# Cost performance of transport infrastructure projects before and after the global financial crisis (GFC) : are differences observed in the conditions of project performance?

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# Cost performance of transport infrastructure projects before and after the Global Financial Crisis (GFC):
## Are differences observed in the conditions of project performance?

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The aim of this research is to identify whether the conditions affecting the performance of European transport infrastructure projects, which are completed before and after the global financial crisis (GFC) (2008), are different. The projects that are tested are 22 European projects that are completed before the financial crisis and 25 European projects that are completed after. The method used is the fuzzy set Qualitative Comparative Analysis (fsQCA). One outcome is tested, being whether or not projects are delivered within the budgeted cost (on/over cost) till their completion. Findings show that after the GFC, the quality of the external environment, in terms of the institutional and the financial-economic context, matters more in order to deliver transport infrastructure projects on cost to completion. This means that transport infrastructure projects' performance is depending on conditions exogenous to the projects more than before the GFC. The level of the cost of capital of the financing scheme is also an important condition, although for projects completed after the GFC, a low cost of capital can still lead to projects being over cost, when the external environment is unfavourable and the remuneration scheme brings high income risks and low cost coverage. Having a robust business model with respect to reducing costs during the construction phase of the project, which is a key factor based on literature, was found to matter both for the occurrence and non-occurrence of the cost outcome for the projects completed before the crisis, when combined with other conditions, but only for the non-occurrence of the cost outcome for the projects completed after the crisis.

**Keywords:** 1) Cost Performance; 2) Financial Crisis; 3) Fuzzy Set Qualitative Comparative Analysis; 4) Transport Infrastructure Projects.

**JEL classification codes:** R4 Transportation Economics

## 1. Introduction

Transport infrastructure projects are projects that require high investments for their realisation, sometimes tens of millions (projects), sometimes hundreds of millions (major projects) and sometimes billions of dollars (megaprojects) (Flyvbjerg, 2014). In 2015, European countries[2]

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[2] The European countries that are taken into consideration are the countries that are included in our samples, except Cyprus, for which no data were available. The 13 countries that are taken into consideration are Belgium, Czech Republic, Finland, France, Germany, Greece, Norway, Poland, Portugal, Serbia, Slovenia, Spain and United Kingdom. These figures are composed by the authors by calculating the sum of the investments in euro per transport infrastructure: rail, roads, inland waterways, maritime ports and airports for 2015. The year 2015 is selected because more data were available compared to 2016, the last year with available data. For rail, data were available for all the 13 countries; for road data were not available for Portugal; for inland waterways data were not available for Greece, Norway, Poland, Portugal, Slovenia, Spain and United Kingdom, mainly because in these countries no navigable inland waterways are present; for maritime port infrastructures, data were not available for Czech Republic, Poland, Portugal, Serbia and United Kingdom and for airport infrastructures data were not available for United Kingdom.

invested approximately 33 billion euro in rail, almost 46 billion euro in road, almost 1.9 billion euro in inland waterways, 1.9 billion euro in maritime port infrastructures and 2.8 billion euro in airport infrastructures (International Transport Forum, 2015). Transport infrastructures are key factors for the economic growth and competitiveness (Nazemzadeh et al., 2015) and also for the regional-economic and social development (OECD, 2011 and International Transport Forum, 2002). The International Monetary Fund (2014) found that in developed economies, like the ones examined in this paper, "1% of GDP increase in investment spending increases the level of output by about 0.4% in the same year and by 1.5% four years after the increase". Therefore, the importance of these projects for the economy and society is evident.

The global financial crisis (GFC) augmented the difficulties related to the investments on transport infrastructures. The funding from the governments decreased (Clucas, 2017 and International Transport Forum, 2013), thus leading to a search for alternative sources of finance for the transport infrastructures, such as Public Private Partnerships (PPPs). Other sources of funding mostly for Central and Eastern European countries (CEECs) are various EU programmes, the European Investment Bank, the European Bank for Reconstruction and Development and World Bank loans (International Transport Forum, 2013). However, if we compare the amounts invested by the European countries before and after the 2008 financial crisis[3], it is observed that the amounts invested after the crisis are significantly higher for rail infrastructures and almost equal for roads and inland waterways (International Transport Forum, 2015), likely due to the economic stimulus packages (International Transport Forum, 2013). On the contrary, for maritime ports and airports, the investments were halved after the crisis.

PPPs[4] were also challenged because of the difficulties in financing (Burger et al., 2009 & Liyanage, 2011). According to Liyanage (2011), the majority of the existing and planned PPP projects have been affected by factors such as "*availability and cost of credit, lower growth, demand below forecasts and unforeseen exchange rate movements*". Burger et al. (2009) state that access to and cost of finance are the main consequences of the financial crisis, affecting particularly PPP projects. According to Kappeler and Nemoz (2010), during the economic crisis, the PPP market shrunk in Europe in the majority of the countries and sectors. The total value of the EU PPPs dropped more than the number of deals; in 2009 the value of the PPP transactions in Europe was equal to 15.8 billion euro, which decreased by almost 50% in comparison with 2007.

Taking into consideration the importance of developing new transport infrastructures and maintaining the existing ones, and also the challenges that the crisis brought with respect to the investments, we realize that financing is important and difficult to get. Thus, investments should be done very carefully in order to avoid excessive costs. Excessive costs would mean that more financing is required, in addition to the initially financing planned, and this would increase the need for higher remuneration and revenue streams that would recover these costs. Therefore, it is very important to ensure that the projects under development have no or at least minimum cost overruns till their completion. Cost is one of the three main components of the so-called Project Management Triangle. That triangle is composed by three elements: cost, time and quality (Atkinson, 1999). In this paper, we focus on one of the triangle's elements, the cost, and we

[3] Before crisis: average spending between 2003-2008 indicatively and after crisis: spending in 2015 as the most recent year with the most available data.

[4] In this paper, a public private partnership is considered a (public interest) project receiving private (co)financing, under a contract that bundles at least construction and operation. The contract also includes the allocation/transfer of project risk(s).

examine *how different the conditions that affect the cost performance of transport infrastructure projects are for the projects that are completed before the crisis and for the projects that are completed after the crisis*. The costs that are taken into consideration are the costs that take place till the completion of the projects' construction (from now on 'actual project construction cost') and are compared with the costs of the projects at the time of the contract award (from now on 'contract construction budget'. Thus, we can say if the project till its completion has more, equal or less costs than the ones planned at the project award time.

As said, the GFC provided a rupture in project take-up and pushed many infrastructure projects into financing and other difficulties. In this paper, we aim to answer *whether and to what extent the (sets of) conditions leading to transport infrastructure project cost success and failure are different for the projects that are completed before the crisis and for the projects that are completed after the crisis*. However, the aim behind this study is not to 'force' the contractor for a project that is 100% on budget but to provide insights to the stakeholders involved in transport infrastructure project development, policy makers and academics about possible 'recipes' that lead projects to be on cost and over cost during times or not of economic recession. Therefore, the research we undertake in this paper seeks to identify and compare the (combinations of) conditions that affect the cost performance (success and failure) of transport infrastructure projects *before* and *after* the financial economic crisis (2008). If the project is delivered within the contract construction budget, it is considered successful from that angle, whereas if it is delivered 'over cost', it is considered non-successful.

However, we should point out that delivering a project on cost might mirror good performance with respect to this specific element of the Project Management Triangle, but a project cannot be considered successful only based on this element but also taking into consideration other critical elements, such as the time, traffic, revenues, environmental, economic and social impact and also the scope for which the project was developed (Edkins et al., 2012, p.10 and Vanelslander et al., 2015).

A fuzzy set Qualitative Comparative Analysis (fsQCA) is conducted. The cases used are 22 European projects that are completed before the crisis and 25 European projects that are completed after.

The paper is structured as follows. Section 2 provides a review of the relevant literature. Section 3 presents the method, case studies, conditions and models that are used for this analysis. Section 4 presents the results of the analyses conducted for the cost outcome. Section 5 provides an interpretation of the findings and section 6 sums up the main findings and comes to conclusions.

## 2. Literature Review

Table 1 shows the factors that are found in literature as the most prominent ones for success and failure of infrastructure projects. Literature points to different factors affecting success. However, in literature, success is most often defined in general terms, and not specifically as the achievement of the cost target, which is the focus in this paper. Moreover, in literature, success is tested also for general construction projects and not only for transport infrastructure projects. Also in literature, papers that focus either on PPPs or public projects are identified, while in this paper, we focus on both privately financed and publicly funded projects. On the other hand, in literature, failure is defined similarly with the present paper, as the non-achievement of the cost target, thus leading to cost overruns. Most of the factors found in literature for success and failure can be clustered into groups of factors that are related to the institutional context and financial-economic context of the country where the project is located, the contractual governance of a

project, the financial side of a project (attractiveness of the remuneration scheme, revenue robustness and the financing scheme) and a large group of project management and project-related factors (cost saving potential of a project) (Table 1). This literature review is based on Moschouli et al. (2017). Table 1 presents the factors that affect success and failure in terms of costs of infrastructure projects identified in literature, not in a random order, but classified in clusters. These clusters are the composite indicators that are later used as conditions for the empirical analysis. In this way, we aim to see how different or similar our results will be compared to the findings in literature. Each of the literature factors is assigned to one of the clusters/composite indicators according to its relevance with them. Some factors that are found in literature have not been included in this table, since they were irrelevant to the clusters.

