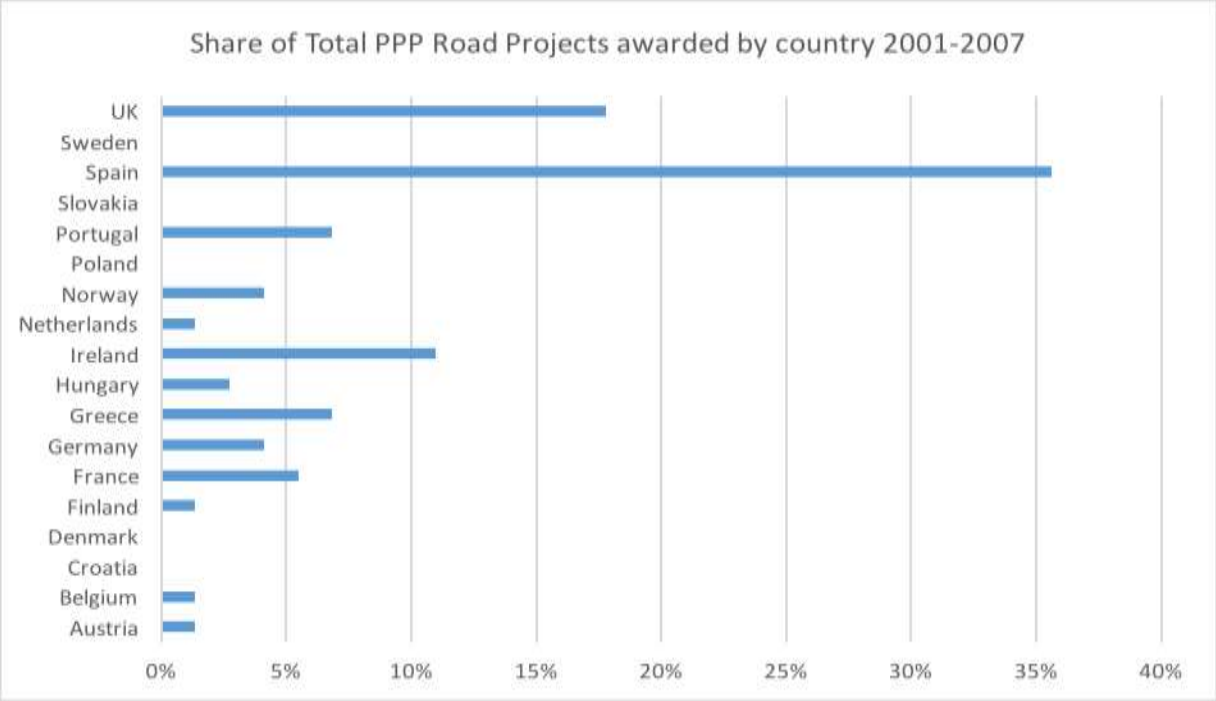

Figure 8.15: Share of total PPP Road projects awarded by country between 2001 and 2007 (PPP projects in number of deals)
Source: Authors' compilation

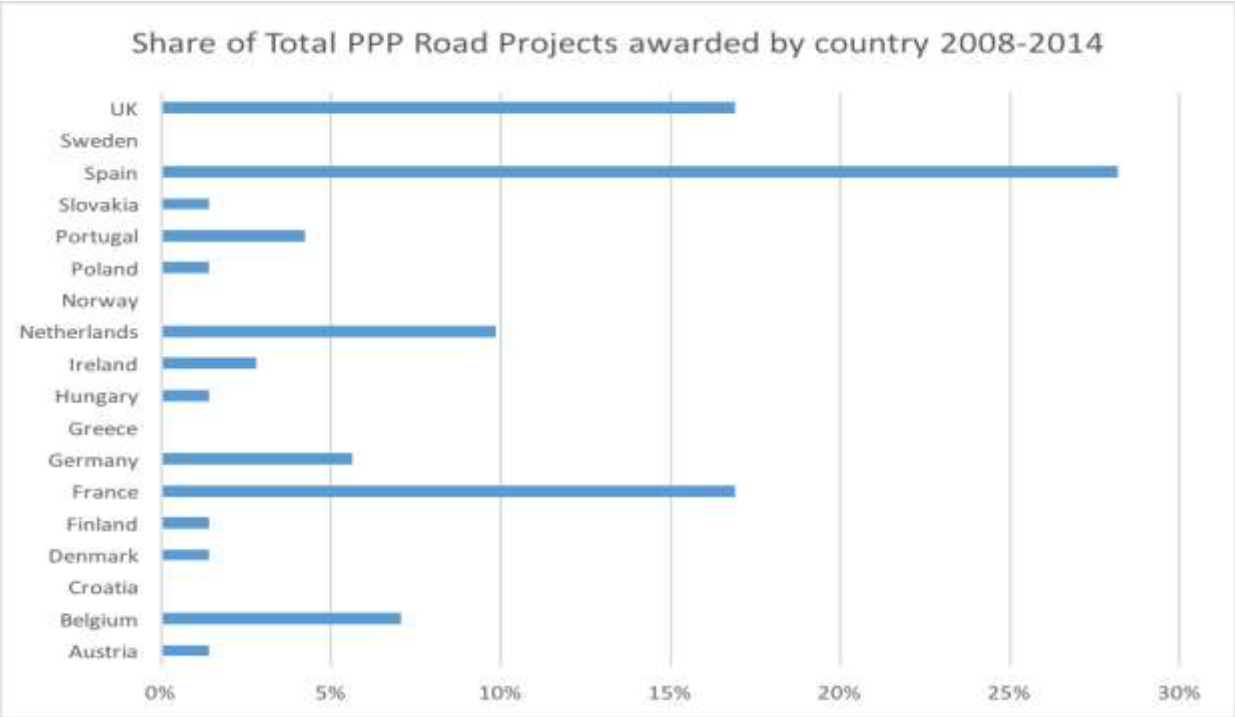

Figure 8.16: Share of total PPP Road projects awarded by country between 2008 and 2014 (PPP projects in number of deals)
Source: Authors' compilation

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In the third period (2008-2014), Spain remains the leader but with a far lesser contribution (29%), while the UK has a rather stable contribution (17%). What is noticeable is the fact that countries with a strong presence during the market growth period (2001-2007) show either significantly reduced contribution (Ireland and Portugal with 4% and 3% respectively) or are even inactive (Greece 0%). In this period, France has a significant contribution matching the UK (17%), while new adopters are present: the Netherlands (10%) and Belgium (6%). In addition, a number of new countries show presence Denmark, Austria, Slovakia.

The distribution in country participation in the three periods brings forward a specific question: What are the selected remuneration schemes per country? Table 8.2, below, presents this distribution over the three periods. Notably, while the share of remuneration schemes varies over the three periods, demand based schemes (real and shadow tolls) favoured during the first two, this is due partially to shifts in the selected remuneration scheme by the Road PPP mature countries (e.g. Spain) but also to the fact that new country-players totally adopt the availability scheme.

This issue is further discussed in the interpretation section that follows.

Table 8.2: Mix of Remuneration schemes selected by country over time

Remuneration schemes / Countries	1995-2000			2001-2007			2008-2014		
	Real Tolls	Shadow Tolls	Availability	Real Tolls	Shadow Tolls	Availability	Real Tolls	Shadow Tolls	Availability
Austria				100%					100%
Belgium						100%			100%
Croatia	100%	0%	0%						
Denmark									100%
Finland	0%	100%	0%			100%			100%
France				100%			38%		62%
Germany	100%	0%	0%	67%		33%			100%
Greece	100%	0%	0%	100%					
Hungary	100%	0%	0%			100%			100%
Ireland				88%		13%			100%
Netherlands						100%			100%
Norway						100%			
Poland	0%	0%	100%						100%
Portugal	0%	100%	0%	40%	60%		33%	67%	
Slovak Republic									100%
Spain	43%	57%	0%	35%	54%	12%	20%	55%	25%
Sweden – Denmark	100%	0%	0%						
United Kingdom	0%	0%	100%			100%	8%		92%
Total	**30%**	**30%**	**40%**	**41%**	**23%**	**36%**	**16%**	**19%**	**66%**

Source: Authors' Compilation

8.1.4 Interpretation of findings

The selection of a particular remuneration scheme implies risks for all parties involved: the concessioner, the government and, also the lenders. These risks also introduce limitations to the application of the various remuneration schemes. These risks and limitations are described briefly in Table 8.3. The table also includes the key impact each scheme may have on traffic. Notably, road traffic demand is a derived and dependent on growth.

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Table 8.3: Risk and limitations of Remuneration Schemes applied in Road PPPs

	Real Tolls	Shadow Tolls	Availability fees
Key impact on traffic	Price dependent	Quality	Quality
Government	User Acceptability	Government Paid	Government Paid
	Allocative efficiency	Performance Monitoring capability	Performance Monitoring capability
Concessioner	Uncontrollable risk		
Lenders	Growth forecast	Country creditworthiness	Country creditworthiness

Notably, all remuneration schemes are not suitable under all country conditions. Even under positive macroeconomic conditions, which might render lenders indifferent to the remuneration scheme risk, governments are limited in their selection. Real tolls reduce the State transaction costs, promote the "user-pays" principle and introduce incentives to concessioners, but are suitable if user culture accepts tolls (a negative example is the M5 in Hungary) and there is no risk for allocative efficiency. Shadow tolls are a direct burden on the government annual budget, while institutions capable of monitoring performance need to be in-place.

Under negative macroeconomic conditions or following the experience thereof, lenders and project sponsors demonstrate greater risk-averseness supporting availability based remuneration and countries with sufficient creditworthiness.

Testing the above reasoning a latent class cluster analysis was used to cluster countries with respect to the probable remuneration scheme selected. This technique:

a) includes a J-category latent variable, each category representing a cluster
b) uses many "dependent" or clustering variables (named *criteria* variables herein);
c) uses a mixture of multiple types of criteria variables (e.g., continuous, categorical, ordered, count);
d) uses and tests the effect of covariates of many different types;
e) is more flexible than many other clustering algorithms;
f) is a model-based clustering approach, so it provides probabilistic membership of observations in clusters; and
g) provides convenient interpretable output

Apart from the data presented here (year, project and remuneration scheme), the following criteria variables were used:

1. The institutional indicator of the implementation context per year and country (see BENEFIT deliverables D2.2 and D3.1)
2. The Financial – economic indicator of the implementation context per year and country (see BENEFIT deliverables D2.2 and D3.1)
3. The acceptability of real tolls based on existing (or not) experience in the specific country
4. The reason to adopt PPPs (see COST Action Discussion series 2013 and 2014)
5. Whether the country is (or not) burdened by sovereign debt

The latent class cluster analysis resulted in two clusters.

Table 8.4 below shows the characteristics of each cluster. The clusters are approximately of equal size. In the first, cluster 1, availability based remuneration is favoured, while in the second, cluster 2, demand based.

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Table 8.4: Characteristics of Clusters

	Cluster 1	Cluster 2
Cluster size	50,3% of sample	49,7% of sample
Probability of adopting a particular remuneration scheme		
Availability Fee	98,20%	1,17%
Real Tolls	1,64%	52,81%
Shadow Tolls	0,16%	46,02%
	100,00%	100,00%
Mean Indicator values		
Institutional Indicator	0,777	0,7007
Financial Economic Indicators	0,6457	0,6065
Sovereign debt	8,65%	80,05%
PPP adopted for budgetary reasons	16,83%	82,42%
Tradition in Real tolls	24,03%	92,90%

Table 8.5 below, presents the probability of each cluster to include each country. Ireland was not included in the latent class cluster analysis, as within the context of the BENEFIT project institutional and financial indicators have not been produced for Ireland. The reported values resulted from the classification cluster analysis, which was also conducted and gave similar results albeit less informative.

Table 8.5: Probably country participation per cluster

	Cluster 1: Availability Based	Cluster 2: Demand Based
Austria	1,17	1,18
Belgium	7,01	0
Croatia	0	0,0118
Denmark	1,17	0
Finland	2,34	1,18
France	9,47	10,54
Germany	5,91	3,48
Greece	0	8,29
Hungary	4,68	1,18
Netherlands	10,52	0
Norway	3,51	0
Poland	2,34	0
Portugal	0	16,58
Slovak Republic	1,17	0
Spain	8,65	55,19
Sweden - Denmark	0	1,18
United Kingdom	42,08	0
Total	100%	100%
Ireland*	7,02	3,39

**Assessed through the classification method*

The above results should be considered with caution in the case when a country is present in the sample with very few cases such as Austria, Croatia, Denmark or Sweden.

Spain dominates the Demand based cluster. Some countries will only appear in one of the two clusters such as Greece or Portugal in the demand based cluster or the UK in the Availability based

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cluster. However, what is most interesting is the fact that countries, which recently boosted Road PPPs such as Belgium and Netherlands, will only appear in the availability cluster.

