Universidade Europeia
LAUREATE INTERNATIONAL UNIVERSITIES

PhD in Management

Thesis

Cost and time overruns in public investment projects:
An exogenous determinants model, theory and practice

Francisco Miguel Pinheiro Catalão

Thesis specially prepared in order to obtain a doctorate degree.
The opinions expressed strictly represent those of the author.

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Doctoral Supervisor: Professor Doutor Joaquim Miranda Sarmento

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List of Acronyms

AMECO - Annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs

AIC - Akaike information criterion

ANOVA – Analysis of Variance

BIM – Building Information Modelling

BLUE – Best Linear Unbiased Estimators

DG ECFIN - European Commission's Directorate General for Economic and Financial Affairs

EC – European Commission

ECB – European Central Bank

EU – European Union

EUR – Euros

G20 – Group of Twenty

GDP – Gross Domestic Product

GLM - Generalized Linear Model regression

IMF – International Monetary Fund

IPD - Integrated Project Delivery

IVprobit - instrumental variable Probit regression

IVOLS - instrumental variable Ordinary Least Squares regression

KPI – Key performance indicator

NIE – Neo-Institutional Economics

NOK – Norwegian Krone

OLS - Ordinary Least Squares regression

PAT – Principal-Agent Theory

PPP – Public-Private Partnership

SEM – Structural Equation Modeling

US$ - United Stated dollars

VIF - Variance Inflation Factor

WGI - World Bank´s Worldwide Governance Indicators

Abstract

The original contribution to knowledge of this research is overtaking the absence of an exogenous variables model in the analysis of cost and time deviations in public projects in the existing literature. This is achieved through the construction of a model that includes exogenous (political, governance, and economic) and endogenous (project-related) determinants. This model aims to help public decision makers develop public policies that seek to minimise cost and time overruns in public infrastructure projects. Cost and time overruns are often perceived to be a sign of project failure, and several past studies have identified potential causes and explanatory factors for the occurrence of such deviations. Governments devote significant resources to public projects, which thus makes cost and time overruns a critical issue for public management.

The research presents a theoretical underpinning based on Opportunistic Behaviour, Institutional, Economic Cycles, and Incomplete contracts theories and provides an empirical analysis of 4,305 public projects developed in Portugal between 1980 and 2014. We used as dependent variables the cost/time deviation (the percentual difference between the final and initial cost/time) and the cost/time overruns (assuming one if the cost/time deviation is positive and zero if the cost/time deviation is zero or negative).

The analysis suggests that these exogenous determinants have been under-valued in the existing literature and that they do, indeed, play a relevant role in understanding cost and time deviations.

Keywords: public projects, transport projects, local government, cost deviations, cost overruns, time deviations, time overruns, endogenous models, exogenous variables

JEL: H54 – Infrastructures, Other Public Investment and Capital Stock

Resumo

A contribuição original desta pesquisa para o conhecimento é a de mitigar o problema da ausência, na literatura atual, de um modelo de variáveis exógenas de análise de desvios financeiros e temporais em projectos públicos. Isto é conseguido através da construção de um modelo que incorpora determinantes exógenas (fatores políticos, legais, regulatórios e económicos) e endógenas (relacionadas com os projectos). Este modelo pretende ajudar os decisores públicos a desenvolver políticas que minimizem derrapagens financeiras e temporais em obras públicas. Frequentemente, as derrapagens financeiras e temporais são entendidas como um indício da existência de falhas nos projetos e vários estudos anteriores identificaram causas potenciais e fatores explicativos para a ocorrência de tais desvios. Atendendo aos os recursos significativos que os governos dedicam a projetos públicos, as derrapagens financeiras e temporais são uma questão crítica para a gestão pública.

Esta investigação apresenta um enquadramento teórico baseado nas teorias do Comportamento Oportunista, Institucional, dos Ciclos Económicos e dos Contratos Incompletos e fornece uma análise empírica de 4.305 projectos públicos realizados em Portugal entre 1980 e 2014. São utilizadas como variáveis dependentes a percentagem de desvio financeiro/temporal (a variação percentual entre o custo/tempo final e o custo/tempo inicial) e a derrapagem financeira/temporal (assume o valor de um se o devio financeiro/temporal é positivo e de zero se o desvio financeiro/temporal for zero ou negativo).

A análise efetuada sugere que as variáveis exógenas, que têm sido subvalorizadas na literatura existente, desempenham um papel relevante na explicação dos desvios financeiros e temporais.