**Table 1:** Factors that affect the success and failure of (transport) infrastructure projects, as identified in literature and clustered based on the composite indicators used in the present analysis.

| Clusters | Factors as stated in literature | Author(s) | Type of (infrastructure) projects |
|---|---|---|---|
| Institutional context (INI) | | | |
| On cost | External Environment: political & social (including political support & stability & public/community support) | Chan et al. (2004)<br>(see also Akinsola et al., 1997;<br>Belout, 1998;<br>Chua et al., 1999;<br>Songer & Molenaar, 1997) | Infrastructure in general<br>Infrastructure in general<br>Projects in general<br>Infrastructure in general<br>Infrastructure in general |
| | Less corruption | Galilea & Medda (2010);<br>Hammami et al. (2006);<br>Percoco (2014) | Transport Infrastructure<br>Infrastructure in general<br>Transport Infrastructure |
| | Effective rule of law/Regulatory quality | Delhi & Mahalingam (2013);<br>Hammami et al. (2006);<br>Mota & Moreira (2015);<br>Percoco (2014) | Infrastructure in general<br>Infrastructure in general<br>Infrastructure in general<br>Transport Infrastructure |
| | Favourable legal framework | Osei-Kyei & Chan (2015) | Infrastructure in general |
| | Institutional quality | Hammami et al. (2006);<br>Zagozdzon (2013) | Infrastructure in general<br>Transport Infrastructure |
| | Role of political and institutional environment where the projects are sited | Castano (2011) and<br>Mahalingam & Kapur (2009) | Transport Infrastructure<br>Infrastructure in general |
| Cost overrun | Inappropriate government policies | Chan & Park (2005) | Construction Projects |
| | Bureaucratic indecision | Morris (1990) | Public Sector projects (including infrastructural projects in general) |
| | Inappropriate organizational structure | Flyvbjerg et al. (2003);<br>Kaliba et al. (2008) | Transport Infrastructure<br>Transport Infrastructure |
| | Un-conducive regulatory environment | Azhar et al. (2008);<br>Shibani & Arumugam (2015) | Infrastructure in general<br>Infrastructure in general |
| | Deliberate cost underestimation | Flyvbjerg et al. (2003);<br>Nijkamp & Ubbels (1999) | Transport Infrastructure<br>Transport Infrastructure |
| | Inaccurate estimates | Mansfield et al. (1994) | Transport Infrastructure |
| | Strategic misrepresentations | Flyvbjerg et al. (2002);<br>Siemiatycki (2015) | Transport Infrastructure<br>Infrastructure Projects |
| | "Creative error" and "beneficial ignorance" | Flyvbjerg (2016) | Infrastructure Projects (including transport) |
| | Over-optimism | Siemiatycki (2015) | Infrastructure Projects |
| | Manipulation of forecasts | Flyvbjerg et al. (2003);<br>Wachs (1987) | Transport Infrastructure<br>Transport Infrastructure |
| | Private information | Arvan & Leite (1990);<br>Flyvbjerg et al. (2003); | Long term projects<br>Transport Infrastructure |

| | | | |
|---|---|---|---|
| | Lack of well-established legal framework | Chan et al. (2010) | Infrastructure in general |
| Financial-economic context (FEI) | | | |
| On cost | External Environment: economic, industrial and the level of technology | Chan et al. (2004);<br>(see also Akinsola et al., 1997;<br>Chua et al., 1999;<br>Kaming et al., 1997;<br>Songer & Molenaar, 1997) | Infrastructure in general<br>Infrastructure in general<br>Infrastructure in general<br>Infrastructure in general<br>Infrastructure in general |
| | Macro-economic stability | Hammami et al. (2006);<br>Mota & Moreira (2015);<br>Zagozdzon (2013) | Infrastructure in general<br>Infrastructure in general<br>Transport Infrastructure |
| | High public debt | Hammami et al. (2006) | Infrastructure in general |
| | Available financial market | Chan et al. (2010) | Infrastructure in general |
| Cost overrun | Currency devaluation | Fouracre et al. (1990) | Transport Infrastructure |
| | Rises in interest charges | Fouracre et al. (1990) | Transport Infrastructure |
| | Price fluctuation | Mansfield et al. (1994) | Transport Infrastructure |
| | Macro-economic factors | Azhar et al. (2008);<br>Shibani & Arumugam (2015) | Infrastructure in general<br>Infrastructure in general |
| | Non-conducive financial market | Chan et al. (2010) | Infrastructure in general |
| | Unstable cost on material | Azhar et al. (2008);<br>Chan & Park (2005) | Infrastructure in general<br>Construction Projects |
| | Increased labour or material costs | Siemiatycki (2015) | Infrastructure Projects |
| Contractual governance (GI) | | | |
| On cost | Procurement-related factors | Chan et al. (2004)<br>(see also Kumaraswamy & Chan, 1999) | Infrastructure in general<br>Infrastructure in general |
| | Transparent & competitive procurement process | Osei-Kyei & Chan (2015) | Infrastructure in general |
| | Suitable/appropriate risk allocation | Osei-Kyei & Chan (2015) | Infrastructure in general |
| | Transparent and adjusted contracts | Mota & Moreira (2015) | Infrastructure in general |
| | Clarity of roles and responsibilities among parties | Osei-Kyei & Chan (2015) | Infrastructure in general |
| Cost overrun | Cost of unforeseen service and utility | Fouracre et al. (1990) | Transport Infrastructure |
| | Wrong method of cost estimation | Azhar et al. (2008);<br>Chan & Park (2005) | Infrastructure in general<br>Construction Projects |
| | Completion time of project | Odeck (2004) | Transport Infrastructure |
| | Misallocation of risk | Chan et al. (2010) | Infrastructure in general |
| | High transaction cost | Chan et al. (2010) | Infrastructure in general |
| | Poor contract management | Mansfield et al. (1994) | Transport Infrastructure |
| | Lack of competition | Chan et al. (2010) | Infrastructure in general |
| | Lowest bidding procurement | Azhar et al. (2008);<br>Chan & Park (2005);<br>Park and Papadopoulou (2012) | Infrastructure in general<br>Construction Projects<br>Transport Infrastructure |
| | High bidding cost | Chan et al. (2010) | Infrastructure in general |
| | Length of bidding and negotiation process | Chan et al. (2010) | Infrastructure in general |
| | Lump-sum contracts | Park and Papadopoulou (2012) | Transport Infrastructure |
| Remuneration attractiveness (RAI) | | | |
| On cost | Economic viability | Mota & Moreira (2015) | Infrastructure in general |
| | Government providing guarantees | Osei-Kyei & Chan (2015) | Infrastructure in general |
| Cost overrun | Inadequate funding of project | Morris (1990) | Public Sector projects (including infrastructural projects in general) |
| | Inadequate dedicated funding process | Flyvbjerg et al. (2003);<br>Pickrell (1992) | Transport Infrastructure<br>Transport Infrastructure |

| | | | |
|---|---|---|---|
| Revenue Robustness[5] (RRI) | | | |
| On cost | Economic viability | Mota & Moreira (2015) | Infrastructure in general |
| Cost overrun | Inadequate funding of project | Morris (1990) | Public Sector projects |
| | Inadequate dedicated funding process | Flyvbjerg et al. (2003) | Inadequate dedicated funding process |
| Financing scheme (FSI) | | | |
| On cost | Financial capabilities of private sectors | Osei-Kyei & Chan (2015) | Infrastructure in general |
| | Government providing guarantees | Osei-Kyei & Chan (2015) | Infrastructure in general |
| Cost overrun | Poor financing | Flyvbjerg et al. (2003); | Transport Infrastructure |
| | | Mansfield et al. (1994) | Transport Infrastructure |
| Cost Saving (CSI) | | | |
| On cost | Project management factors | Chan et al. (2004) | Infrastructure in general |
| | | (see also Belout, 1998; | Projects in general |
| | | Chua et al., 1999) | Infrastructure in general |
| | Project participants related factors | Chan et al. (2004) | Infrastructure in general |
| | | (see also Belassi & Tukel, 1996; | Projects in general |
| | | Chua et al., 1999; | Infrastructure in general |
| | | Dissanayaka & Kumaraswamy, 1999; | Building projects |
| | | Hassan, 1995; | Construction Projects |
| | | Songer & Molenaar, 1997) | Infrastructure in general |
| | Suitable/appropriate risk allocation | Osei-Kyei & Chan (2015) | Infrastructure in general |
| | Good feasibility studies | Osei-Kyei & Chan (2015) | Infrastructure in general |
| | Detailed project planning | Osei-Kyei & Chan (2015) | Infrastructure in general |
| | Technology innovation | Osei-Kyei & Chan (2015) | Infrastructure in general |
| | Pre-project planning & clarity in scope | Tabish & Jha (2011) | Public construction projects |
| | Effective management control | Chan et al. (2010) | Infrastructure in general |
| | High level of know-how from both partners | Mota & Moreira (2015) | Infrastructure in general |
| | Project-related factors: type, nature, complexity & size | Chan et al. (2004) | Infrastructure in general |
| | | (see also Akinsola et al., 1997; | Infrastructure in general |
| | | Belout, 1998; | Projects in general |
| | | Chua et al., 1999; | Infrastructure in general |
| | | Songer & Molenaar, 1997; | Infrastructure in general |
| | | Park and Papadopoulou, 2012) | Transport Infrastructure |
| | Previous PPP experience | Hammami et al. (2006); | Infrastructure in general |
| | | Zagozdzon (2013) | Transport Infrastructure |
| | Strong private consortium | Osei-Kyei & Chan (2015) | Infrastructure in general |
| Cost overrun | Poor project design and implementation | Morris (1990) | Public Sector projects (including infrastructural projects in general) |
| | Changes in specification | Fouracre et al. (1990) | Transport Infrastructure |
| | Scope changes and change orders | Siemiatycki (2015) | Infrastructure Projects |
| | Technical uncertainty | Flyvbjerg et al. (2003); | Transport Infrastructure |
| | | Kaliba et al. (2008) | Transport Infrastructure |
| | Forecasting errors and inadequate planning process | Flyvbjerg et al. (2003); | Transport Infrastructure |
| | | Nijkamp & Ubbels (1999); | Transport Infrastructure |
| | | Pickrell (1992) | Transport Infrastructure |
| | Inaccurate forecasting | Siemiatycki (2015) | Infrastructure Projects |
| | Poor project management | Azhar et al. (2008); | Infrastructure in general |
| | | Chan & Park (2005) | Construction Projects |

[5] Similarities are observed in the allocation of the literature findings to the remuneration attractiveness and the revenue robustness indicators. Funding, in the present study, refers to the long term financial streams that will support the repayment of the project financing and is related to its overall economic and financial viability (Roumboutsos et al., 2018). The factor 'Government providing guarantees' is not allocated under the revenue robustness indicator because money from public budget does not belong to revenues generated by or for the project.