8.1.5 Preliminary conclusions and research under way

The availability based remuneration scheme is more pronounced following the economic crisis.

While this may very well be a demonstration of PPP sponsors and lender risk averseness evident in a shift of the remuneration scheme adopted by countries like Spain, it is also contributed to the preferred remuneration scheme adopted by new dynamic PPP market entrants.

It is therefore important to identify existing dynamism and the potential impact this may have on both existing country –players and new comers.

In this context further emphasis is placed on analysing Spain (dominant player showing signs of shifting preference) as well as the potential of new entrants. Respective analysis is undertaken in this respect while simultaneous an effort is made to improve on the sample size by including PPP Road projects identified via other databases and project listings.

8.2 Trends In Revenue Schemes Employed In Latin America

8.2.1 Introduction

This section attempts to perform similar analysis to those presented in Section 8.1, but for Latin American context, and to assess how PPP projects evolved throughout numerous crises in Transport sector in Latin America. It aims to catch trends in respect of sub-sectors, numbers and types of project and revenue schemes from 1991 to mid-2015. The additional aim is to determine if there is a shift in revenue scheme of PPP projects due to financial and economic crisis which hit Latin America in 2008. The PPIAF Database for Transport sector in Latin America was used for this analysis.

This section is structured on the following way. The first section describes the timeline of financial crises in Latin America from the 1990s to date. The second section contains descriptive analysis which starts with total share by countries in number of PPP project financially or contractually closed in Latin America. This is followed by distribution of PPP types in transport sector. Finally a distribution of revenues sources in transport sector and its sub-sector roads is presented.

8.2.2 Timeline of global financial and economic crises in Latin America and their impact on PPPs

In respect of financial crises impact on PPPs two facts should be noted. The first is significant history and experience in crises in Latin America. According to Kaminski and Reinhart, Latin America suffered a higher number of crises than any other region and its major countries experienced more than one crisis in the last third of the twentieth century (Kaminsky and Reinhart, 1998). The second is that financial crises in Latin America were caused by inability of countries to repay debts to international creditors. From 1960s and 1970s this region borrowed money mostly for industrialization and infrastructure programs. The first crisis emerged in Mexico in 1982, spread over all region and lasted a decade. The second one called “Tequila crisis” occurred in Mexico in 1994-95 and Argentina in 1995, continued to Brazil in 1998-99, again to Argentina in 2001-02 and Uruguay in 2002 (Damili et all, 2013). There were no crises between the crisis in Uruguay in 2002 and the one that started in US in 2008-09. The last one hit Latin America very hard, but some authors argued that financial shock has

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been less severe than during two previous crises (Ocampo, 2009). In 2009 IMF studied impact that global financial crisis had on PPPs. This was based on the theoretical and country evidence. In Canada access to financing, higher costs for international projects and difficulties to secure long term loans were identified as key challenges. In Korea planning of new PPP projects declined, the contract signed were than initial projection, interest rates and access to financing were labelled as areas that the financial crisis had affected or was expected to be affected. Finally, in South Africa reported that financial crisis affected higher borrowing cost and lower expected returns, lower demand, PPPs profitability and the risk aversion of the government. IMF paper also identified possible measures to help PPPs during the crisis include contract extensions, output-based subsidies, revenue enhancements and step-in rights (Burger et all, 2009).

PPPs in Latin America experienced similar problems. On one side it was more difficult to finance building of infrastructure in post-crisis period and some governments were forced to cut their commitments and on the other side reducing infrastructure investment inexorably led to slower growth. According to the Inter-American Development Bank (IDB), infrastructure investment in Latin America and Caribbean (LAC) was above 3% of GDP in the 1980s, but decreased since, ranging from 2% to 3% of GDP. IDB concluded that LAC needs to invest approximately 5% of GDP (an amount equivalent to US$250 billion in 2010) in infrastructure over a long period in order to close the infrastructure gap .The United Nations Economic Commission for Latin America and the Caribbean (ECLAC) also highlighted infrastructure deficits in four sectors critical to national and regional prosperity: transport, energy, water and sanitation, and telecommunications.

The following analysis tries to demonstrate how PPP projects in Latin America responded on crises over time with a special focus on the quantitative analysis in respect of a risk allocation after the last crisis. In this analysis revenue source distribution over time was used to demonstrate possible change in risk allocation between the public and private partner. Although it has to be noted that change in revenue source does not necessarily mean the change in risk allocation because sometime revenue depends on particular conditions of contracts.

8.2.3 Descriptive analysis

The World Bank's PPI Database (henceforth Database) was used in the analysis. This database provides information on projects from low-income and middle-income countries in various sectors such as energy, telecommunication, transportation and water sector. The data has been collected since 1984 and is updated yearly.

The database draws its information exclusively from the publicly available sources such as commercial news, industry publications, etc. It includes only the projects that have reached financial and contractual closure and contains over 30 fields per project record, including country, financial closure year, infrastructure services provided, and type of private participation, technology, capacity, project location, contract duration, private sponsors, development bank support, revenue source, etc.

Database includes four types of PPPs that reached financial or contractual closure: managements and lease contracts, brownfield projects, greenfield projects and divestitures (World Bank, 2016a).

There are 857 project records the database for 21 countries of Latin America and Caribbean with financial closure between 1991 and mid-2015. Records of the same project but different investment year were disregarded. This resulted in 561 project records left, meaning that from 1991 to mid-2015 561 PPP contracts have been signed. This includes 159 projects since the end of 2008 which was taken as a basis when referring to the last financial crisis. Only a few countries singled out from the database in number of projects. The first group represents Brazil with 158 projects closely followed by Mexico with 98 projects. In the second group are Argentina, Chile and Columbia with 68, 66 and 63

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projects respectively. Peru with 36 projects belongs to the third group of countries with significant number of projects. Other countries, with exception of Ecuador and Dominican Republic, have less than 10 projects in this period. The exact share of PPP projects in Transport sector by countries over different periods is demonstrated on Figure 8.17 bellow. Periods were chosen with respect to crises timeline. Also these four periods have approximately equal number of projects awarded.

When it comes to periods with significant number of projects, historic maximum of 50 projects that reached financial closure was in 1997-98. The main contributor was Brazil which was at that time on the verge of financial crisis. From 2006 to 2014 there has been an average of 24 projects that reached financial closure. Judging by the number of projects, the least prosperous period for PPP projects in Latin America was between 1999 and 2002 with an average of 17 projects. This corresponds to the financial crisis in Brazil, Argentina and Uruguay.

Figure 8.18 shows concession as a predominant type of PPP projects in Transport sector in Latin America through entire period. Concession in this database involves build-rehabilitate-operate-transfer, rehabilitate-operate-transfer and rehabilitate-lease or rent-transfer sub-type. The other types of PPPs were present to a lesser extent, except greenfield projects which had significant share in total number of projects in 2005, 2007, 2011 and 2013.

As there were no records on the revenue source for 561 project, to identify trends in revenue schemes the database was compressed to 256 project records. This eliminated records in years 1991, 1992 and 1999. Additionally, years 1993 and 1994 were excluded as there was only one project record per year. In these 256 project records that were used, the following 8 categories of revenue sources exist:

1) Annuity/availability payment
2) Annuity/availability payment, Shadow tools
3) Annuity/availability payment, User fees
4) Tax Deduction, Others
5) User fees
6) User fees and fixed payment(s) from the government
7) User fees and variable payment(s) from the government
8) Variable payment(s) from the government

The distribution of all revenue source categories over time in Transport sector is presented in Figure 8.19. Considering that the analysis showed sub-sector roads as sub-sector with most of the PPP projects awarded in this period with a share of almost 50%, revenue scheme types for sub-sector roads is presented separately in Figure 8.20.

From Figure 8.19 it can be concluded that user fees is a predominant type when it comes to revenue sources in transport sector in Latin America. Other types of financing, mostly combination of user fees and fixed payments from government, quietly emerge in 2005 gaining its peak in 2007 and 2010.

Sub-sector roads experienced similar distribution. Government took greater role in financing PPPs in 2005, but the share of revenue types other than user fees was much greater in 2007 and 2010. More than 60% of project that reached financial closure in 2007 and 2010 were supported through government subsidies.

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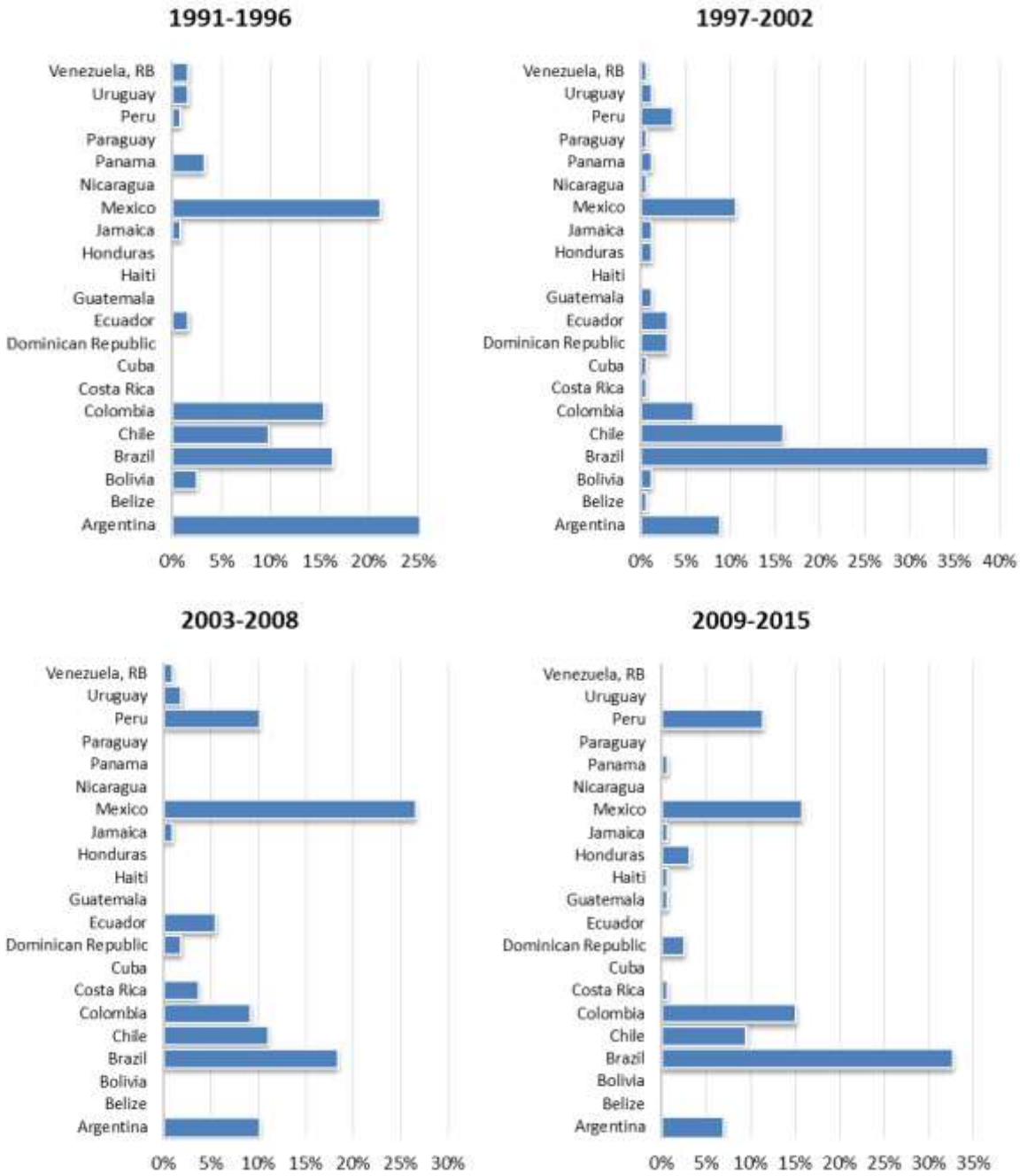

Figure 8.17: Share of PPP projects in Transport sector by countries for four distinctive time periods