Palavras-chave: obras públicas, projetos de transporte, governo local, desvios financeiros, derrapagens financeiras, desvios temporais, derrapagens temporais, modelos de endogeneidade, variáveis exógenas

JEL: H54 - Infraestruturas, outros investimentos públicos e stock de capital.

1. Introduction & Theme Relevance

1.1. Introduction

In this thesis, we aim to analyse the main determinants of cost and time deviations and overruns in public infrastructures projects. We built a methodology, based on existing approaches, that provides a more ambitious (and innovate) approach towards the incorporation of exogenous determinants, examples being political, legal and regulatory, and economic determinants. The analysis suggests that these exogenous variables have been undervalued in the existing literature, and that they do, indeed, play a relevant role in understanding cost deviations. The research also aims to test whether endogenous models can help understand whether the context and environment of the project being developed have an impact.

According to the G20 initiative of the Global Infrastructure Outlook (Oxford Economics, 2018), it is forecasted that the worldwide need for infrastructure investment reach US$94 trillion by 2040. An additional US$3.5 trillion will be needed if countries want to reach the United Nations' Sustainable Development Goals for electricity and water. Asia accounts for the larger share of investment needs, representing slightly more than 50% of global investment needs, while Europe accounts for US$15 trillion of investment needs, which is a short distance from the US$20 trillion needs in the Americas. Furthermore, (Woetzel, Garemo, Mischke, Hjerpe, & Palter, 2016) state that governments all around the world need to invest annually, an average of US$3.3 trillion, which is considerably greater than today's US$2,5 trillion annual investment. These additional investments are only enough to support the currently-expected growth rates. Therefore, the challenge is for countries to evolve to a model where projects overruns are scarce, or preferably inexistent, as this will maximise the efficiency of public resources. The debt constraint problems make current public choices more important for minimising errors and for maximising public choices efficiency (Buiter, 1985; Persson & Tabellini, 2012).

Due to countries' fiscally-unbalanced public accounts, which increased since the 2008 financial crisis, investment in public infrastructures has diminished. Countries have been expanding their budgets to accommodate higher welfare and social contributions and have had less fiscal space for new infrastructure investments (Casal & Gómez, 2018). Simultaneously, governments need to enhance economic growth with additional public investments, especially in infrastructures, which is an important variable for promoting growth (Agénor, 2010; Spackman, 2001). Public investments was defined by Bowen (1948) as being investments that are used simultaneous by several (or all) individual investments, whereby the total benefit of the investment is the sum of all these individual benefits, and therefore the supply of public goods will result in an increase of social utility, as was added later by (Samuelson, 1954). This has raised concerns about the efficiency of the use of public resources (Bovaird, 2014; Quirk, 2005). In the case of infrastructures projects, the main concern is with regards to cost and time deviations and overruns (Flyvbjerg, Skamris Holm, & Buhl, 2002, 2004; Guccio, Pignataro, & Rizzo, 2014; McQuaid, 1993).

Therefore, why do public infrastructure projects in general present final costs and completion times that are different (and usually higher) from those forecasted, particularly in the case of the transport field or those developed by central/local governments? In such public projects, what determines the existence of cost and time deviations (when final cost and completion time is different than those forecasted, which can either be a positive or negative deviation) and cost and time overruns (whereby final costs and completion times deviations are positives, i.e., deviations are higher than the forecasted costs and completion time)? Overruns represent a failure in planning and an inefficient use of public resources (Gori, Lattarulo, & Mariani, 2017).

Are these deviations solely the effect of endogenous reasons which are related to the project characteristics, or are they also the result of exogenous motives related to political, governance and economic factors? The literature on public projects cost and time deviations is mainly focused on endogenous motives. Based on this, our research aims to identify the main exogenous determinants of cost and time deviations and overruns in public projects. Additionally, our research also aims to test whether endogenous models can help understand whether the context and environment of the project being developed have an impact.

It is fundamental that public policy makers (both current and future) make more effective investment decisions. Accordingly, it is necessary to improve the selection of projects in order to develop and maximise the deliverability of projects and create mechanisms to combat the under-utilisation of existing infrastructures and their means (Pickrell, 1992). Furthermore, public investments are important because there are certain categories of infrastructures, whose promotion and availability to society, either by social and political reasons lie within the public sphere and through public funds (Savas, 2000).