| | | |
|---|---|---|
| Problems coordinating a large cast of contractors and subcontractors | Siemiatycki (2015) | Infrastructure Projects |
| Long period between design and tendering (pre-construction) | Azhar et al. (2008); Chan & Park (2005) | Infrastructure in general Construction Projects |
| Additional work, improper planning | Azhar et al. (2008); Chan & Park (2005) | Infrastructure in general Construction Projects |
| Misallocation of risk | Chan et al. (2010) | Infrastructure in general |
| Lack of suitable skills and experience | Chan et al. (2010) | Infrastructure in general |
| Lack of innovation and design | Chan et al. (2010) | Infrastructure in general |
| Length of implementation phase & pre-construction phase | Cantarelli et al. (2012); Flyvbjerg et al. (2004) | Transport Infrastructure Transport Infrastructure |
| Accurate project planning & monitoring | Doloi (2013) | Construction Projects |
| Poor monitoring of projects | Siemiatycki (2015) | Infrastructure Projects |
| Design efficiency | Doloi (2013) | Construction Projects |
| Effective site management | Doloi (2013) | Construction Projects |
| Contractor's efficiency | Doloi (2013) | Construction Projects |
| Lengthy lead time | Chan et al. (2010) | Infrastructure in general |
| Shortages of materials | Mansfield et al. (1994) | Transport Infrastructure |
| Strategic behaviour | Arvan & Leite (1990); Flyvbjerg et al. (2003) | Long term projects Transport Infrastructure |
| Inadequate decision making process | Morris (1990) | Public Sector projects (including infrastructural projects in general) |

## 3. Methodological approach and case selection

Section 3.1 describes the method employed to do the analysis. Section 3.2 introduces the cases used in the analysis. Section 3.3 describes the input conditions selected for the analysis. Finally, section 3.4 describes the models used for doing the analysis.

### 3.1 Method Description

The method that is used in this research is the fsQCA and the software used is the fsQCA 2.5. QCA is a comparative method that offers a middle path between quantitative and qualitative measurement (Ragin, 2008, p.71). It is comparative because "it explores and finds similarities and differences in outcomes across comparable cases by comparing configurations of conditions" (Marx and Dusa, 2011, p.105). FsQCA is a set-theoretic approach with the assessment of causal complexity being based on a few assumptions. First, a condition will only have an effect in combination with other conditions (conjunctural causation); second, an outcome can be elucidated by multiple, mutually non-exclusive (paths of) conditions (equifinality) and third, the presence of the outcome may have different explanations than its absence (causal asymmetry). The method allows defining necessary and (sets of) sufficient conditions for a particular outcome (Rihoux & Ragin, 2009), just like we do in this paper. X is a necessary condition for outcome Y is to say that it is impossible to have Y without X ($Y \rightarrow X$). X is a sufficient condition for Y is to say that the presence of X guarantees the presence of Y ((combination of) $X \rightarrow Y$) but the outcome Y can also result from other conditions (Rihoux and Ragin, 2009, p. xix). QCA is not very useful for very small samples (for example less than 12 cases) (Fiss, 2008).

According to Verweij & Gerrits (2013), a comparative case-based approach, such as QCA, is the most suitable way to study the relationship between outcomes and context in projects. QCA keeps the middle between a case-based and a variable-based approach, thus allowing to understand in depth the cases and also observe the interactions among the conditions leading to the achievement or not of a target of transport infrastructure projects (cost target). Thus, its

“advantage” compared to other methods is that identifies combinations of conditions that affect the outcome and not just one independent condition (Ragin and Fiss, 2008). This is important, considering that reality is complex and therefore it is usually not only one factor that leads projects to be on or over cost.

QCA encompasses three different comparative methods: the crisp set (csQCA), the fuzzy set (fsQCA) and the multi-value QCA (mvQCA). FsQCA is selected for this paper. The main reason is that the crisp set is ideal for binary conditions, with only two values, either "in" or "out" of a set, while the fuzzy set allows ‘membership in the interval between 0 and 1’ (calibration step) (see Annex C for the calibration details). MvQCA was not used because if used, the outcome still has to remain dichotomous, although this is not an obligation for the conditions (Rihoux and Ragin, 2009, p. 85). Additional benefits of the fsQCA is that the assessment of consistency is more precise and also encompassing because it involves all cases in the assessment of each combination of conditions. Also, fsQCA does not exacerbate the problem of limited diversity in contrast to mvQCA (Rihoux and Ragin, 2009, p. 119).

The methodological steps that are taken within the fsQCA are 1) identifying the conditions and the outcome that will be used, 2) calibrating the outcome and conditions (see Annex C), 3) doing the necessity analysis, 4) doing the sufficiency analysis (see Annex D for the truth tables) and 5) interpreting the results.

The results are mainly interpreted based on their consistency and coverage values. In the sufficiency analysis, consistency measures *“the proportion of cases with a given cause or combination of causes that also display the outcome”*, like significance of a correlation (Ragin, 2008). The minimum acceptable threshold for consistency is 0.75 (Rihoux and Ragin, 2009, p. 121), however an even higher threshold, equal or higher to 0.85 is highly recommended. The 0.75 consistency threshold is used for the present analysis. Coverage measures *“the degree to which a cause or causal combination “accounts for” instances of an outcome”* (Ragin, 2008). There are no minimum acceptable thresholds for coverage as for consistency, because even solution paths with a low value of coverage might be of significant theoretical or substantive importance (Schneider & Wagemann, 2012). We can differentiate between 'solution coverage' (measuring *“the proportion of memberships in the outcome that is explained by the complete solution”*); 'raw coverage' (measuring *“the proportion of memberships in the outcome explained by each term of the solution”*); and 'unique coverage' (measuring “*the proportion of memberships in the outcome explained solely by each individual solution term*”) (Ragin, 2008a).

### 3.2 Cases

The data used for this analysis are retrieved from the database of the European Commission’s Horizon 2020 project BENEFIT[6]. These data are collected by 14 country teams through desk research and interviews with direct stakeholders of transport infrastructure projects. The interviews are conducted based on questionnaires developed especially for the BENEFIT research work. These questionnaires include the key characteristics related to financing and funding of transport infrastructures. The completed questionnaires for each of the case studies are uploaded on the BENEFIT website. The datasets used in this analysis are composed of 47 European projects, covering all transport infrastructures (airport, road, rail, seaport, metro, tram, and depot), of which 22 were completed before the GFC (Annex A), and 25 after[7] (Annex B).

[6] The data are available on the BENEFIT website http://www.benefit4transport.eu/.

[7] 10/25 projects that were completed after 2008 were awarded before 2008. 6/10 were on budget or below budget and the rest 4 over budget. 15/25 projects that were completed after 2008 were awarded after 2008. Only 4/15 were over budget. 3/4 of these over budget projects were awarded in 2009 and one of them in 2008. However, this finding does not allow us to come to rigid

### 3.3 Conditions[8]

According to Roumboutsos et al. (2018), the basic elements of transport infrastructure investment projects are: 1) the business model (BM) of the project, 2) the financing scheme, 3) the funding scheme, 4) the contractual governance arrangements, 5) the implementation context and 6) the transport mode context. For these elements, composite indicators were developed that are used as 'conditions' for the present analysis (Roumboutsos et al., 2018) (see Box 1). A condition in the fsQCA is an explanatory variable that might affect the outcome (Rihoux and Ragin, 2009, p. 182). A comprehensive system model, similar to Easton's (1965) model, was used, by distinguishing the above six major categories of conditions (Rihoux and Ragin, 2009, p.26). For each of these major categories, several conditions were identified and each of them was tested separately using different scientific methods, including fsQCA, sensitivity analysis and regression analysis. In a second step, only the conditions that showed strong relationships were kept and tested again. In this way, the long list of original conditions was reduced to nine conditions, from which two are eliminated from the present analysis due to limited variation across the cases (Rihoux and Ragin, 2009, p. 28). Thus, for the present analysis seven conditions are kept, from which models of maximum five conditions can be composed due to the size of our two samples (Marx and Dusa, 2011).

The categorization of the conditions used is that of Table 1. These conditions will compose the models for the analysis of both projects completed before the GFC and after the GFC, so as to be able to compare the results of the two samples and come to conclusions.

The Institutional Indicator (INI) captures the political, regulatory and administrative dimensions. The political dimension is composed by the governance indicators of i) political stability and absence of violence, ii) control of corruption and iii) voice and accountability; thus giving an overview of the general political situation of a country. The regulatory dimension is composed by the governance indicators of i) rule of law, ii) regulatory quality and iii) liberalization of markets; thus showing the judicial and regulatory context of a country. The administrative dimension is composed by the indicator of government effectiveness. All indicators are World Bank Governance Indicators (WGIs), except the liberalization of markets indicator (the inverse of the ETCR developed by OECD).

The Financial Economic Indicator (FEI) measures more than just the macro-economic and macro-financial context of a country, but more broadly the business environment and can be seen as a proxy for the level of productivity of a country. The Growth Competitiveness Index of the World Economic Forum was selected to describe this indicator.

The Contractual Governance Indicator (GI) refers to factors setting the governance scene within a project. Governance focuses on the relationships between a contracting authority and a contractor or contractors. These relationships are usually formed by transactions during the procurement process and are reflected in a contract and its changes. In this respect, it is defined by the contractual conditions and the process leading to them.

The Remuneration Attractiveness Indicator (RAI) represents the various income sources with their assessed risk and potential cost coverage. Remuneration schemes refer to the revenue streams that are used as payments to the project actors that have incurred project related costs (being the construction and operational/maintenance costs), thus seeking to recover their investment.

The Revenue Robustness Indicator (RRI) represents the various revenue sources with their assessed risk and potential cost coverage. Revenue schemes concern the way the project produces revenues.

conclusions with respect to the relation of the time of the project award and the project performance because there were other projects in the sample that were awarded in 2009 and 2008 and they were on budget.

[8] The conditions that are used are typology indicators that are developed for this specific research purpose. *"A typology is a group of factors that aims to describe the characteristics of Key Elements"*; in this case key elements for the performance of transport infrastructure projects are the 1) business model of the project, 2) financing scheme, 3) funding scheme, 4) contractual governance arrangements, 5) implementation context and 6) transport mode context, according to Roumboutsos et al. (2018).