Source: Authors' compilation

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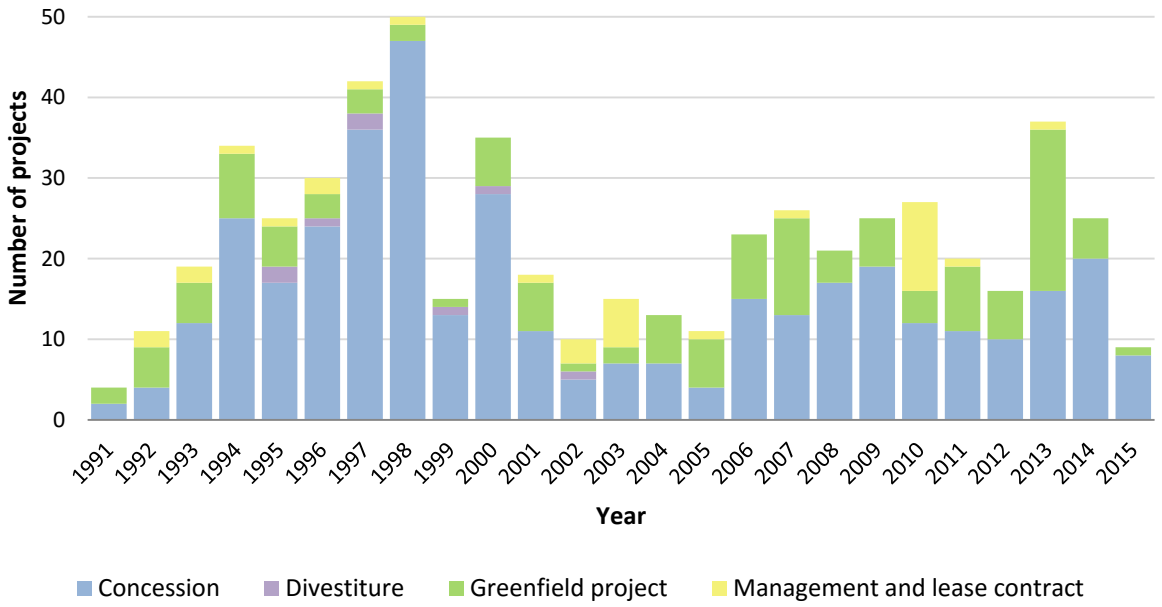

Figure 8.18: Overview of PPP types in Transport sector in Latin America from 1991 to mid-2015
Source: Authors' compilation

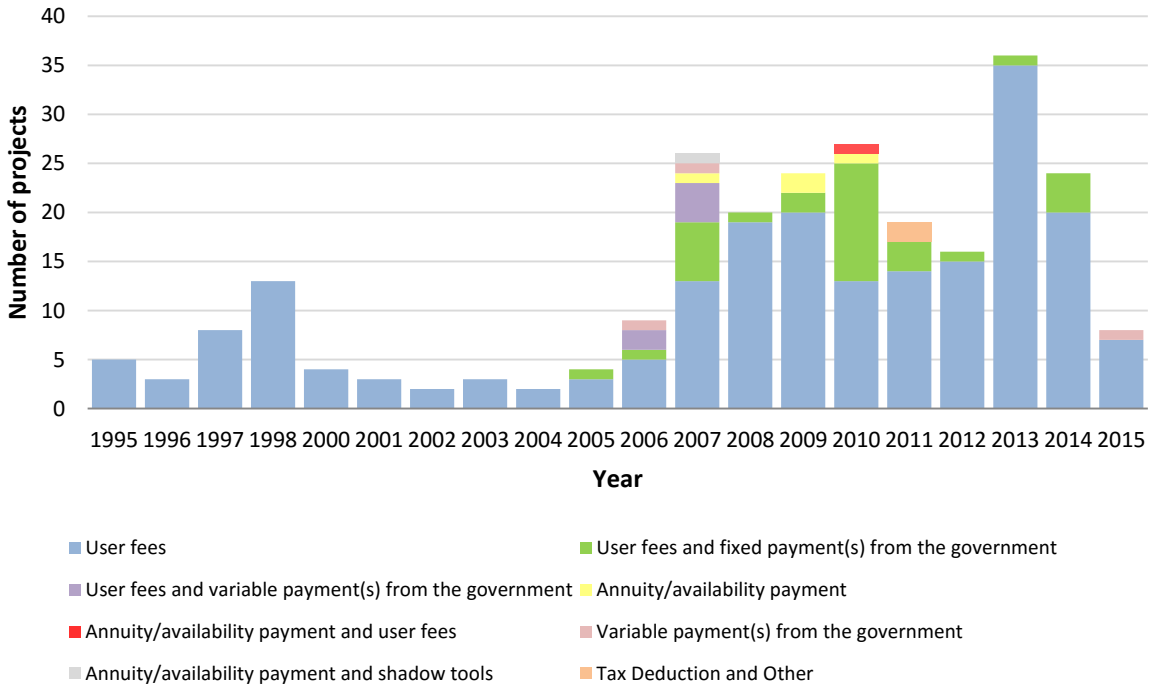

Figure 8.19: Revenue Source (all types of revenues) per financial closure year in Transport sector
Source: Authors' compilation

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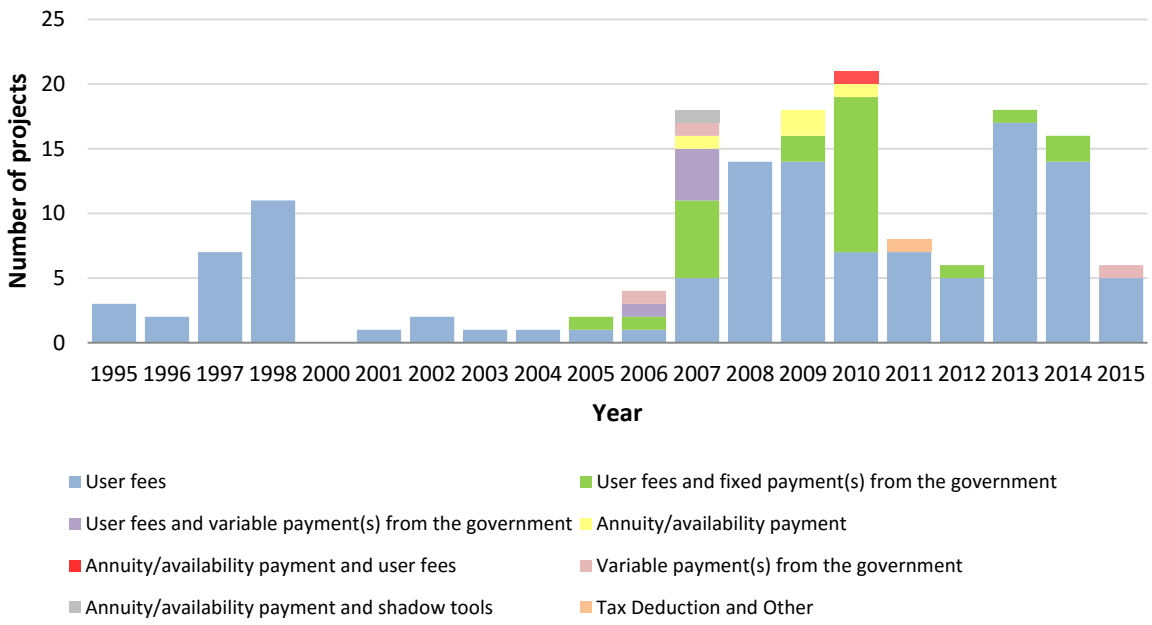

Figure 8.20: Revenue Source (all types of revenues) per financial closure year in transport sector, sub-sector roads
Source: Authors' compilation

The afore-mentioned 8 categories of revenue sources from the database were grouped and analysed based on two characteristics: demand versus availability and origin of payment. Real tools, shadow tools, tax deduction, fixed and variable payments from government are sub-types of demand based schemes, while availability fees are sub-type of availability based schemes. In respect to origin of payment, government pays availability fees, tax deduction and variable payments, opposing to user payment schemes, i.e. user fees. Two main groups were combined in order to cover other revenue sources from the database.

Table 8.6: Identifying two main groups of revenue sources

<table>
<tr><th>Demand/availability</th><th>Origin of payment</th></tr>
<tr><td rowspan="3">Demand based
a. Tax deduction
b. User fees
c. User fees and fixed payment from the government
d. User fees and variable payment from government
e. Variable payment from government</td><td>User paid
a. User fees</td></tr>
<tr><td>Government paid
a. Annuity/availability
b. Annuity/availability and shadow tools
c. Tax deduction and others
d. Variable payment from the government</td></tr>
<tr><td rowspan="3">Combined
a. Annuity/availability and user fees
b. User fees and fixed payment from government
c. User fees and variable payment from government</td></tr>
<tr><td>Availability based
a. Annuity/availability</td></tr>
<tr><td>Combined
a. Annuity/availability and shadow tools
b. Annuity/availability and user fees</td></tr>
</table>

Source: Authors' compilation

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Figure 8.21 and Figure 8.22 show revenue sources distribution grouped on the basis of origin of payment in transport sector and its sub-sector roads respectively. As previously explained 8 types of revenue sources are grouped on the basis of the origin of payment into user paid, government paid and combined. This grouping allows a much clearer view on government involvement in PPP financing. Judging by the figures below significant involvement of governments may be noted in sub-sector roads, either in combination with user fees or strictly through tax deduction of availability fees. Since 2012 government paid revenues showed constant decrease in favour of user fees.

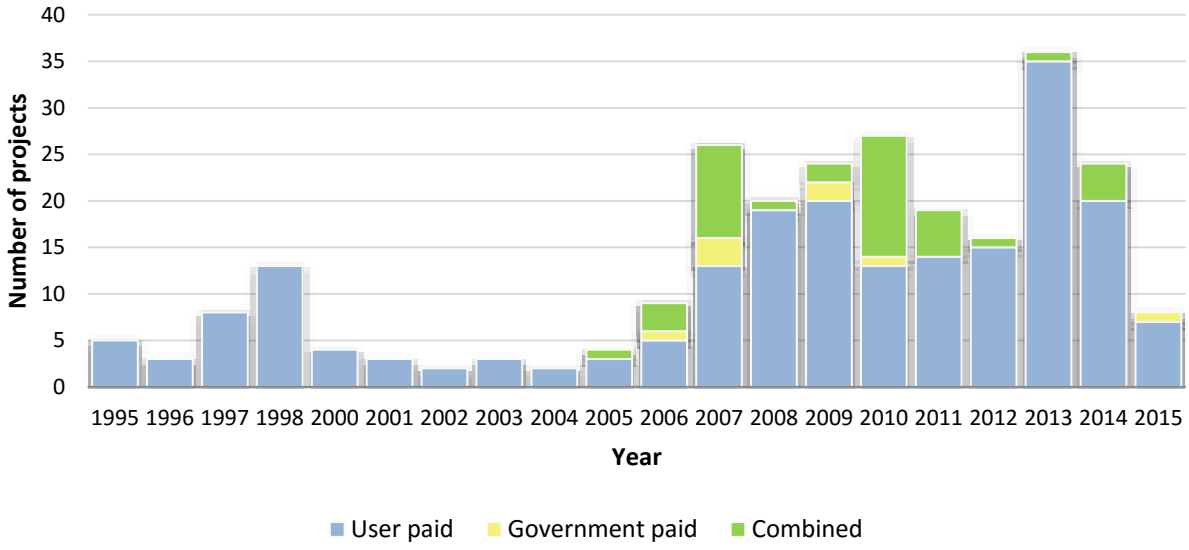

Figure 8.21: Revenue Source (grouped on the basis of origin of payment) per financial closure year in Transport sector
Source: Authors' compilation

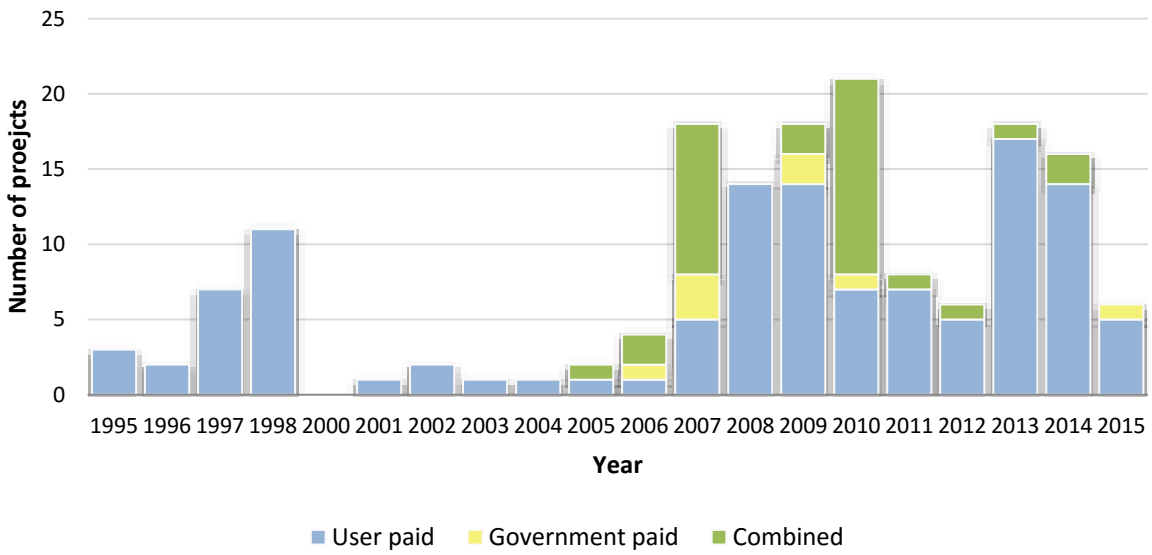

Figure 8.22: Revenue Source (grouped on the basis of origin of payment) per financial closure year in transport sector, sub-sector roads
Source: Authors' compilation

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Figure 8.23 and Figure 8.24 demonstrate revenue sources distribution grouped on the basis of demand vs. availability in sector transport and its sub-sector roads. Revenue sources based on demand such as tax deduction, user fees, user fees with fixed and variable payments from government, shadow tools, etc., showed to be a predominant funding choice in Latin America during all period. Availability based fees to a lesser extent can be noted from 2007 until 2010 which may be explained with the need for the alternative sources of funding due to global financial and economic crisis which emerged in 2008.