The Financing Scheme Indicator (FSI) captures the risk-return profile of transport infrastructure financing schemes, based on the evaluation of the contribution of different financing sources. Financing refers to the raising of capital at the beginning of a project to pay for its development costs, e.g. construction costs. Financing schemes show whether a project is developed by a private or public sponsor. The financial viability condition of the transport infrastructure projects is the ability of the project to meet its financial targets, so as to repay fully and in due time the debt investors and additionally to generate sufficient returns for the equity investors. FSI reflects an expanded version of the weighted average cost of capital included in the project from both public and private sources (1-WACCad). It reflects the level of the cost of capital (low/cheap versus high/expensive).

The Cost Saving Indicator (CSI) shows the robustness of the BM with respect to reducing costs during the construction and operation phase of the project (construction, operation, maintenance costs). It is a composite indicator taking into consideration the following elements for the construction phase: Level of civil works/technical difficulty; Capability to construct; Capability of the Contracting Authority to monitor the construction; Level of optimal construction risk allocation; Adoption of innovation; Capability to innovate and the Capability of the Contracting Authority to plan. For the operation phase, the following elements are examined: Life cycle planning; Capability to operate and Level of optimal operation risk allocation.

Box 1. List of conditions included in the analysis (Roumboutsos et al., 2018).

For selecting the five conditions (out of the seven in total that are proven to strongly affect the performance of transport infrastructure projects), we initially select the conditions that appear to have the highest necessary consistency in the fsQCA necessity analysis, either for the presence or the absence of the outcome (Bol and Lupi, 2013). Thus, a group of five conditions is created based on the above method and is presented in Table 2 below. In a second step, the combinations of conditions that are found to be sufficient for the occurrence and non-occurrence of the cost outcome in the sufficiency analysis, are used together with the CSI condition and/or the RRI condition, which were initially left out of the analysis, since they showed the lowest values of necessary consistency. These seven conditions are presented in Table 1 as clusters. The emphasis on financing and funding features of projects is relevant as the hypothesis is that the GFC affected mainly that side of the transport infrastructure projects.

The necessity analysis within the fsQCA method measures how necessary a specific condition is to bring about a certain outcome, meaning projects being on cost in this case (Y→X). The same five conditions are found to have the highest necessary consistency values for both samples. These conditions are (1) INI , (2) FEI, (3) GI, (4) RAI, and (5) FSI (see Table 2). The more the value of each of these conditions comes closer to the value '1', the more positively it affects the respective outcome and vice versa.

### 3.4 Models

The initial tested models are shown in Table 2.

**Table 2:** Initial models tested

| Initial Models | Involved projects | Included conditions |
|---|---|---|
| Models for the presence of the **'cost'** outcome | For both samples<br>• Sample of projects completed before the GFC | INI<br>FEI<br>GI |
| Models for the absence of the **'cost'** outcome | • Sample of projects completed after the GFC | RAI<br>FSI |

## 4. Results

In this section, the results of the two sufficiency analyses (for projects completed before and after the crisis) are presented, each time including the analyses for the presence of the outcome (projects being on cost) and the analyses for the absence of the outcome (projects being over cost). Please note that none of the five conditions met the threshold for necessary conditions (necessary consistency being at least 0.90), implying that none of the five conditions needs to be present for projects to be on cost or for projects to be over cost. The analyses shown in this section of the results refer to the analyses for sufficient (set of) conditions in order to bring about a certain outcome. 'A condition or a combination of conditions is sufficient for an outcome, if the outcome always occurs when the condition or the combination is present' (Rihoux and Ragin, 2009, p. 184). However, the outcome can also occur from other conditions. Part A of this section presents the results of the initial models, presented in Table 2, and Part B shows the results of the additional models, as mentioned in section 3.3, which use as input the solution paths of Part A.

### Part A

After having selected the five conditions with the highest necessary consistency, the initial models are created and tested for their sufficiency.

#### Projects completed before the GFC

First, we show the results on the sample of projects completed *before* the GFC.

The solution of the on cost analysis shows that being under an unfavourable FEI and being in a good INI (as core[9] conditions) combined with having a sound GI and a cheap FSI (with low cost of capital) can explain almost half of the membership in the outcome **'on cost[10]' (completed before the GFC)** (49%) (Table 3). The consistency is not very high but still satisfying, at 0.78. This means that 78% of the cases behave consistently, meaning that they are subsets of the outcome. In other words, consistency shows that 78% of the cases have a degree of membership in this given combination of conditions that is less or equal to the degree of membership in the outcome (Ragin and Fiss, 2008).

**Table 3**: Sufficiency analysis of projects being 'on cost' - completed before GFC

| Conditions | OUTCOME: Presence of On Cost<br>Solution 1 |
|---|---|
| INI | ● |
| FEI | ○ |
| GI | • |
| RAI | |
| FSI | • |
| | |
| Individual Consistency | 0.78 |
| Coverage (Raw) | 0.49 |

[9] Core conditions are decisive causal conditions included both in the parsimonious and intermediate solution and the additional conditions that are only included in the intermediate solution are the "complementary" or "contributing" conditions (Ragin and Fiss, 2008) or peripheral conditions (Fiss, 2011).

[10] The projects that were completed before crisis and that were on cost (and below cost: 1 case) were 17/22 (see Annex A).

| | |
|---|---|
| Coverage (Unique) | 0.49 |
| Number of cases | 5 |
| Relevant Cases[11] | **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**) |

1) Black circle illustrates the presence of conditions and white circle indicates the absence of conditions. Large circles refer to core conditions and the small ones to peripheral conditions. Blank spaces show 'don't care'.
2) The table includes only the intermediate solution.

Testing the absence of the cost outcome shows that 45% of the membership in the outcome **over cost[12] (completed before the GFC)** can be explained by having an expensive FSI (high cost of capital) (as a core condition) combined with a RAI with high risk and low cost coverage (as a peripheral condition) (Table 4). The consistency is high, more specifically at 0.87.

**Table 4:** Sufficiency analysis of projects being 'over cost' - completed before GFC

| **Conditions** | **OUTCOME: Absence of On Cost Solution 1** |
|---|---|
| INI | |
| FEI | |
| GI | |
| RAI | ○ |
| FSI | ◯ |
| Individual Consistency | **0.87** |
| Coverage (Raw) | 0.45 |
| Coverage (Unique) | 0.45 |
| Number of case | 1 |
| Some relevant cases | **C-16 Terrasa Manresa toll motorway (0.75,1)** |
| Overall Consistency/Coverage | (0.87/**0.45**) |

1) Black circle illustrates the presence of conditions and white circle indicates the absence of conditions. Large circles refer to core conditions and the small ones to peripheral conditions. Blank spaces show 'don't care'.
2) The table includes only the intermediate solution.

[11] A main aim of the QCA is to identify the cases that are linked to the causal conditions or combinations of conditions (Ragin, s.d.). The fsQCA 2.5 software presents the cases with a greater than 0.5 membership in the specific causal combination. Thus, the cases indicated in each of the results' tables are the relevant cases in terms of their membership in the causal combination (Ragin and Fiss, 2008).

[12] The projects that were completed before crisis and were over cost were 5/22 (see Annex A).

**Projects completed after the GFC**

When considering the results on the sample of projects completed after the GFC, we clearly observe differences in the set of sufficient conditions for projects being on cost or over cost, compared to projects completed before the GFC.

The analysis shows that 56% of the membership in the outcome **on cost[13] for projects completed after the GFC** can be explained by being in both a sound INI and a favourable FEI context (core conditions) combined with having a cheap FSI (low cost of capital) (peripheral condition) (Table 5). The consistency of the solution path equals 0.85.

**Table 5**: Sufficiency analysis of projects being 'on cost' - completed after the GFC

| Conditions | OUTCOME: Presence of On Cost<br>Solution 1 |
|---|---|
| INI | ● |
| FEI | ● |
| GI | |
| RAI | |
| FSI | • |
| 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**) |

1) Black circle illustrates the presence of conditions and white circle indicates the absence of conditions. Large circles refer to core conditions and the small ones to peripheral conditions. Blank spaces show 'don't care'.
2) The table includes only the intermediate solution.

The analysis of the 'over cost' outcome shows that 41% of the membership in the outcome **over cost[14] completed after the GFC** can be explained by – even when having a cheap FSI– being in a poor INI and having a RAI with high risk and low cost coverage (core conditions), combined with being in an unfavourable FEI (peripheral condition). The consistency equals 0.85 (Table 6).

**Table 6**: Sufficiency analysis of projects being 'over cost' – completed after GFC

| Conditions | OUTCOME: Absence of On Cost<br>Solution 1 |
|---|---|

[13] The projects that were completed after crisis and they were on cost (and below cost: 3 cases) were 15/25 (see Annex B).
[14] The projects that were completed after crisis and they were over cost were 10/25 (see Annex B).

| | |
|---|---|
| INI | ○ |
| FEI | ∘ |
| GI | |
| RAI | ○ |
| FSI | ● |
| | |
| 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**) |

1) Black circle illustrates the presence of conditions and white circle indicates the absence of conditions. Large circles refer to core conditions and the small ones to peripheral conditions. Blank spaces show 'don't care'.
2) The table includes only the intermediate solution.