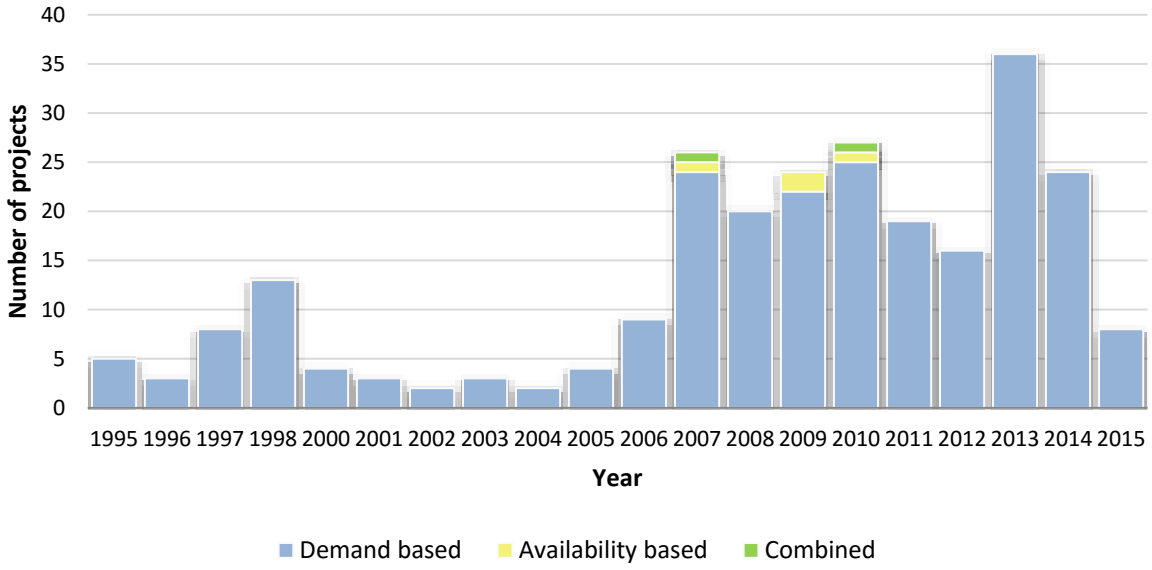

Figure 8.23: Revenue Source (grouped on the demand/availability basis) per financial closure year in Transport sector
Source: Authors' compilation

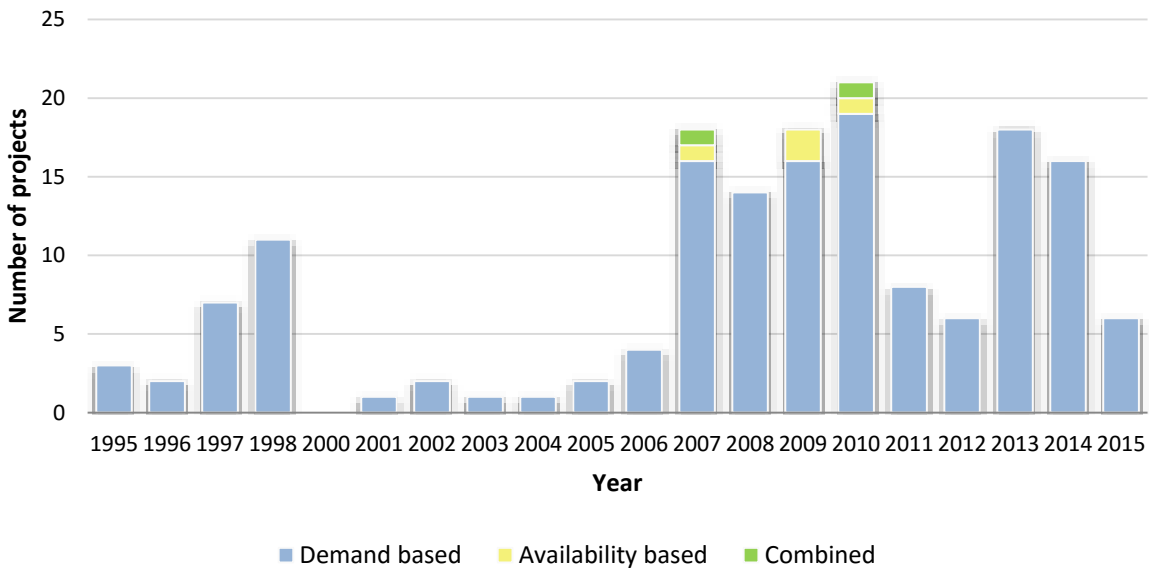

Figure 8.24: Revenue Source (grouped on the demand/availability) per financial closure year in Transport sector

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Source: Authors' compilation

Considering that financial crises in Latin America were frequent and that few countries singled out with respect to number of projects, a closer look on revenue source distribution grouped by origin of payment was made. The information gathered may seem insignificant due to a small number of projects, but it might be interesting to see how revenue sources evolved in connection with countries GDPs. Hence, on the next figures distribution of projects and revenue sources in time compared with GDP values is shown. GDP was taken as it represents a measurement of a nation's overall economic activity. World Bank database of GDP at market prices was used with exception for 2015 since there were no data (World Bank, 2016b).

Figure 8.25 and Figure 8.26 represent revenue scheme distribution in Chile and Brazil. Apart from having a rich PPP project's history, these two countries have a high degree of PPP maturity in respect to operational, regulatory and institutional framework, investment climate and financial facilities (EIU, 2014).

From the figures it can be concluded that the last financial crisis had minor or no effect on revenue source selection of these two countries. Even GDPs did not show slowdown immediately after crisis in 2008-09. One my concluded that strong regulatory, institutional and investment conditions helped in this respect. Chilean government was involved in financing of PPP project to a lesser extent in 2011 and 2014 which corresponds to a minor drop of GDP in 2010. Involvement in PPP financing of Brazilian government started back in 2007-08, then in 2011 and again in 2014 to a higher extent which also corresponds to GDP's drop-off.

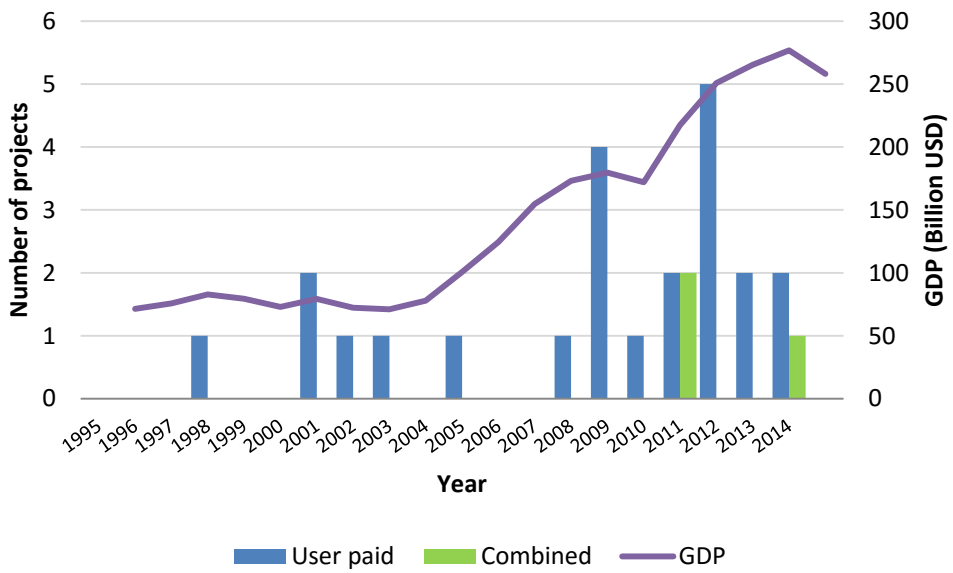

Figure 8.25: Revenues schemes adopted over time in Chile compared to its GDP
Source: Authors' compilation

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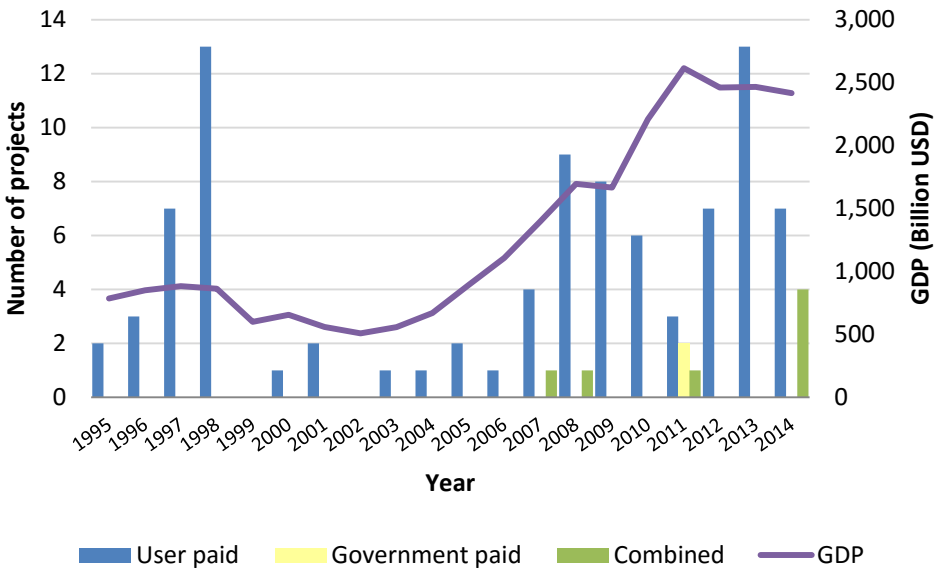

Figure 8.26: Revenues schemes adopted over time in Brazil compared to its GDP
Source: Authors' compilation

Further development of PPP projects may bring more information on revenues sources and GDP connection. In Chile is included in its national infrastructure plan for the period 2014-2020 anticipating $9bn in new concession projects, including highways and airports (Lagorio, 2014). On the other hand Brazil in 2012 announced the Logistic Investment Programme (PIL) to promote investment of approximately $64bn in PPP models for highways, railways ports and airports.