## Part B

Based on the approach used for selecting five conditions out of the seven to include in the model of the fsQCA shown in Part A of the results, the CSI condition, which is found in literature to be of high importance, is not included due to its lower necessary consistency. Thus, so as to be able to also examine what the impact of the CSI (and RRI) to the occurrence or not of the cost outcome is, we re-ran the sufficiency analysis. This time, we used as models the solution paths shown in Part A and we added either only the CSI, either only the RRI or both. The additional models that are tested are the following:

**Table 7:** Additional models tested

| Additional Models | Involved projects | Included conditions (a) | Included conditions (b) | Included conditions (c) |
|---|---|---|---|---|
| 1. Models for the presence of the 'cost' outcome | Sample of projects completed **before** the GFC | INI<br>FEI<br>GI<br>FSI<br>**CSI** | INI<br>FEI<br>GI<br>FSI<br>**RRI** | |
| 2. Models for the absence of the 'cost' outcome | Sample of projects completed **before** the GFC | FSI<br>RAI<br>**CSI** | FSI<br>RAI<br>**RRI** | FSI<br>RAI<br>**RRI**<br>**CSI** |
| 3. Models for the presence of the 'cost' outcome | Sample of projects completed **after** the GFC | INI<br>FEI<br>FSI<br>**CSI** | INI<br>FEI<br>FSI<br>**RRI** | INI<br>FEI<br>FSI<br>**CSI**<br>**RRI** |
| 4. Models for the absence of the 'cost' outcome | Sample of projects completed **after** the GFC | INI<br>FEI<br>RAI<br>FSI<br>**CSI** | INI<br>FEI<br>RAI<br>FSI<br>**RRI** | |

The findings of the new model (1a) show that when the CSI is also added in the model, then the occurrence of the cost outcome is derived from the absence of FEI (core), presence of GI, presence of FSI and presence of CSI (core), with consistency/coverage equal to 0.83/0.53 and seven relevant cases. This implies that CSI is considered that matters in explaining the cost outcome, since the consistency/coverage ratio increases from 0.78/0.49 to 0.83/0.53. The findings of the new model (1b) show that including the RRI in the model has no impact on the occurrence of the outcome and gives the exact same solution path presented in Table 3.

The findings of the new model (2a) show that when the CSI is also added in the model, then the non-occurrence of the cost outcome is derived from the absence of RAI, absence of FSI (core) and absence of CSI with 0.86/0.44 (one relevant case). When adding the RRI & CSI (model 2c), the solution path is the same with the path of the model (2a). Therefore, it is shown that RRI has no impact on the non-occurrence of the outcome, which is also shown by the analysis of the model (2b). Model 2b showed the same solution path presented in Table 4.

The findings of the model (3a) show that CSI has no impact on the occurrence of the outcome. Thus when adding the CSI, it gives the same path with Table 5. The model (3b) showed again the same path with Table 5. Thus we can conclude that adding RRI in the model 'INI,FEI,FSI' does not change the solution path, similarly when adding only the CSI. When adding both the CSI and RRI to the model (model 3c), again the same path of Table 5 is found. Therefore, either when adding CSI, or RRI or both to the solution path of Table 5, the path remains the same. Thus, for the sample of the projects completed after the crisis and they were on cost, CSI & RRI have no impact.

The findings when adding the RRI (model 4b) showed the same path with Table 6. Thus, RRI has no impact on the non-occurrence of the outcome. When adding the CSI, the non-occurrence of the outcome is derived by the absence of FEI, absence of RAI and presence of FSI either combined with the absence of INI, (path 4a1) or the absence of CSI (path 4a2). The consistency/coverage values for these solutions are 0.85/0.41 and 0.81/0.38 respectively. Path (4a) is very similar with the path of Table 6, apart from the fact that INI is not a core condition here but FEI is core, but it is the reverse for Table 6 (see Annex E).

## 5. Interpretation

In the present section of interpretation, we compare the findings of the analyses before and after GFC. In this way, we can observe how different the (combinations of) conditions that affect cost performance of transport infrastructure projects are for the projects that are completed before the crisis and for the projects that are completed after the crisis.

**ON COST-**BEFORE vs AFTER CRISIS

Two common conditions (in combination with other conditions) seem to help projects to be on cost in both the periods before the GFC and after the GFC. Being under a sound institutional context and having a cheap financing scheme (low cost of capital) are important for projects that were completed on cost both before and after crisis. This finding stresses the importance of a) having a cheap financing scheme with a low cost of capital, which mostly comes through public financing and the importance of b) being in a country with a stable and democratic political, legal and regulatory framework and public sector capacity for projects being delivered on cost.

Also for both analyses, the financial-economic context appeared to contribute to the achievement of the cost target. However, while the projects that were completed before the GFC

(2008) could be well-performing in terms of being on cost under an unfavourable macro-economic and macro-financial context, the projects that were completed after the crisis need a favourable financial-economic context in order to be delivered on cost. This shows that for the projects that were completed after the crisis, it was more critical to be in a favourable macro-economic and macro-financial context in order to be delivered on cost or below cost. Apparently, for transport infrastructure projects that were completed before the GFC and that were on cost, the negative impact of an unfavourable financial-economic context could be absorbed by the positive effect of being in a sound institutional context, having a cheap financing scheme and also having good contractual governance arrangements and clauses that protect the involved stakeholders from different types of risks that an instable financial-economic environment may cause. However, this is no longer the case for the projects completed after the GFC. For these projects, having a good contractual governance in combination with other conditions is no longer sufficient for them to be on cost. After the GFC, the majority of projects on cost were found in a positive financial-economic context and sound institutional context, while having a cheap financing scheme. Also having a robust BM that reduces costs during the construction and operation phase of the project was found to explain the occurrence of the on cost outcome (in combination with other conditions: unfavourable financial economic context, good contractual governance and a cheap financing scheme) only for the projects that were completed before the crisis but not for the ones completed after the crisis. Thus showing that a favourable exogenous environment together with a cheap financing scheme is sufficient for the projects that are completed after crisis so as to be on cost.

**OVER COST-**BEFORE vs AFTER CRISIS

87% of the cases completed before the GFC sharing the combination of a remuneration scheme with a high income risk and a low cost coverage and an expensive financing scheme (high cost of capital) agreed in displaying the over cost outcome. For these projects, the institutional and financial-economic context and the quality of their contractual governance arrangements did not matter much. Having a high-risk remuneration scheme and an expensive financing scheme are sufficient conditions for projects being delivered over cost. This is logical if we consider that remuneration attractiveness reflects the attractiveness of the remuneration scheme for investors. Thus if the remuneration schemes of the projects are non-attractive in the sense that they come from high risk income sources and have a high potential of lower cost coverage of the projects' cost expenses, investors will be less willing to finance the projects which indirectly might cause cost overruns due to leading to a more expensive financing scheme (with higher cost of capital). Also, almost the same % of projects was found to be explained by the above combination of a non-attractive remuneration scheme and an expensive financing scheme, also combined with a weak BM with low ability to reduce costs during the construction and operation phase of the project, due to e.g. low capability to construct, to operate, to plan, to monitor the project, to allocate the risks, to adopt innovation etc. This was found as the most prominent cause of infrastructure projects' cost overruns in literature and it is also confirmed by the present study.

However, for projects being completed after the GFC, even projects with a cheap financing scheme (low cost of capital) might be delivered over cost when they have a remuneration scheme with high income risk and low cost coverage, while being in a poor institutional context and an unfavourable financial-economic context. Therefore, we can see the strong influence of the external environment on the cost performance of the transport infrastructure projects; thus weakening the positive impact that a cheap financing scheme could have. A low potential of cost

saving during the construction and operation of the project combined also with an unfavourable financial economic context, unattractive remuneration scheme and even a cheap financing scheme might also deliver projects that are over cost after the GFC.

## 6. Conclusions

To sum up, it is clear that after the GFC, the quality of the external environment, in terms of the institutional context and the financial-economic context, matters more in order to deliver transport infrastructure projects on cost. This means that project performance is depending on conditions exogenous to the projects, which are beyond the control of the involved public and private transport infrastructure delivering actors, more after than before the GFC. On top of that, the finding that a not very strong institutional context causes cost overruns (in combination with certain conditions) and that a strong institutional context makes projects to be on cost (in combination with certain conditions) is very important for the time period after the GFC, when most governments reduced the available budgets for infrastructure investment. That is because when institutions are more solid, jurisdictions will be more resistant to any kind of pressure that affects project selection and contract. The level of the cost of capital and hence the expensiveness of the financing scheme is also an important condition, although for projects completed after the GFC, a low cost of capital can still lead projects to be over cost, when the external environment is unfavourable and the remuneration scheme brings high income risks and low cost coverage. Also with respect to the cost saving condition, which was found as key condition in literature, it is found to be of higher importance for the projects completed before crisis, since its presence and absence was found sufficient in combination with other conditions for both the occurrence and non-occurrence of the cost outcome respectively. On the other hand, for the projects completed after crisis, the cost saving condition (its absence) is found to be sufficient (in combination with other conditions) only for the non-occurrence of the cost outcome. What is also interesting to observe is that the cost saving condition behaves as expected (as our simplifying assumptions, which are saying that the presence of the condition will be sufficient for the occurrence of the outcome and its absence for the non-occurrence). The two conditions that do not behave according to our assumptions are the financial-economic context and financing scheme condition. The absence of the former explains the presence of the outcome and the presence of the latter the absence of the outcome. This is interesting because the results of the present analysis provide new insights to the existing substantive and theoretical knowledge of the existing literature, which says that it is the presence of the conditions that is linked to the presence of the cost outcome and their absence linked to the absence of the outcome.

Also, having good contractual arrangements in combination with other conditions explains the presence of the outcome for the projects completed before crisis but not for the ones completed after the crisis. It is also interesting to observe that a non-attractive remuneration scheme explains the absence of the cost outcome in combination with other conditions for both samples of projects completed before and after the crisis but not the presence of the outcome. The only condition that is a 'don't care' condition[15] for all the solution paths that are found, is the revenue robustness condition. However, we should point out at this point that it is the interplay among single conditions that explains the outcome and not single conditions in isolation (Schneider & Wagemann, 2010).

With respect to the literature, it can be observed that our findings match to some extent to its findings, at least with respect to the cost overruns. This is because literature often examines factors

[15]A 'don't care' condition means that this condition is irrelevant (Ragin and Strand, 2008, p.437) (see also Ragin and Fiss, 2008).

that cause cost overruns but not factors that cause cost underruns or on-cost performance, when comparing the contract construction budget with the actual project construction cost. With respect to the results of the 'over cost-before crisis' analysis, only a few factors are found in literature that are related to the attractiveness of the remuneration scheme and the financing scheme and many factors that are related to the cost saving. The results of the 'over cost-after crisis' analysis appear to match to a much higher extent with literature, since both the institutional context of the country and the financial-economic context of the country (exogenous conditions) are found to cause cost overruns and the cost saving condition as well. What is interesting is that in literature, it is always negative factors that lead to cost overruns, but the QCA analysis from this paper shows that also a positive condition, when it is combined with certain negative conditions, can still cause cost overruns.