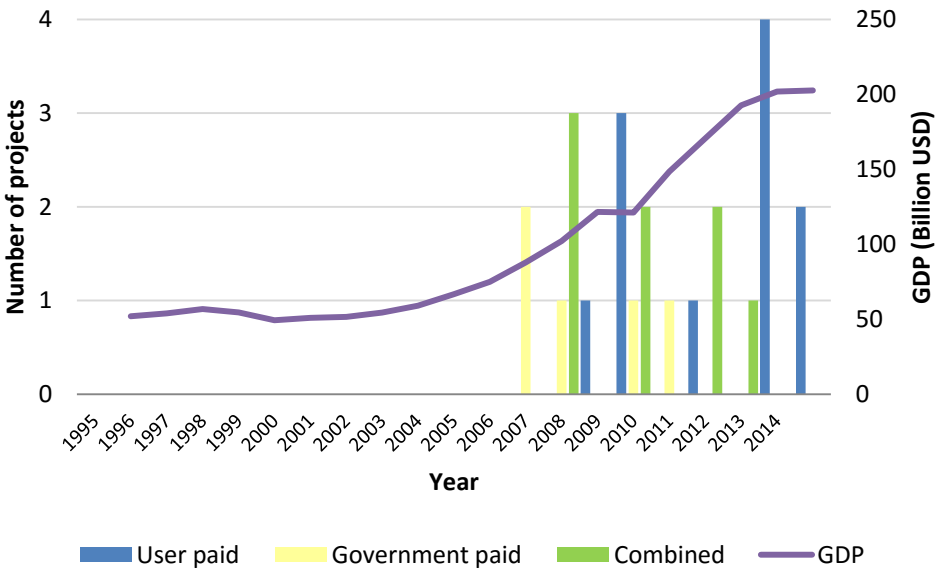

Figure 8.27: Revenues schemes adopted over time in Peru compared to its GDP
Source: Authors' compilation

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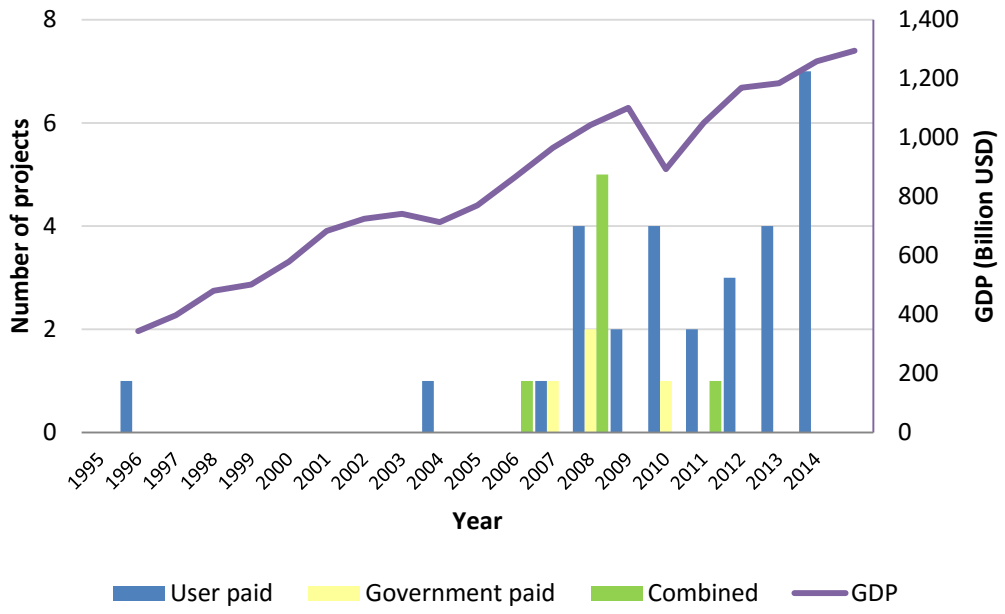

Figure 8.28: Revenues schemes adopted over time in Mexico compared to its GDP
Source: Authors' compilation

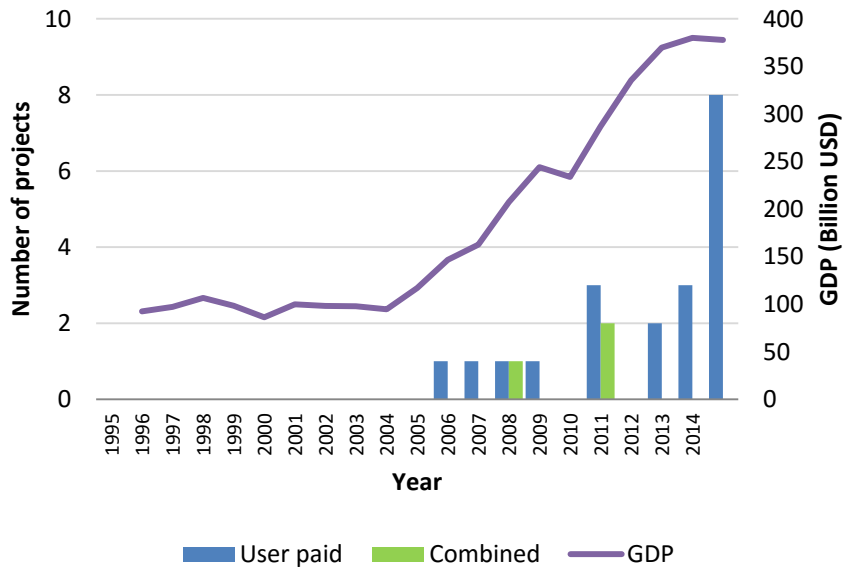

Figure 8.29: Revenues schemes adopted over time in Colombia compared to its GDP
Source: Authors' compilation

The other three countries that closely follow Chile and Brazil in most favourable environments for PPP project in Latin America are Peru, Mexico and Colombia. Even though three countries has been initiated PPP projects from 1993, the first information available for revenue sources in database are the ones from 2006-07. According to Figure 8.27, Figure 8.28 and Figure 8.29, Peruvian, Mexican and Colombian governments offered support to PPP projects through subsidies not long before and immediately after crisis in 2008. Additionally, Mexico and Columbia suffered a drop in GDPs in 2010

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as a reaction to financial crisis. In Peru government or combined payments are represented with a larger share than the user payment options. It is also interesting to notice that Peru to date had no significant drop of GDP since 2003.

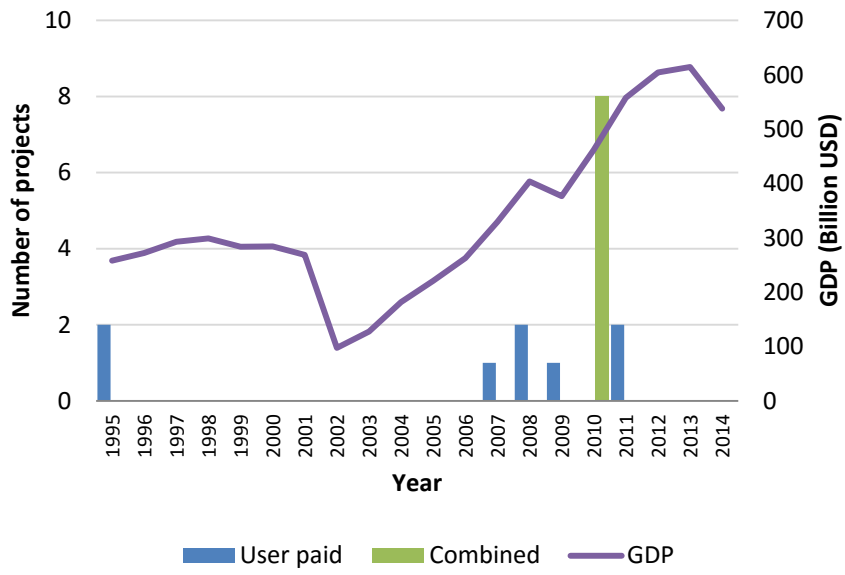

Figure 8.30: Revenues schemes adopted over time in Argentina compared to its GDP
Source: Authors' compilation

The last country that was observed in respect of revenue source and GDP connection is Argentina. Argentina is labelled as a difficult environment primarily due to high degree of public scepticism due to negative privatization experiences. Even though legal and institutional frameworks are in place since 1990s they have not been used (EIU, 2014). Little information is available on the revenue source on project that reached financial closure until mid-2015. According to this information, Argentina turned to a combination of user and government payment immediately after GDP drop and crisis in 2008-09.

8.2.4 Findings and further research

To conclude, not many changes to revenues schemes were noted in PPP projects in Latin America following the crisis. User fee is still a predominate one with 207 records out of 256. Government payment or a combination of user and government payment were employed during and immediately after crisis but substantially reduced in recent years. When countries are looked separately, although the amount of information is questionable, countries with more favourable PPP environment (Chile and Brazil) signed PPP contracts with lesser involvement by the government in financing. Peru, Mexico and Colombia were more eager to sign contracts with government involvement during and after crisis. Revenue source schemes are mostly demand based with some availability based from 2007 to 2010 with exception of 2008 which again corresponds with the last financial crisis occurrence.

Last crisis had no effect on the number of project closed financially or contractually since the number of project from 2009 increased significantly. Even though the number of projects increased, it may be that the values of investment in PPP projects dropped after the crisis. This can be a subject of further research. Since, almost all counties announced further investments in PPP projects in the next few years it can be expected that the amount of information in database will increase in respect of revenue schemes which will then allow an updating of this analysis.

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8.3 Summary

The analysis presented in this chapter showed quite different trends in revenue schemes employed in Europe and Latin America following the global financial crisis.

In Europe, there is clear shift towards the availability based remuneration scheme that may be the result of PPP sponsors and lender risk averseness. This may also be a result of European sovereign debt crisis that extended till 2012, especially in southern European countries.

In Latin America there was increased number of projects with Government support from 2007 to 2010. However, number of these projects declined in recent years. In addition, most of projects realized since 2011 are demand based.

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9 Conclusions and recommendations

9.1 Introduction

The analyses presented in this report are based on the BENEFIT database of cases. The database contains about 80 cases of PPP and public projects in main transport modes that were realized mostly in the last 40 years and that were in different stages on implementation during the global financial crisis. However, it was not possible to achieve uniform distribution of cases across countries and across modes, as well as across time scale, having in mind the number of cases collected, so the dataset cannot be considered unbiased.

The impact of global financial crisis on funding and financing of transport infrastructure has been approached in this report through different streams of analysis, i.e. qualitative analysis, that was performed by mode, and through Fuzzy set Qualitative Comparative Analysis (FsQCA), Importance Analysis (IA) and Econometric Analysis (EA). Finally, trends in remuneration schemes employed for PPP projects and the impact of the crisis have been presented for European and South American context.

The analysis used BENEFIT Matching Framework based on indicators initially identified in BENEFIT Deliverables D2.2, D2.3 and D2.4; and elaborated and initially validated in D4.2. Revision of these indicators to their final configuration is presented in Chapter 3 of this report.

Key findings were identified with respect to the influence indicators have on the four specific outcomes considered within the BENEFIT Matching Framework, i.e. Cost to Completion, Time to Completion, Actual versus Forecast Traffic and Actual versus Forecast Revenues. The latter are time related as traffic and revenue performance may change over time depending on the context.

This section presents the summary of findings of the performed analysis and recommendations for improving resilience of transport infrastructure projects to crisis.

9.2 Comparative analysis of findings

As described in D4.2 chapter 9, each analysis has a different theoretical background and limitations in its application. In this respect, findings should be interpreted with the respect to the methodology applied and within the respective limitations.

In addition, all indicators could not be investigated in all analyses. The Fuzzy Set Qualitative Comparative Analysis (FsQCA) does not include the Reliability /Availability and the Revenue Support indicators. The latter being of importance as it includes the “Level of Coopetition” or control over traffic the project may have. The Econometrics analysis does not include the Institutional indicator (InI) as it was found to be highly correlated to the Financial–Economic indicator (FEI). Finally, the importance analysis includes only the factor “Level of Coopetition” of the Revenue Support indicator.

In the following part of this section, the comparison of findings is presented by individual outcomes.

Figure 9.1 presents the influencing parameters obtained by FsQCA, IA and EA for cost and time to completion outcomes. Only the most important solutions that explain substantial number of cases are presented.

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Figure 9.1: The influencing parameters for cost and time outcomes

Outcome	FsQCA		Importance	Econometric	
	Before Crisis	After Crisis		Bivariate	Logistic
Cost	"ON COST" MODEL • Financing scheme* • Institutional Context + • Governance + • Financial Economic context – Cases explained: 49% • Institutional Context + • Financial Economic context – Cases explained: 51% "OVER COST" MODEL • Remuneration attractiveness- • Financing scheme - Cases explained: 45%	ON COST" MODEL • Institutional Context + • Financial Economic context + • Financing scheme + Cases explained: 56% • Institutional Context + • Financial Economic context + Cases explained: 57% "OVER COST" MODEL • Institutional Context - • Financial Economic context - • Remuneration attractiveness- • Financing scheme + Cases explained: 41% • Institutional Context - • Remuneration attractiveness- • Financing scheme + Cases explained: 41%	• Institutional setting • Governance • Level of control revenue (Revenue support) • Cost saving	• Financial economic setting + • Governance + • Cost savings + • Revenue support +	• Financial economic setting + • Governance + • Cost savings + • Revenue support +
Time	"ON TIME" MODEL • Governance + • Financing scheme+ Cases explained: 74% • Governance + • Institutional Context + • Financial Economic context + Cases explained: 53%	"OVER TIME" MODEL • Institutional Context – Cases explained: 56% • Governance – Cases explained: 50% • Institutional Context – • Transport market efficiency and acceptability - Cases explained: 46%	• Governance • Institutional setting, • Remuneration attractiveness • Level of control (Revenue support)	• Crisis - • Governance + • IRA + • Revenue robustness +	• Crisis - • Governance + • IRA +

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Cost to completion

According to the FsQCA analysis, the high Financing scheme indicator (FSI) was a necessary condition for projects being “on cost” that were completed before the crisis, meaning that projects that were heavily subsidized by the public sector or that were purely public had more chances to be on budget than the PPPs. For solution after the crisis, the FSI is one of core conditions in both the “on cost” and “over cost” models, so it is not be possible to differentiate projects based on this indicator regarding cost performance after the crisis.