With respect to the achievement of the cost target, a comparison between the findings of the literature and our findings is not recommended to be made, since in literature, success is defined broader than it is in this paper. Thus, the factors that are found in literature contribute to the overall success of (transport) infrastructure projects. However, we can say that the exogenous conditions, the conditions related to the contractual arrangements, the financing scheme condition and the cost saving condition, which are found in our analysis as sufficient conditions for projects to be on cost, are also found in literature to affect overall success of (transport) infrastructure projects. Especially for the latter condition, related factors appeared extensively as main causes of cost overruns and as main reasons of project success.

The selection of the fsQCA method and the development of a framework and conditions for conducting the specific type of analysis are considered strengths of this paper. FsQCA allows identifying combinations of conditions that affect the cost performance of transport infrastructure projects. These combinations of conditions reflect the complexity of transport infrastructure project management that is affected by different conditions. However, it is good to mention that although QCA is the most suitable method for this type of analysis, since it combines the variable-based and case-based approaches, it is a static method that does not take into consideration the dimension of time (Verweij & Gerrits, 2013 and Rihoux and Ragin, 2009, 161). The time dimension is taken into consideration indirectly in the present analysis by using the comparison of the samples before and after the crisis.

Finally, regarding the conditions that are used, although they are a result of a thorough and long literature review and empirical research, some conditions that may affect the performance of transport infrastructure projects may not be included among the final conditions in this paper. Also, with respect to the conditions that were used in the analysis, they are composite conditions. Using composite conditions does not show which exact sub-condition is the one that mostly affects the cost performance. Also, the results of this analysis depend on the specific sample of projects used and thus do not necessarily reflect cost performance conditions for all transport infrastructure projects but may only do so for projects with similar characteristics. Therefore, it is hard to find a pattern and follow it as a "rule" so as to have transport infrastructure projects that are on the budget (contract construction budget vs actual project construction cost). Last but not least, it is important to point out that the aim of this study is not to 'force' the contractor for a project that is 100% on budget but to provide insights to the stakeholders involved in transport infrastructure project development, policy makers and academics about possible 'recipes' that lead projects to be on cost and over cost during times or not of economic recession.

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# References


- Akinsola, A. O., Potts, K. F., Ndekugri, I., & Harris, F. C. (1997). Identification and evaluation of factors influencing variations on building projects. *International Journal of Project Management, 15*(4), 263–267.
- Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria, *International Journal of Project Management*, *17*(6), pp. 337-342.
- Azhar, N., Farooqui, R.U., & Ahmed, S.M. (2008). Cost Overrun Factors in Construction Industry in Pakistan. *First International Conference on Construction in Developing Countries (ICCIDC–I) "Advancing and Integrating Construction Education, Research & Practice"* August 4-5, 2008, Karachi, Pakistan.
- Arvan, L., & Leite, A. P. (1990). Cost overruns in long term projects. *International Journal of Industrial Organization*, *8*(3), 443-467.
- Belassi, W., & Tukel, O. I. (1996). A new framework for determining critical success/failure factors in projects. *International Journal of Project Management, 14*(3), 141–151.
- Belout, A. (1998). Effects of human resource management on project effectiveness and success: toward a new conceptual framework. *International Journal of Project Management, 16* (1), 21–26.
- Bol, D. and Lupi, F. (2013). Confronting Theories Based on Necessary Relations: Making the Best of QCA Possibilities. *Political Research Quarterly, 66*(1), 2013.
- 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.
- Cantarelli, C. C., van Wee, B., Molin, E. J., & Flyvbjerg, B. (2012). Different cost performance: Different determinants? The case of cost overruns in Dutch transportation infrastructure projects. *Transport Policy*, *22*, 88–95.
- Castano, J.M. (2011). Impact of the Institutional Environment on the Development of Public Private Partnerships in the Road Sectors: Comparison of two Settings: The Netherlands and Tamil Nadu, Phd Dissertation.
- Chan, S., & Park, M. (2005). Project cost estimation using principal component regression. *Construction Management and Economics*, *23*, 295-304.
- Chan, A.P.C., Scott, D., & Chan, A.P.L. (2004). Factors Affecting the Success of a Construction Project. *Journal of Construction Engineering and Management, 130*(1), 153-155.
- Chan, A. P., Lam, P. T., Chan, D.W. M., Cheung, E., & Ke, Y. (2010). Critical Success Factors for PPP in Infrastructure Development: Chinese Perspective. *Journal of Construction Engineering and Management 5*, 484-494.
- Chua, D. K. H., Kog, Y. C., & Loh, P. K. (1999). Critical success factors for different project objectives. *Journal of Construction Engineering and Management, 125*(3), 142–150.
- Clucas, F. (2017). Long-term investments: Barriers and opportunities for regions and cities, Councillor at Cheltenham (LGA, UK) - CEMR-CCRE spokesperson on local finances, European Parliament, 8 March 2017.
- Delhi, V. S. K., & Mahalingam, A. (2013). A Framework for Post Award Project Governance of Public-Private Partnerships in Infrastructure Projects. In P. M. Carrillo & P. Chinowsky (Eds.), *Engineering Project Organization Conference*.
- Dissanayaka, S. M., & Kumaraswamy, M. M. (1999). Evaluation of factors affecting time and cost performance in Hong Kong building projects. *Engineering Construction and Architectural Management, 6*(3), 287–298.
- Doloi, H. (2013). Cost Overruns and Failure in Project Management: Understanding the Roles of Key Stakeholders in Construction Projects. *Journal of Construction Engineering and Management*, *139*(3), 267-279.
- Easton, D. (1965). *A systems analysis of political life*. New York: Wiley and Sons.
- Edkins, A., Geraldi, J., Morris, P., & Smith, A. (2012). Exploring the Front-end of Project Management, Working Paper Proceedings, Engineering Project Organizations Conference, Rheden, The Netherlands, July 10-12, 2012 (p.2 and p.6) http://www.epossociety.org/epoc2012/Papers/Edkins_Geraldi_Morris_Smith.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, Accessed 12.12.2016.
- Fiss, P. (2011). Building Better Casual Theories: A Fuzzy Set Approach to Typologies in Organizational Research, *Academy of Management Journal, 54*(2), 393–420.

- Flyvbjerg, B. (2016). The Fallacy of Beneficial Ignorance: A Test of Hirschman's Hiding Hand, *World Development*, *84*, 176-189.
- Flyvbjerg, B. (2014). What You Should Know about Megaprojects and Why: An Overview, *Project Management Journal*, *45*(2), April-May, 6-19, DOI: 10.1002/pmj.21409
- Flyvbjerg, B., Skamris Holm, M. K., & Buhl, S. L. (2004). What Causes Cost Overrun in Transport Infrastructure Projects? *Transport Reviews*, *24*(1), 3-18.
- Flyvbjerg, B., Bruzelius, N., & Rothengatter, W. (2003). *Megaprojects and Risk: An Anatomy of Ambition*. Cambridge University Press, Cambridge.
- Flyvbjerg, B., Skamris Holm M., & Buhl S. (2002). Underestimating Costs in Public Works Projects: Error or Lie?, *Journal of the American Planning Association*, *68*(3), 279-295, DOI: 10.1080/01944360208976273
- Fouracre, P. R., Allport, R. J., & Thomson, J.M. (1990). *The performance and impact of rail mass transit in developing countries.* Crowthorne, Berkshire, Transport and Road Research Laboratory.
- Galilea, P., & Medda, F. (2010). Does the political and economic context influence the success of a transport project? An analysis of transport public-private partnerships. *Research in Transportation Economics*, *30*(1), 102-109.
- Hammami, M., Ruhashyankiko, J.F., & Yehoue, E. (2006). Determinants of Public-private partnerships in Infrastructure. *IMF Working Paper WP/06/99.*
- Hassan, A. Q. (1995). Don't burn that bridge. *Journal of Management in Engineering*, *11*(6), 22.
- International Monetary Fund (2014). World Economic Outlook: Legacies, Clouds, Uncertainties. Washington (October), chapter 3, retrieved from the following link: http://www. imf. org/external/pubs/ft/weo/2014/02/pdf/c3. pdf , Accessed 12.12.2016.
- [dataset] International Transport Forum (2015). Transport infrastructure investment, maintenance spending and infrastructure capital value, http://stats.oecd.org/Index.aspx?&datasetcode=ITF_INV-MTN_DATA#, Accessed 3.07.2018.
- International Transport Forum (2013). Spending on Transport Infrastructure 1995-2011 Trends, Policies, Data, OECD/ITF, https://www.itf-oecd.org/sites/default/files/docs/13spendingtrends.pdf
- International Transport Forum (2002). Impact of Transport Infrastructure Investment on Regional Development, OECD, France, http://www.itf-oecd.org/sites/default/files/docs/02rtrinveste.pdf, Accessed 12.12.2016.
- Kaliba, C., Muya, M., & Mumba, K. (2008). Cost escalation and schedule delays in road construction projects in Zambia. *International Journal of Project Management*, *27*(5), 522-531.
- Kaming, P. F., Olomolaiye, P. O., Holt, G. D., & Harris, F. C. (1997). Factors influencing construction time and cost overruns on high-rise projects in Indonesia. *Construction Management and Economics*, *15*(1), 83–94.
- Kappeler, A., & 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/attachments/efs/efr_2010_v04_en.pdf
- Kumaraswamy, M. M., & Chan, W. M. (1999). Factors facilitating faster construction. *Journal of Construction Procurement*, 5(2), 88–98.
- Liyanage, C. (2011). Impact of Global Financial Crisis on PPPs, *Symposium: Public Private Partnerships in Transport: Trends & Theory- Research Roadmap*, Lisbon.
- Mahalingam, A., & Kapur, V. (2009). Institutional Capacity and Governance for PPP projects in India. *Lead 2009 Conference, South Lake Tahoe, CA, USA*.
- Mansfield, N. R., Ugwu, O. O., & Doran, T. (1994). Causes of delay and cost overruns in Nigerian Construction projects. *International Journal of Project Management*, *12* (4), 254-260.
- 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.
- Morris, S. (1990). Cost and Time Overruns in Public Sector Projects. *Economic and Political Weekly*, *25*(47), 154-168.
- Moschouli, E., Raden, M., Vanelslander, T., & Verhoest, K. (2017). Factors affecting the cost performance of transport infrastructure projects, as presented in the ICTR2017, 8th International Congress on Transportation Research, 27-29 September 2017, Thessaloniki, Greece.
- Mota, J., & Moreira, A. C. (2015). The Importance of non-financial Determinants on Public Private Partnerships in Europe. *Journal of Project Management*, *33*(7), 1563-1575.
- Nazemzadeh, M., Meersman, H., & Vanelslander, T. (2015). Transport contribution to the economic development, case study of Antwerp, paper presented in the *World Conference Transport Research Society*, The Port And Maritime Sector: Key Developments And Challenges, WCTRS - Special Interest Group 2, 11- 12 May 2015, unpublished.
- Nijkamp, P., & Ubbels, B. (1999). How Reliable are Estimates of Infrastructure Costs? A Comparative Analysis. *International Journal of Transport Economics*, *26*(1), pp. 23-53.
- Odeck, J. (2004). Cost Overruns in Road Construction – What are their Size and Determinants? *Transport Policy*, *11*(1), 43-53.

- OECD (2011). International Futures Programme - Strategic Transport Infrastructure Needs to 2030- Main Findings- OECD Futures, retrieved from http://www.oecd.org/futures/infrastructureto2030/49094448.pdf
- Osei-Kyei, R., & Chan, A.P. (2015). Review of Studies on Critical Success Factors for Public Private Partnerships (PPP) Projects from 1990 to 2013. *International Journal of Project Management*, *33*(6), 1335-1346.
- Park, Y.I., & Papadopoulou, T.C. (2012). Causes of cost overruns in transport infrastructure projects in Asia: Their significance and relationship with project size. *Built Environment Project and Asset Management*, *2*(2), 195-216, https://doi.org/10.1108/20441241211280873
- Percoco, M. (2014). Quality of Institutions and Private Participation in Transport Infrastructure Investment: Evidence from developing countries. *Transport Research Part A*: *Policy and Practice*, *70*(C), 50-58.
- Pickrell, D. (1992). A Desire Named Streetcar: Fantasy and Fact in Rail Transit Planning. *Journal of the American Planning Association*, *58*(2), 158-176.
- Ragin, C. C. (2008). *Redesigning social inquiry: fuzzy sets and beyond*, University of Chicago Press: Chicago and London, p.71.
- Ragin C.C. (2008a). USER'S GUIDE TO Fuzzy-Set / Qualitative Comparative Analysis, Assisted by: Sarah Ilene Strand and Claude Rubinson, Department of Sociology, University of Arizona http://www.u.arizona.edu/~cragin/fsQCA/download/fsQCAManual.pdf
- Ragin, C., & Fiss, P. F. (2008). Net effects analysis versus configurational analysis: An empirical demonstration. In *Redesigning social inquiry: Fuzzy sets and beyond* (pp. 190–212). Chicago: University of Chicago Press.
- Ragin, C. C., & Strand, S. I. (2008). Using Qualitative Comparative Analysis to Study Causal Order: Comment on Caren and Panofsky (2005). *Sociological Methods & Research*, *36*(4), 431–441. https://doi.org/10.1177/0049124107313903
- Ragin, C.C. (s.d). What is Qualitative Comparative Analysis (QCA)? http://eprints.ncrm.ac.uk/250/1/What_is_QCA.pdf
- Rihoux, B. & Ragin, C. C. (2009). *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques*, SAGE Publications, Inc.
- Roumboutsos, A., Voordijk H., & Pantelias A. (Ed.) (2018). *Funding and Financing Transport Infrastructure: Business Models to Enhance and Enable Financing of Infrastructure in Transport*, Routledge, Taylor and Francis Group, ISBN 978-1-138-29389-2, Abingdon, UK.
- Siemiatycki, M. (2015). Cost Overruns on Infrastructure Projects: Patterns, Causes, and Cures. *IMFG Perspectives*, *11*, Retrieved from http://munkschool.utoronto.ca/imfg/uploads/334/imfg_perspectives_no11_costoverruns_matti_siemiatycki.pdf
- Shibani, A., & Arumugam, K. (2015). Avoiding Cost Overrun in Construction Projects in India. *Management Studies*, *3*(7-8), 192-202.
- Schneider, C. Q., & Wagemann, C. (2010). Standards of Good Practice in Qualitative Comparative Analysis (QCA) and Fuzzy-Sets. *Comparative Sociology*, *9*(3), 397-418, https://doi.org/10.1163/156913210X12493538729793
- Schneider, C. Q., & Wagemann, C. (2012). *Set-Theoretic Methods for the Social Sciences: A Guide to Qualitative Comparative Analysis*. New York: Cambridge University Press.
- Songer, A. D., & Molenaar, K. R. (1997). Project characteristics for successful public-sector design-build. *Journal of Construction Engineering and Management*, *123*(1), 34–40.
- Tabish, S.Z.S., & Jha, K.N. (2011). Identification and Evaluation of Success Factors for Public Construction Projects. *Construction Management & Economics*, *29*(8), https://doi.org/10.1080/01446193.2011.611152
- Vanelslander, T., Sys, C., & Carlan, V. (2015). Innovation among Seaport Operators: A QCA Approach for Determining Success Conditions, Proceedings of the IAME Annual Conference 2015, International Association of Maritime Economists, Kuala Lumpur, 24-26 August 2015, unpublished.
- Verweij, S., & Gerrits, L.M. (2013). Understanding and Researching Complexity with Qualitative Comparative Analysis: disvaluating Transportation Infrastructure Projects. *Evaluation: The International Journal of Theory, Research and Practice*, *19*(1), 40-55, https://ssrn.com/abstract=2551501
- Wachs, M. (1987). Forecasts in urban transportation planning: uses, methods and dilemmas. *Climatic Change*, *11*(1-2), 61-80.
- Zagozdzon, B. (2013). Determinants of Implementation of Public Private Partnership in Poland: the Case of Transport Infrastructure. *Advances in Economics and Business*, *1*(2), 57-71, DOI: 10.13189/aeb.2013.010203

# Annex A

Table A.1: Presentation of the 22 transport infrastructure projects tested in the "completion before crisis" analysis

| Project Title | Principle Mode | Country | Public financing/private co-financing | On / Below / Over Cost |
|---|---|---|---|---|
| 1. Athens International Airport | Airport | Greece | PPP | On |
| 2. A-19 Dishforth | Road | United Kingdom | PPP | On |
| 3. A22 motorway | Road | Portugal | PPP | On |
| 4. A23 motorway | Road | Portugal | PPP | On |
| 5. Athens Ring Road | Road | Greece | PPP | On |
| 6. BNRR (M6 Toll) | Road | United Kingdom | PPP | On |
| 7. C-16 Terrasa Manresa toll motorway | Road | Spain | Concession of operation | Over |
| 8. E4 Helsinki-Lahti | Road | Finland | PPP | On |
| 9. E39 Orkdalsvegen Public Road | Road | Norway | PPP | On |
| 10. Eje Aeropuerto (M-12) Motorway | Road | Spain | PPP | Over |
| 11. M-45 | Road | Spain | PPP | Over |
| 12. Radial 2 Toll Motorway | Road | Spain | PPP | Over |
| 13. FERTAGUS Train | (Urban) Rail | Portugal | PPP | On |
| 14. Metro do Porto | Metro | Portugal | PPP | Below |
| 15. Athens Tramway | Tram/Light Rail | Greece | PPP | On |
| 16. Port of Agaete | Seaport | Spain | Concession of operation | On |
| 17. Port of Leixoes | Seaport | Portugal | PPP | On |
| 18. Port of Sines Terminal XXI | Seaport | Portugal | PPP | On |
| 19. Lusoponte Vasco da Gama Bridge | Bridge/Tunnel | Portugal | PPP | On |
| 20. Rion-Antirion Bridge | Bridge/Tunnel | Greece | PPP | On |
| 21. Herrentunnel Lübeck | Bridge/Tunnel | Germany | PPP | On |
| 22. Lyon's VeloV | Bicycle | France | PPP | Over |

# Annex B

Table B.1: Presentation of the 25 transport infrastructure projects tested in the "completion after crisis" analysis

| Project Title | Principle Mode | Country | Public financing/private co-financing | On / Below / Over Cost |
|---|---|---|---|---|
| 1. Larnaca and Paphos International Airports | Airport | Cyprus | Private co-financing | On |
| 2. Modlin Regional Airport | Airport | Poland | Public financing | Over |
| 3. A5 Maribor Pince motorway | Road | Slovenia | Public financing | Below |
| 4. Belgrade By-pass Project, Section A: Batajnica-Dobanovci | Road | Serbia | Public financing | On |
| 5. E18 Muurla-Lohja | Road | Finland | Private co-financing | On |
| 6. Koper - Izola Expressway | Road | Slovenia | Public financing | Below |
| 7. Moreas Motorway | Road | Greece | Private co-financing | Over |
| 8. Motorway E-75, Section Donji Neradovac - Srpska kuca | Road | Serbia | Public financing | Over |
| 9. Motorway E-75, Section Horgos-Novi Sad (2nd phase) | Road | Serbia | Public financing | Over |
| 10. M-80 (Haggs) | Road | United Kingdom | Private co-financing | On |
| 11. M-25 Orbital | Road | United Kingdom | Private co-financing | On |
| 12. Via-Invest Zaventem | Road | Belgium | Private co-financing | Below |
| 13. Liefkenshoek Rail Link | Rail | Belgium | Private co-financing | On |
| 14. Metro de Malaga | Metro | Spain | Private co-financing | Over |
| 15. Warsaw's Metro II-nd line | Metro/Rail | Poland | Public financing | Over |
| 16. Metrolink LRT, Manchester | Metro/Tram | United Kingdom | Private co-financing | On |
| 17. Brabo 1 | Tram/Light Rail | Belgium | Private co-financing | Over |
| 18. MST-Metro Sul do Tejo | Tram/Light Rail | Portugal | Private co-financing | Over |
| 19. Lyon's tramway T4 | Tram/Light Rail | France | Public financing | On |
| 20. Reims tramway | Tram/Light Rail | France | Private co-financing | Over |
| 21. Barcelona Europe South Terminal | Seaport | Spain | Private co-financing | Over |
| 22. Deurganckdock Lock | Seaport | Belgium | Private co-financing | On |
| 23. Muelle Costa Terminal Barcelona | Seaport | Spain | Private co-financing | On |
| 24. Piraeus Container Terminal | Seaport | Greece | Private co-financing | On |
| 25. Central PT Depot of city of Pilsen | Other (depot) | Czech Republic | Private co-financing | On |

## Annex C

The scores are given based on a) the minimum and maximum values that the conditions can take, which are (0,1) for all of the conditions and b) the variation of each condition across all cases.