The high Institutional context indicator (InI) is present in all FsQCA and all IA paths. This indicator has not been used in the EA, but solution paths for EA include Macro Financial-Economic indicator (FEI) which has been highly correlated with InI. This implies that strong institutional context with good political capacity, support and policies, good legal and regulatory framework and good public sector capacity is important for achieving “on cost” target during project construction. However, a contradictory solution has been obtained for the FsQCA “on cost” model before the crisis, which includes as core conditions high values of InI, but low values of FEI, meaning that strong institutional conditions, but poor macro-economic conditions were preconditions for projects being “on cost” before the crisis and this combination could explain 51% of projects. However, the FsQCA Model for “on cost” target after the crisis includes as core conditions both positive InI and FEI and explains 57% of cases. The low InI and FEI were also among core conditions for both solutions that could explain about 41% of cases with cost overrun after the crisis. The EA showed that marginal improvement in the FEI leads to increase of 56% of probability that project would be finished within available budget.

High Governance indicator (GI) appears for FsQCA “on cost” model before the crisis, as well as in the importance and econometric analysis. It does not appear only in the FsQCA “on cost” model after the crisis. This means that high level of efficiency and effectiveness of governance and contractual flexibility are important for achieving “on cost” target during construction. According to the EA, marginal improvement in GI raises the probability of success of the project for 15.8%.

Almost half of projects (45%) of projects being ‘over cost’ (and completed before crisis) can be explained by low FSI as a core condition and low Remuneration attractiveness indicator (RAI) as a peripheral condition, meaning that PPP projects and projects where remuneration scheme is less attractive to investors had more chances to be over cost before the crisis. Contrary to this, after the crisis high FSI indicator, meaning mostly publicly financed projects is considered necessary condition for cost overrun. The low RAI also appears as core condition in both “over cost” models for projects completed after the crisis.

IA and EA analysis showed that Cost savings (CSI) and Revenue support (RSI) indicators are also important for achieving the “on cost” target. The IA outlined the “Level of control” as the most relevant part of the RSI indicator that was ranked first among significant indicators for projects awarded before the crisis, but the rank was lower for projects completed before and after the crisis. The combination of high values of GI, CSI and RSI indicators appear in both IA and EA solutions, coupled with the InI in the case of IA, or FEI in the case of EA, as conditions for projects being on cost.

According to the EA, projects conducted during the economic crisis have reduced probability of finishing the project successfully on cost or below cost by 17.9%.

Time to completion

Similarly to the “cost to completion” outcome for projects completed before the crisis, the FSI indicator was necessary condition also for the outcome “on time” before the crisis.

The Governance indicator (GI) appears in almost all solutions for all three different analyses used, stressing the importance of good governance during project construction for the “on time” outcome.

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The combination of high GI and high FSI explains 74% of cases before the crisis and means that public projects with good contractual agreements were “on time”.

InI and GI also appear in all three IA sets, i.e. projects awarded before the crisis, projects completed before the crisis, and completed after the crisis, but for projects completed before the crisis these two conditions were the only one. For projects awarded before the crisis or completed after the crisis, they are complemented with Level of control, and Remuneration attractiveness.

In addition, the financial crisis showed negative and significant impact on time performance, according to the EA, together with IRA and Revenue robustness (RRI) that appeared only in the bivariate model.

After the crisis two core conditions for the absence of “on time” outcome were low InI and low GI. Only low InI, or low GI, as a core condition for FsQCA explains 56% of cases. In addition, low InI combined with low Transport market efficiency and acceptability indicator (MEAI) explains 46% of cases being “over time” after the crisis. Additional factors that are present in FsQCA solutions for project with cost overrun after the crisis include low FEI and low FSI, but these solutions have smaller explanatory power.

Traffic performance

Figure 9.2 provides the significant parameters for the traffic outcome for different analyses.

Figure 9.2: The influencing parameters for traffic outcome

Outcome	FsQCA		Importance	Econometric
	Before Crisis	After Crisis		Logistic
Traffic	<u>“BELOW TRAFFIC” MODEL</u> • Institutional Context - • Financial Economic context - • Remuneration attractiveness - Cases explained: 54% • Financial Economic context - • Remuneration attractiveness - • Financing scheme - Cases explained: 27% • Institutional Context - Cases explained: 56%	<u>“ON TRAFFIC” MODEL</u> • Institutional context + • Remuneration attractiveness + • Financing scheme + • Governance + Cases explained: 64% • Remuneration attractiveness - • Governance - Cases explained: 31% <u>“BELOW TRAFFIC” MODEL</u> • Financial Economic context - • Remuneration attractiveness - • Financing Scheme + Cases explained: 51% • Governance - • Remuneration attractiveness - • Financing Scheme + Cases explained: 37% • Institutional context + • Governance- • Remuneration attractiveness - Cases explained: 38%		• Financial-macroeconomic context + • IRA + • Revenue support + • Remuneration attractiveness + • Market efficiency and acceptability -

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For the FsQCA analysis for subset of projects “Before crisis” and for IA no solution was obtained regarding “on traffic” performance.

High InI and high RAI are core conditions, combined with high GI, that explain 64% of project being “on traffic” that were completed after the crisis.

Low InI combined with low FEI and low RAI explains 54% of projects being “below traffic” before the crisis, and 56% of cases “below traffic” can be explained by only the low InI in the simplified FsQCA. High FSI is necessary condition for “below traffic” outcome after the crisis, meaning that heavily subsidized, or public projects are underperforming after the crisis. In all three solutions the low RAI is condition for “below traffic” outcome after the crisis, together with low FEI or low GI, which explains between 37% and 51% of cases.

The EA found that significant variables explaining the traffic forecast are FEI, IRA, revenue support, RAI and Market efficiency and acceptability. However, marginal analysis showed that only FEI has strong impact, and its marginal increase would increase probability of improving outcome for 72.6%. All other indicators had much smaller influence. The parameter “crisis” did not appear to have significant influence on the traffic outcome.

Revenue performance

Figure 9.3 provides the significant parameters for the revenue outcome for different analyses.

Figure 9.3: The influencing parameters for revenue outcome

Outcome	FsQCA		Importance	Econometric
	Before Crisis	After Crisis		Logistic
Revenue	“ON REVENUE” MODEL • Governance + • Revenue Robustness+ Cases explained: 62% • Revenue Robustness+ • Financing scheme+ Cases explained: 60% • Governance+ • Cost saving + • Financing scheme+ Cases explained: 54% *Simplified models:* • Revenue Robustness+ Cases explained: 74% • Cost saving + Cases explained: 63%	“ON REVENUE” MODEL • Institutional Context + • Governance + • Financing scheme + Cases explained: 65% • Financial Economic context - • Governance - Cases explained: 42% *Simplified models:* • Institutional Context + • Governance + Cases explained: 70% • Institutional Context + • Financial Economic context - Cases explained: 50%	• Level of control revenue variable • Remuneration attractiveness	• IRA + • Remuneration attractiveness + • Revenue robustness + • Financing scheme -

The high FSI was shown to be necessary condition for projects below revenues. However, this finding was not further examined, since no solution was found for the absence of revenue outcome.

High Revenue robustness was found to be a core condition for most on solutions for “on revenue” projects before the crisis. Only high RRI can explain 74% of projects with actual revenues equal or above the expectations, before the crisis, while CSI can explain 63% of cases. Other peripheral conditions include high GI and high FSI with explanatory power of 54% to 62% of cases.

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High InI and high GI are core conditions for successful projects after the crisis, being able to explain 70% of cases. The other solution is based on low FEI and low GI, but able to explain only 42% of cases.

IA showed that Level of control revenue (part of Revenue scheme) indicator was significant for both, projects awarded and projects completed before the crisis. In addition, the RAI was relevant for projects awarded before the crisis, and no indicator was relevant for projects completed after the crisis.

The variables that could explain the revenue outcome in the EA are IRA, RAI, RRI, and FSI. However, the marginal analysis showed that contribution of these variables is relatively small compared to models for other outcomes.

Similarly to traffic, the parameter “crisis” did not appear to have significant influence on the revenue outcome.

9.3 Recommendations

This section presents recommendations for improving the resilience of transport infrastructure projects to economic crisis, as a result of qualitative assessment and analysis performed on cases in the BENEFIT database.

In times of crisis, there is an evident need for more accountability in all phases of the projects. Based on the results of analyses conducted within task 4.3 and presented in this report, several recommendations are offered in relation to planning, design, construction and operation of transport infrastructure projects in the time of economic crisis.

Importance of Implementation context. All solution paths found that Implementation context and its indicators, institutional context (InI) and financial – macroeconomic context (FEI) have impact on all outcomes throughout the modes. This implies that strong institutional context with good political capacity, support and policies, good legal and regulatory framework and good public sector capacity is crucial for achieving targeted performance of transport infrastructure projects in case of crisis. Improvement of financial – macroeconomic context significantly increases probability of successful project performance.

Importance of good governance. The analysis also showed importance of good governance, especially in times of crisis in terms of competence (institutional and other) of the public authorities monitoring implementation for both PPP and traditional delivery of infrastructure. The high level of efficiency and effectiveness of governance and contractual flexibility are important for achieving “on cost” and “on time” targets during construction. In case of urban transit projects, the competence of the (local) public authorities may be critical for achieving expected performance, as it involves following closely stakeholder objectives. Good governance can be looked upon also as an expression of public authority competence and good institutions which is crucial in difficult times for number of reasons, one of those being conducting competitive tendering which allows choosing competent and experience contractor or service provider.

Proper planning and design. In planning and design phases, special attention should be made on checking predicted and planned financial and socio-economic costs and benefits. If necessary, wider context shall be taken into account in the project selection phase. For example, in the realm of urban mobility is the introduction of network optimization in the planning process. This means that a

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response to the funding and financing implications of scarcity of public money, a salient impact of the economic crisis, is to ensure that the resources and the urban mobility network, both in terms of infrastructure and services, are utilized at an optimal level.

Well matured projects have better resilience to crisis. For these projects main technical problems have been resolved through detailed design. The BENEFIT database, and in particular the narratives, highlight a number of cases where project design visibly suffered from obvious lack of a proper a priori assessment, leading either to high additional costs related to unforeseen events during the construction phase or to completely inadequate estimate of usage.

Good connectivity to transport network. Good connectivity is particularly important for capital infrastructure projects, like bridges and tunnels, as well as for the airport and other transport modes.

Exclusivity. The absence of competition protects the project from price completion. The exclusive location of bridges and tunnels provides natural monopoly that improves the project resilience to the crisis.

Contractual flexibility. Including contracting arrangements in terms of future service, cost decisions, including downsizing and upsizing the project, that can be adaptable enough for sudden and unpredictable severe changes in the projects' surrounding (e.g. to GFC) improves project resilience.

To deal with the drops in demand that happen during a crisis, strategies to attract more demand may be adopted. For example, for airport that would mean being flexible with airport fees, possibly diversifying prices, and providing for the needs of low-cost airlines

Splitting larger projects of linear infrastructure into smaller ones would increase the flexibility during times of economic crisis.

Contractual flexibility regarding remuneration sources and their independence on the external demand fluctuations contributes to the project resilience to the crisis, but will externalize the instability caused by the economic crisis to the State.

Using real options may also increase the project resilience to the crisis.

Contractor's capacity to construct. IA and EA analysis showed that Cost savings (CSI) and Revenue support (RSI) indicators are also important for achieving the "on cost" target. The contractor's capacity to construct is a factor of project resilience in case of crisis. Monopolistic situations are quite important when unique structures are required because these structures are very specialized and require very specialized consortia; consequently, private sector has to be highly prepared to construct these type of infrastructures.

The operator's capability to operate. The participants mentioned the operator's capacity to operate as a factor of airport resilience, namely its flexibility and ability to adequately respond to a crisis situation by intervening at a number of operational levels.

Involvement of major transport operators. Involvement of transport facility operator of certain transport infrastructure facilities with major transport companies (low-cost companies in case of airports of major shipping line in case of ports) improves the resilience to crisis.

Diversification. The risk of revenues is reduced if the project features bundling with other services (providing diversification of revenues and control over demand). For example, bundling the main airport services of transporting people and goods with non-aeronautical uses was seen as crucial to the ability to endure drops in demand.

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Another diversification possibility is diversification across demand segments. For example, a railway infrastructure project featuring urban and inter-urban sections, as well as passenger and freight transport, is more resilient to the crisis.

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10 References

Chapter 2

Burger P., Tyson J., Karpowicz I., Coelho D.M. (2009), The Effects of the Financial Crisis on Public-Private Partnerships, International Monetary Fund Working Paper

Izaguirre A. K., (2010), PPI Data Update Note 36: Assessment of the impact of the crisis on new PPI projects – Update 6. Private Participation in Infrastructure Database, PPIAF/World Bank, Washington, D.C. Available from: http://ppi.worldbank.org/features/April2010/Impact-of-the-financial-crisis-05-04-10.pdf

Kappeler A., Nemoz M. (2010), Public-Private Partnerships in Europe - before and during the recent financial crisis, Economic and financial reports / European Investment Bank, No. 2010/04

Pantelias, A., Roumboutsos, A., Bernardino, J., Bonvino, G., Cardenas, I., Dimitriou, H., Karadimitriou, N., Karousos, I., Kolahi, A., Mitusch, K., Moraiti, P., Moschouli, E., Trujillo, L., Vajdic, N., Vanelslander, T., Verhoest, K., Voordijk, H., Willems, T., Wright, P., (2015). Deliverable D3.1 – Methodological Framework for Ex-post Analysis, BENEFIT (Business Models for enhancing Funding and enabling Financing for Infrastructure in Transport) Horizon 2020 project, grant agreement No 635973. *Available at http://www.benefit4transport.eu/index.php/reports.*

BENEFIT E-BOOK: Business Models for enhancing funding and enabling financing for infrastructure in transport: PPP and Public Transport Infrastructure Financing Case Studies. Horizon 2020 European Commission. Department of Shipping, Trade and Transport, University of the Aegean, Greece, ISBN 978-618-82078-1-3, *forthcoming.*

Chapter 2.2.

Abrantes, P. (2009) Impact of the economic crisis on public transport demand and investment: a reflection, Pedro Abrantes, University of Leeds, 2009.

Cerema (2015) *Annual urban public transport survey by Cerema-DGITM-GART-UTP.*

Dargay, J.M. and Hanly, M. (2002) The demand for local bus services in England, Journal for Transport Economics and Policy, 36(1), pp. 73-91

Metro Report intenational (2013) Economic crisis halts Spanish projects

PTI (2012) Figure it Out 2010

Segretain, P. (2009) Crisis? Which one do you mean? Egis

Transport Public (2014) Le transport public face à la crise

UITP (2009a) Metro systems in the global economic downturn, UITP, Metro Division.

UITP (2009b) Position paper, Financial and economic crisis, The situation of the public transport in EU 27.

European Commission | This BENEFIT project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635973

UITP (2011) Restructuring the public transport network in times of financial crisis: solutions from Thessaloniki

UITP (2014) Local public transport trends in European Union, Statistics Brief

UITP (2015) Mobility in cities database, Synthesis report

UTP (2015) Les chiffres clés du transport public

Chapter 2.3.

KIT (2015 Karlsruhe Institute of Technology (KIT) "Herrentunnel Lübeck" in Łukasiewicz, A., Roumboutsos A., Liyanage C., Pantelias A., Mladenovic G., Brambilla M., Bernardino J. and Mitusch K. BENEFIT Database, Deliverable of WP6, BENEFIT Business Models for Enhancing Funding and Enabling Financing of Infrastructure in Transport, Horizon 2020, DG Research and Innovation

OMEGA (2015) OMEGA Centre case studies http://www.omegacentre.bartlett.ucl.ac.uk/publications/omega-case-studies/

Steenstrup, B. (ed.) (2012) Øresund Trends 2012, The Öresund Committee, Copenhagen

TIS (2015) Consultores em Transportes, Inovação e Sistemas, s.a. (TIS), "Lusoponte Vasco da Gama Bridge" in Łukasiewicz, A., Roumboutsos A., Liyanage C., Pantelias A., Mladenovic G., Brambilla M., Bernardino J. and Mitusch K. BENEFIT Database, Deliverable of WP6, BENEFIT Business Models for Enhancing Funding and Enabling Financing of Infrastructure in Transport, Horizon 2020, DG Research and Innovation

UAEGEAN (2015a) University of the Aegean (UAEGEAN) "Rion – Antirion Bridge" in Łukasiewicz, A., Roumboutsos A., Liyanage C., Pantelias A., Mladenovic G., Brambilla M., Bernardino J. and Mitusch K. BENEFIT Database, Deliverable of WP6, BENEFIT Business Models for Enhancing Funding and Enabling Financing of Infrastructure in Transport, Horizon 2020, DG Research and Innovation

UAEGEAN (2015b) University of the Aegean (UAEGEAN), 2015, "Blanka Tunnel Complex" in Łukasiewicz, A., Roumboutsos A., Liyanage C., Pantelias A., Mladenovic G., Brambilla M., Bernardino J. and Mitusch K. BENEFIT Database, Deliverable of WP6, BENEFIT Business Models for Enhancing Funding and Enabling Financing of Infrastructure in Transport, Horizon 2020, DG Research and Innovation

UT (2015) University of Twente (UT) "Second Coen Tunnel" in Łukasiewicz, A., Roumboutsos A., Liyanage C., Pantelias A., Mladenovic G., Brambilla M., Bernardino J. and Mitusch K. BENEFIT Database, Deliverable of WP6, BENEFIT Business Models for Enhancing Funding and Enabling Financing of Infrastructure in Transport, Horizon 2020, DG Research and Innovation

Chapter 2.4.

ACI Airports Council International, accessed March 2016 at www.aci.aero

Barros, C.P. (2008). Airports in Argentina: technical efficiency in the context of an economic crisis. *Journal of Air Transport Management*, 14 (6), pp. 315-319. doi: 10.1016/j.jairtraman.2008.08.005

Carballo-Cruz, F. and Costa, V. (2014). Success factors of regional airports: The case of Oporto airport. *Tourism & Management Studies*, 10 (1), pp. 37-45. http://tmstudies.net/index.php/ectms/article/download/645/1150

European Commission | This BENEFIT project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635973

Coto-Millán, P., Casares-Hontañón, P., Inglada, V., Agüeros, M., Pesquera, M.A. and Badiola, A. (2014). Small is beautiful? The impact of economic crisis, low cost carriers, and size on efficiency in Spanish airports (2009–2011). *Journal of Air Transport Management*, 40, pp. 34-41. doi: 10.1016/j.jairtraman.2014.05.006.

Eurostat database, accessed March 2016 at ec.europa.eu/Eurostat

Voltes-Dorta, A. and Pagliari, R. (2012). The impact of recession on airports' cost efficiency. *Transport Policy*, 24, pp. 211-222. doi:10.1016/j.tranpol.2012.08.012

Roumboutsos, A. et al. (eds.) (2013). *COST Action TU1001, Public Private Partnerships in Transport: Trends & Theory P3T3, 2013 Discussion Papers, Part II Case Studies,* COST Office, ISBN 978-88-97781-61-5

Štimac, I.; Vince. D.; Kovačić, I. (2015). Analysis of European airports' strategy during the global economic crisis. In proceedings of the 17th International Conference on Transport Science ICTS 2015.

Chapter 3

Business Model Indicators

Bryant F.B., and Yarnold P.R. (1995), Principal components analysis and exploratory and confirmatory factor analysis. In Grimm and Yarnold, Reading and understanding multivariate analysis. American Psychological Association Books.

Gorsuch R. L. (1983), Factor Analysis. Hillsdale, NJ: Lawrence Erlbaum. Orig. ed. 1974.

Hutcheson G. and Sofroniou N.(1999), The multivariate social scientist: Introductory statistics using generalized linear models, Thousand Oaks, CA: Sage Publications.

Nunnaly J. (1978), Psychometric theory, New York: McGraw-Hill.

Governance Typology

Clarke, T. (ed.) (2004), Theories of corporate governance: the philosophical foundations of corporate governance. London: Routledge.

Clarke, T. (2007), International corporate governance: a comparative approach. London: Routledge.

Chen, L., & Manley, K. (2014), Validation of an instrument to measure governance and performance on collaborative infrastructure projects, Journal of Construction Engineering and Management, 140(5)

Eriksson, P. E., & Westerberg, M. (2011). Effects of cooperative procurement procedures on construction project performance: A conceptual framework. International Journal of Project Management, 29(2), 197-208.

Li, H., Arditi, D., & Wang, Z. (2012). Factors that affect transaction costs in construction projects. Journal of Construction Engineering and Management, 139(1), 60-68.

Mallin, C.A. (2004) Corporate governance. Oxford: Oxford University Press.

Mallin, C.A. (ed.) (2006) Handbook of international corporate governance. Cheltenham: Edward Elgar.

Ng, A., & Loosemore, M. (2007). Risk allocation in the private provision of public infrastructure. International Journal of Project Management, 25(1), 66-76.

European Commission | This BENEFIT project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635973

BENEFIT

Onisko A, Druzdzel MJ, Wasyluk H. Learning Bayesian network parameters from small datasets: Application of noisy-or gates. International Journal of Approximate Reasoning, 2001; 27(2):165–182

Susarla, A. (2012). Contractual flexibility, rent seeking, and renegotiation design: An empirical analysis of information technology outsourcing contracts. Management Science, 58(7), 1388-1407.

Financing Scheme Typology

Brealey R., Myers S., and F. Allen (2011), Principles of corporate finance (10th edition), McGraw Hill

Gatti, S. (2013), Project finance in theory and practice: designing, structuring and financing private and public projects, Academic Press

Chapter 4

Implementation context typology

Verhoest, K., Petersen, O. H., Scherrer, W. & Soecipto, Raden Murwantara, (2015, forthcoming), How do governments support the development of Public Private Partnerships? Measuring and comparing governmental PPP support across 20 European countries, Transport Reviews, DOI:10.1080/01441647.2014.993746

Chapter 5

Bol D. and Lupi F. (2013) Confronting Theories Based on Necessary Relations: Making the Best of QCA Possibilities" *Political Research Quarterly* 66 (1), 2013.

Elliot T. (2013) Fuzzy Set Qualitative Comparative Analysis, Part 2
http://thomaselliott.me/pdfs/fsqca2.pdf

Fiss, P. (2008) Using Qualitative Comparative Analysis (QCA) and Fuzzy Sets,
http://professor-murmann.info/index.php?ACT=24&fid=11&aid=56_oPhPCLjduXz7KtWCeJbr&board_id=1

Legewie, N. (2013) An Introduction to Applied Data Analysis with Qualitative Comparative Analysis, Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 14(3). Retrieved from http://www.qualitative-research.net/index.php/fqs/article/view/1961/3594

Marx A. & Dusa A., (2011) Crisp-Set Qualitative Comparative Analysis (csQCA): Contradictions and consistency benchmarks for model specification, Methodological Innovations Online, 6(2) 103-148

Ragin, C. C., (2000) Fuzzy-Set Social Sciences. Chicago: University of Chicago Press.

Ragin, C. C. (2008) Redesigning social inquiry: fuzzy sets and beyond, University of Chicago Press: Chicago and London, p.71

Rihoux, B. & Ragin, C. C. (2009) Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques, SAGE Publications, Inc.

Schneider, C. Q., & Wagemann, C. (2010) Standards of Good Practice in Qualitative Comparative Analysis (QCA) and Fuzzy-Sets. Comparative Sociology, 9, 1–22.

European Commission | This BENEFIT project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635973

BENEFIT

Schneider, C. Q. & Wagemann, C. (2012). Set–Theoretic Methods in the Social Sciences: A Guide to Qualitative Comparative Analysis. Cambridge, UK. The Cambridge University Press.

Vanelslander, T. Sys, C. and Carlan V. (2015) 'Innovation among Seaport Operators: A QCA Approach for Determining Success Conditions', Proceedings of the IAME Annual Conference

Verhoest K., Molenveld A. & Willems T., (2014) Explaining Self-Perceived Accountability of Regulatory Agencies in Comparative Perspective: How do Formal Independence and De Facto Managerial Autonomy Interact? Palgrave Macmillan, Series Title: Executive politics and governance ,Host Document: Accountability and Regulatory Governance pages: 51-77, Article number: 3, ISBN: 9781137349576, Public Governance Institute

Vis, B. (2012) The Comparative Advantages of fsQCA and Regression Analysis for Moderately Large-N Analyses. Sociological Methods & Research, 41, 168–198. http://smr.sagepub.com/content/41/1/168.full.pdf+html

Chapter 8.1.

Engel, E. M. R. A.; Fischer, R. D.; Galetovic, A. (2010) The economics of infrastructure finance: Public-private partnerships versus public provision, EIB Papers, ISSN 0257-7755, Vol. 15, Iss. 1, pp. 40-69

EPEC (2014) Market Update: Review of the European PPP Market in 2013

Hodge, Graeme; Greve, Carsten (2013) Public-private Partnership in Developing and Governing Mega-projects. International Handbook on Mega-projects. red. / Hugo Priemus; Bert van Wee. Cheltenham : Edward Elgar Publishing, Incorporated, 2013. s. 182–208 (Elgar Original Reference).

Hodge, Graeme A.; Greve, Carsten (2007) Public-Private Partnerships: An International Performance Review. I: Public Administration Review, Vol. 67, Nr. 3, 2007, s. 545-558

Kappeler, A. and Nemoz, M. (2010) Public-Private Partnerships in Europe – Before and during the recent financial crisis; Economic and Financial Report 2010/04, http://www.eib.org/epec/resources/efr_epec_ppp_report1.pdf

Meaney, A. and Hope, P. (2012) Alternative ways of financing infrastructure investment: Potential for "novel" financing models, Discussion Paper No. 2012-7, ITF/OECD

Martin, L., Lawther, W., Hodge, G., & Greve, C. (2013) Internationally Recommended Best Practices in Transportation Financing Public-Private Partnerships (P3s). Public Administration Research, 2(2), 15-25.