As Rihoux & Ragin (2009) underlined, the calibration method should be based on theoretical and substantive knowledge. Ragin (2008) distinguished two methods being direct and indirect calibration.

1) Outcome: Based on substantive knowledge of the BENEFIT working group, we score outcome (cost) into three categories: below budget; on budget and over budget. We use the indirect calibration taking on budget as benchmark (0.8). The outcome below budget is assigned to full membership (1.0) because it should be higher than on budget and the outcome over budget is scored 0.0.

2) Conditions: The score of all conditions, except one (cost saving condition) varies between 0 and 1. We use direct calibration by specifying the qualitative breakpoints of fuzzy sets being full membership, full non-membership and cross over point. This threshold is then formulated in the following way:

(1) We compare the values of the Institutional Context and Financial Economic Context of the 26 BENEFIT countries to stipulate the threshold of full membership, full non-membership and cross over point.

(2) Within BENEFIT working group, we formulated the following specific conditions: governance, remuneration attractiveness and financing scheme, revenue robustness and cost saving. Based on our theoretical and substantive knowledge, the maximum condition value is 1.0 and the minimum condition value is 0.0 for all them apart from the latter, whose maximum value is 1.0 and minimum value -0.333.

Table C.1: Method of Calibration of Outcome and Conditions

| | **SCORING** | **METHOD** | | **CALIBRATION** |
|---|---|---|---|---|
| | | TYPE | Scaling | fsQCA |
| **1. OUTCOME** | | | | |
| • Cost | Below budget, On budget, Over budget | Indirect | Below budget | 1 |
| | | | On budget | 0.8 |
| | | | Over budget | 0 |
| **2. TYPOLOGY INDICATORS/CONDITIONS** | | | | |
| • Institutional Context | The value of the condition varies between 0 to 1 (Review of conditions' | Direct | Threshold for full membership (0.95) | 0.90 |
| | | | Cross over point | 0.65 |

| | | | | |
|---|---|---|---|---|
| | values of 26 countries from 1996 to 2013) | | Threshold for non-full membership (0.05) | 0.40 |
| • Financial-Economic Context | The value of the condition varies between 0 to 1 (Review of conditions' values of 26 countries 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 |
| • Governance | The value of the condition 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 |
| • Remuneration Attractiveness | The value of the condition 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 | The value of the condition 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 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 |

## Annex D

The truth tables below are the ones of the initial models.

Table D.1: Truth table-before crisis sample-on cost-all conditions present

| INI | FEI | GI | RAI | FSI | n | incl | PRI | cases |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 0 | 1 | 5 | 0.791 | 0.699 | A22,A23,FER,LEIX,LUS |
| 1 | 1 | 1 | 0 | 1 | 4 | 0.743 | 0.636 | M6,E4 ,E39 ,HER |
| 0 | 0 | 1 | 0 | 1 | 4 | 0.733 | 0.612 | ATH,ARR,ATTR,RION |
| 1 | 1 | 0 | 0 | 1 | 2 | 0.683 | 0.517 | Eje,R 2,Porto,AGA,SINES |
| 1 | 1 | 1 | 1 | 1 | 2 | 0.652 | 0.385 | A-19,M-45 |
| 1 | 1 | 1 | 0 | 0 | 1 | 0.554 | 0.239 | C-16 ,VELO |

Table D.2: Truth table-before crisis sample-over cost-all conditions absent

| INI | FEI | GI | RAI | FSI | n | incl | PRI | cases |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 0 | 0 | 1 | 0.860 | 0.761 | C-16, VELO |
| 1 | 1 | 1 | 1 | 1 | 2 | 0.782 | 0.615 | A-19,M-45 |
| 1 | 1 | 0 | 0 | 1 | 2 | 0.661 | 0.483 | Eje,R 2,Porto,AGA,SINES |
| 0 | 0 | 1 | 0 | 1 | 4 | 0.579 | 0.388 | ATH,ARR,ATTR,RION |
| 1 | 1 | 1 | 0 | 1 | 4 | 0.551 | 0.364 | M6,E4 ,E39 ,HER |
| 1 | 0 | 1 | 0 | 1 | 5 | 0.514 | 0.301 | A22,A23,FER,LEIX,LUS |

Table D.3: Truth table-after crisis-on cost-all conditions present

| INI | FEI | GI | RAI | FSI | n | incl | PRI | cases |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 0 | 1 | 2 | 0.862 | 0.733 | LAR,MST |
| 1 | 1 | 1 | 1 | 1 | 6 | 0.833 | 0.757 | A5,E18,M-80,LYONS, REIMS,DEPOT PILSEN |
| 1 | 1 | 0 | 0 | 1 | 1 | 0.819 | 0.540 | MOD |
| 0 | 0 | 1 | 0 | 0 | 1 | 0.746 | 0.480 | PIRAEUS |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 1 | 1 | 1 | 1 | 0.741 | 0.500 | WARSW |
| 1 | 0 | 0 | 0 | 0 | 2 | 0.716 | 0.443 | BARCEL,MUELLE |
| 1 | 0 | 1 | 0 | 1 | 1 | 0.694 | 0.442 | MALAGA,METROL |
| 0 | 0 | 1 | 0 | 1 | 1 | 0.633 | 0.283 | MOREAS |
| 0 | 0 | 0 | 1 | 1 | 3 | 0.589 | 0.369 | BEL,E75a,E75b |

Table D.4: Truth table-after crisis-over cost-all conditions absent

| INI | FEI | GI | RAI | FSI | n | incl | PRI | cases |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 1 | 1 | 0.855 | 0.717 | MOREAS |
| 1 | 1 | 0 | 0 | 1 | 1 | 0.788 | 0.460 | MOD |
| 1 | 0 | 0 | 0 | 0 | 2 | 0.775 | 0.557 | BARCEL,MUELLE |
| 0 | 0 | 1 | 0 | 0 | 1 | 0.766 | 0.520 | PIRAEUS |
| 0 | 0 | 0 | 1 | 1 | 3 | 0.760 | 0.631 | BEL,E75a,E75b |
| 1 | 0 | 1 | 0 | 1 | 1 | 0.757 | 0.558 | MALAGA,METROL |
| 0 | 1 | 1 | 1 | 1 | 1 | 0.741 | 0.500 | WARSW |
| 1 | 1 | 1 | 0 | 1 | 2 | 0.620 | 0.267 | LAR,MST |
| 1 | 1 | 1 | 1 | 1 | 6 | 0.480 | 0.243 | A5,E18,M-80,LYONS, REIMS,DEPOT PILSEN |

# Annex E

Table E.1: An overview of the solutions of both the initial and additional models

| **Sample** | **Before crisis-ON COST** | | | **After crisis-ON COST** | | | |
|---|---|---|---|---|---|---|---|
| **Model** | **Initial solution** | **Solutions of the additional models** | | **Initial solution** | **Solutions of the additional models** | | |
| | | **1a** | **1b** | | **3a** | **3b** | **3c** |
| **Conditions** | **+INI**<br>**~FEI**<br>+GI<br>+FSI | **~FEI**<br>+GI<br>+FSI<br>**+CSI** | Same with the initial solution | **+INI**<br>**+FEI**<br>+FSI | Same with the initial solution | Same with the initial solution | Same with the initial solution |
| **Consistency** | 0.78 | 0.83 | | 0.85 | | | |
| **Coverage (raw)** | 0.49 | 0.53 | | 0.56 | | | |

| | | | |
|---|---|---|---|
| **Coverage (unique)** | 0.49 | 0.53 | 0.56 |
| **Number of relevant cases** | 5 | 7 | 9 |
| **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) | Lusoponte Vasco da Gama Bridge (0.78,0.8), Port of Leixoes (0.73,0.8), A22 motorway (0.7,0.8), A23 motorway (0.69,0.8), Athens International Airport (0.62,0.8), FERTAGUS Train (0.56,1), Rion-Antirion Bridge (0.55,0.8) | 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) |

| **Sample** | **Before crisis-OVER COST** | | | | **After crisis-OVER COST** | | | |
|---|---|---|---|---|---|---|---|---|
| **Model** | **Initial solution** | **Solutions of the additional models** | | | **Initial solution** | **Solutions of the additional models** | | |
| | | **2a** | **2b** | **2c** | | **4a1** | **4a2** | **4b** |
| **Conditions** | ~RAI<br>**~FSI** | ~RAI<br>**~FSI**<br>~CSI | Same with the initial solution | Same with the 2a solution | **~INI**<br>~FEI<br>**~RAI**<br>**+FSI** | ~INI<br>**~FEI**<br>**~RAI**<br>**+FSI** | **~FEI**<br>**~RAI**<br>**+FSI**<br>~CSI | Same with the initial solution |
| **Consistency** | 0.87 | 0.86 | | | 0.85 | 0.85 | 0.81 | |
| **Coverage (raw)** | 0.45 | 0.44 | | | 0.41 | 0.41 | 0.38 | |
| **Coverage (unique)** | 0.45 | 0.44 | | | 0.41 | | | |
| **Number of relevant cases** | 1 | 1 | | | 1 | 1 | 1 | |
| **Relevant cases** | C-16 Terrasa Manresa toll motorway (0.75,1) | C-16 Terrasa Manresa toll motorway (0.73,1) | | | Moreas Motorway (0.66, 1) | Moreas Motorway (0.66,1) | Metro de Malaga (0.75,1) | |

Note: + means that condition is present; ~ means that condition is absent; bold means that it is a core condition, while non-bold refers to peripheral conditions.