Roumboutsos, A. and Saussier, S. (2014) Public Private Partnerships and Investments in Innovation: The Influence of the Contractual Arrangement, Construction Management and Economics, DOI:10.1080/01446193.2014.895849

European Commission | This BENEFIT project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635973

BENEFIT

Chapter 8.2.

Burger P., Tyson J., Karpowicz I., Coelho D.M (2009) The Effects of the Financial Crisis on Public-Private Partnerships, International Monetary Fund Working Paper

Damill M., Frenkel R., Rapetti M. (2013) Financial and currency crises in Latin America, in: M.H.Wolfson and G.A.Epststein (eds.) The Handbook of th Political Economy of Financial Crise, Oxford, Oxford University Press

EIU (Economist Intelligence Unit). 2014. Evaluating the environment for public-private partnerships in Latin America and the Caribbean: The Infrascope. EIU, New York, NY.

Kaminsky G.L. and Reinhart M.C. (1998) Financial Crises in Asia and Latin America: Then and Now, Banking and Currency Crises and Macroeconomics, vol. 88, no.2.

Lagorio, J. (2014) Chile presents US$28bn infrastructure master plan, BN Americas, available at Business News web-site: http://www.bnamericas.com/news/infrastructure/chile-presents-us28bn-infrastructure-master-plan1

Ocampo A.J. (2009) Latin America and the Global financial crisis, Cambridge Journal of Economics, vol 33 pg 703-724

World Bank (2016a) Private Participation in Infrastructure Database Methodology, available at World Bank web site: http://ppi.worldbank.org/methodology/ppi-methodology, [accessed on: 31.03.2016]

World Bank (2016b) World bank database on GDP at market prices available at World Bank web-site: http://data.worldbank.org/indicator/NY.GDP.MKTP.CD/countries/AR?display=default [accessed on 24.04.2016]

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A1. Rebuttal

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REVIEW OF DELIVERABLE D4.4
TASK LEADER: UNIVERSITY OF BELGRADE
REBUTTAL

The Authors wish to thank the internal and external reviewers for their comments and suggestions. The following table describes how comments have been incorporated in the final document.

Reviewer's comments Pekka Leviäkangas	Authors' Response
Figure 2.1: E4 Helsinki-Lahti project has been terminated already, so this perhaps should be visible in the timeline	Figure 2.1 has been corrected.
Some auto-references are missing. Also there is a reference to Annex 'xxx' in chapter 6.2.	References to D4.2, Annexes A.1 and A.2 have been made in the report.
Executive summary could include a flow chart or an illustration of the deliverables objectives and outcomes. This would be very useful for all readers. For example, making it explicit which questions are answered by which chapter (e.g. 5, 6, and 7).	Figure 1 with the overall overview of project has been included in the Executive summary.
Some figures clearly lack a reference/source (e.g. Figures 2.4, 2.5, 2.6)	The reference/source for figures 2.4, 2.5, 2.6 and 2.12 has been added.
Figure 2.8 hard to read – make it larger for one exclusive page?	The size of figure 2.8 has been increased to almost two pages.
In some places, there is a question of the relevance of the presented data. Financial crisis obviously affected share prices and freight volumes on national level. How this is then translated into project-level parameters is unclear in the deliverable. Particularly chapter 2.3 is suffering from this 'disconnectivity'. A simple trick would be e.g. to point out in the figures (such as 2.22 and similar) where the project is positioned in the market curves. This is somewhat done in Airport analysis, which is much easier to follow and the connection between the market impact and projects is more explicit (see e.g. Fig. 2.50).	Additional clarifications are provided in the text, including new figures for Rion-Anturion and Lusoponte bridges.
Airport summary is good (2.44). It would be excellent, if Figures 2.53 and 2.54 would have been merged and updated further with data from 2013-2014 (which probably was already there) together with timing of	Former figures 2.53 and 2,54 are merged and updated with 2013 and 2014

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Reviewer's comments	Authors' Response
projects and timing of different stages of the crisis.	data into new figure 2.58.
Ports chapter (2.5) is very brief compared to the other modes. Also the different sections per mode do not follow comparable formats.	A note has been added at the end of introductory section of Chapter 2 indicating that teams have approached the analysis on a slightly different way depending on number of cases in each mode and data available.
The WACC formula is interesting – I would consider (this is for the future) simplifying the financing indicator to comprise three or four simple categories, e.g. 1) public financed, 2) public-private financed with public finance more than 50%, 3) public-private financed with less than 50% public finance, 4) private financed.	Thank You. Certainly this proposal can be considered for future work.
Figure 4.1 could be in the executive summary – with the projects too?	Figure 4.1 has been included in the Executive summary.
Chapter 4 summary and conclusion falls slightly short	The Summary and conclusion section has been slightly expanded.
Table 8.1 represents a considerable sample. I see no reason to be too cautious with interpretation, especially regarding road projects.	The Authors agree in general, but are just cautious regarding findings since the dataset covers only a small portion of all PPP projects.
Chapter 8.2 is interesting, but I would leave it out. It represents another setting, and this deliverable should focus on EU cases. This chapter could well be a part of BENEFIT final report or an annex. Sources should be mentioned for the figures.	Chapter 8.2 is important since it provides data on different reaction on crisis in another significant part of the world. The sources for all figures are added.
In chapter 9.3 I would put Governance forth as a critical indicator. When looking at the tables, Governance and Institutional Context seem to be the most critical. More important than some others now listed as 'equally' important.	The authors agree. The paragraph about importance of good governance has been moved forward, right after the paragraph about importance of institutional context.
Jonathan Gifford	Authors' Response
General comments	
The report, and the BENEFIT project more generally, tackles a profoundly difficult problem, understanding how infrastructure delivery is affected by governance structure, concessionaire capacity, and global and country-specific market conditions, in a dynamic framework.	Thank You
The report provides an expansive treatment of an extremely wide-gauged assessment of the impact of the financial crisis on project performance across a range of several decades. The majority of the underlying data is drawn from the BENEFIT database, supplemented with data from OECD and the World Bank's PPIAF.	Thank You
The report applies a wide range of methodologies for assessing impacts, including qualitative, econometric, fuzzy set theory,	Thank You.

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Reviewer's comments	Authors' Response
importance analysis and sensitivity analysis. This methodological breadth is commendable.	
The conclusions presented in chapter 9 underscore the importance of strong governance and mature project development processes. In some ways this is not surprising – it would be surprising if that were not found to be the case. But the report provides a detailed and highly context-specific look.	Thank You.
The qualitative discussion in section 2 provides a valuable presentation and review of a wide portfolio of projects in different countries and of different modes, developed and implemented across several decades. The section provides an excellent discussion of the impacts of the Crisis on projects within the BENEFIT database. It is the longest chapter, constituting almost half of the report, with separate discussions of road, urban transit, bridge and tunnel, airport and port projects.	Thank You
The BENEFIT project has already produced a broad set of volumes and articles, far more than are known to this reviewer. Focused outputs to the many audiences and stakeholders with an interest in this topic will continue to be a valuable method for disseminating the results of this significant work.	Thank You
The underlying data of the BENEFIT database are objectively assessed as to their reliability and suitability for analyzing the impact of the crisis. Strengths and limitations of the dataset are noted.	Thank You
An additional section on recent trends (sec. 8) provides a valuable broader context for the discussion.	Thank You
The authors and the overall project team, as well as their sponsors, are to be commended for a valuable contribution to the body of knowledge.	Thank You
The biggest challenge of the report is to provide a high-level overview of such a formidable body of work from an intellectually diverse team that has sought to tackle the problem with "every tool in the toolbox."	Thank You
Areas for improvement in the report include some unevenness in the writing and English that would benefit from a careful copy edit if the report is to be widely disseminated.	Thank You for the comment. We are aware of the unevenness in the writing and English that was result of involvement of many different teams in the project with diverse background.
More detailed comments	
P. 9. The assumption that estimates are unbiased is very problematic and not widely held. Indeed, to the contrary, many observers claim that such estimates are highly biased in the self-interest of those who produce them. "BENEFIT makes a key assumption: input to the system (Matching Framework) is correct. This in practical terms means that cost and time to completion, forecasted traffic and revenues estimates are considered correct involving no bias. This, however, remains an assumption to be confirmed. This assumption also implies that the feasibility study and all other assessments leading to the final project decisions were also correct."	The Authors agree in general. However, it was out of the scope of this project to assess all elements and process that led to project realization. Objective and unbiased project assessment should be priority and therefore in this study it was assumed that estimates of cost and time were correct.
P. 10. The discussion of the relationship between project performance	The Authors agree. The

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Reviewer's comments	Authors' Response
and impact of the global financial crisis is ambiguous about causality. This text implies that the global financial crisis caused the projects to perform poorly. The causality may not be so clear. For example, countries with poor project selection might have been more vulnerable to the global financial crisis. Thus, poor project performance and susceptibility to the global financial crisis might be symptoms of another factor, such as weak institutional structures.	paragraph discussing the impact of crisis has been modified to indicate importance of strong institutional context and proper project selection.
P. 15. The report may want to expand on the recommendations to more clearly explain the benefit of the BENEFIT project. This statement, for example, seems fairly obvious: "This implies that strong institutional context with good political capacity, support and policies, good legal and regulatory framework and good public sector capacity is crucial for achieving targeted performance of transport infrastructure projects in case of crisis." But BENEFIT has done more than to just validate these logical statements. Perhaps the report could explain that BENEFIT provides heretofore unavailable data about how each of these factors contributed to poor (or good) project performance during the global financial crisis.	The Authors agree. An additional paragraph has been added at the end of the Executive summary explaining the contribution of the BENEFIT project.
P. 30, tables 2.6 and 2.7 (for example) – these tables would be easier to understand if the abbreviations were spelled out in a note or the column headings.	The List of abbreviations was presented on page 8, at the beginning of the report. In addition, the abbreviations are spelled out in the notes below tables.
P. 43, section 2.1.5, Conclusions based on the road cases – this section (and perhaps others) could benefit from a summary table showing median (or mean) measures of several of the indicated, with the rows being the 3 categories examined (not impacted by the Crisis, moderately impacted, and heavily impacted).	The table 2.21 with average values of indicators by clusters, and for High impact cluster by countries, has been added to section 2.1.5.
P. 53, figure 2.8 (for example): this visual presentation of project data is very useful and packs a lot of information into a compact and easily understandable form.	Thank You
P. 64 (beginning), Sec. 2.3 on bridges and tunnels – use of share price data is useful.	Thank You
Sec. 2 overall. Not all of the sections use the BENEFIT Matching Framework consistently -- Urban transit and highways use tables; bridges/tunnels, airports use the figure.	Number of cases in urban transit and Highways was much larger than for other modes, and that's why different teams have used different ways to present available data.
Sec. 2 has some uneven treatment of the BENEFIT overall framework that reflects different work of different teams. Some of this is unavailable for a project of such a large scale. But it is nonetheless worth noting.	A note has been added at the end of introductory section of Chapter 2.
Section 3, Revision of Typology Indicators, focuses on the internal methodology and consistency of the BENEFIT project typology indicators.	
The discussion in section 3.1 is coherent and logical, and provides an objective critique and evaluation of the Typology Indicators.	Thank You
Sections 3.2 to 3.5 are highly technical and would require a reviewer deeply familiar with the details of the BENEFIT methodology.	The Authors agree. The BENEFIT project is

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Reviewer's comments	Authors' Response
	approaching to its end and at this stage some parts of the developed methodology are refined.
Pp. 128-130 and tables 3.7 and 3.8. The assumptions for these key variables would appear to have a significant impact on the outcomes of the analysis. The values in the tables are somewhat arbitrary changing market conditions.	The values presented in tables 3.7 and 3.8 are considered prevailing values on the market at this point. However, these values can be adjusted in the future within the developed methodology.
Pp. 130-132, Sec. 3.5.4. The examples in this section are clear enough, but again seem oversimplified compared to the realities of project finance.	The objective of examples was to clarify the calculation of Financing scheme indicator. The Authors agree that they may be compared to the reality of project finance, but some simplifi-cations are necessary in order to model such a broad process.
Sec. 4, Matching Framework, provides a large number of scatter plots. As the conclusion notes, it is hard to draw any conclusions. It is not clear how to refine or abstract the analysis to allow a more general picture.	The Summary and conclusion section has been slightly expanded.
Sec. 8, Trends in Remuneration Schemes, provides a very useful overview of the topic, with excellent data. The descriptive analysis is useful and objective.	Thank You

The end of the Report

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