It should be noted that market failure is one of the first fundaments for governments to intervene in an economy, as this justifies public intervention for reason of economic efficiency (Wood, 2010). From an economic perspective, a public intervention, such as the building and operation of infrastructures is justified by the need to correct market failures. Infrastructures with specific characteristics, such as exceptionally long length, high funding requirements, and a complex evaluation of their cost-benefit and profitability all lead to a demand that such infrastructures are financed, most of the time, by public entities and public funds (Grimsey & Lewis, 2002). Accordingly, market failures occur when there is an inefficient allocation of goods and services by the market forces (Bator, 1958). Another reason to justify public intervention is the correction of resource allocation, which can only be fully-achieved if project overruns are inexistent. Infrastructures are also important as they generate positive externalities. As they are long-term investments and without financial revenues, infrastructures are not able to generate interest in the private for-profit sector (Grimsey & Lewis, 2007; Martin, 1999) and consequently these infrastructures are perceived as being public goods.

Public goods are known for having two characteristics, namely non-rivalry and non-excludability. This distinction comes from the reason that no one individual cannot be be excluded from its use and that the use by one individual does not reduce the access to other individuals (Musgrave & Musgrave, 1989). Non-rivalry means that when an infrastructure is used, it does not reduce the amount available for others (e.g. benefitting from a road use or public transportation). Non-excludability occurs when it is possible to provide a good without making it impossible for others to enjoy it (Glomm & Ravikumar, 1994).

In the literature there are several examples of the benefits (and also of the limits) of public investments, namely: (i) helping drive economic growth, however to be successful in the long term, these investments need to meet the needs of the population, rather than be the result of the influence of political cycles (Munnell, 1992); (ii) an increase in labour productivity, which leads to an increase in tax revenues without the need to raise tax rates (Barro, 1990; Kneller, Bleaney, & Gemmell, 1999; Wilkinson, 2006), and; (iii) bringing positive externalities to the populations where the projects are implemented in particular, and to the economy in general (Grimsey & Lewis, 2007). Additionally, Estache & Fay (2008) surveyed the literature and confirmed the importance of the construction of infrastructures for economic growth, although they observed that such effects produce different results from country to country and over time. Better public investment brings indirect benefits that are often overlooked in simple cost-benefit analyses. The Global Infrastructure Outlook (Oxford Economics, 2018) supports the view that countries focus on the role of infrastructures to improve economic growth and community well-being.

Nevertheless, the positive aspects of public investments can be endangered by the precipitated action of public decision makers who are driven by calendars (normally political ones) (Gordon & Huber, 2009). Decisions are often made on a political whim, rather than on an economic or financial basis (Gruening, 2001; Perry & Wise, 1990). Later, already well into the construction phase, projects have to tackle such problems. This is frequently manifested by amendments and changes to the initial project, technical challenges and environmental impact factors that lead to financial shifts and time-consuming delays, as well as the over-budgeting of the conclusion of public contracts. Indeed, other problems may arise, such as misinformation problems and the lack of cost-benefit analysis, which endangers project viability and tends to result in higher-than-expected costs (Cantarelli, Flyvbjerg, van Wee, & Molin, 2008).

Consequently, public investment overruns are a management problem in terms of the collective decision-making process of whether to invest, or not, in a specific infrastructure. Overruns are also a management problem when appraised through the lens of the financial management process and policy rules that may be implemented to control and avoid the occurrence of cost and time overruns (Reilly & Brown, 2004). The magnitude of the problem is enormous, involving millions of Euros of taxpayers' money which is not being properly used and which is being diverted from funding other public needs. Furthermore, more relevant is the confirmed idea that public decision-makers do not necessarily own all the necessary information required to take the best management decisions when deciding on public investment in an infrastructure (Easterly, Irwin, & Servén, 2008).

In addition to cases of the abuse of public spending, one of the main problems is project delivery, which involves several areas, ranging from design, technical specifications, evaluation of risks and environmental danger through to socioeconomic impacts, among others (Tryggestad, Georg, & Hernes, 2010). Even so, projects overruns are a challenging concern to public decision-makers, due to the negative effects that they can have on the amount of taxes being charged to unhappy taxpaying citizens, and they can be a destabilising problem for an incumbent political party running for re-election (Gordon & Huber, 2009; Love, Smith, Simpson, Regan, & Olatunji, 2015).

To present successful results, governments need to provide certainty on public investment budgets beyond annual budgeting or electoral cycles (Drazen & Eslava, 2010). However, the effective delivery of these public investments is greatly affected by the way public contracts are awarded and managed (Domberger & Jensen, 1997). In general, problems are related to the execution of public contracts that are awarded to private for-profit companies. Such private companies have different goals and mindsets than public procurers (Brown, Potoski, & Van Slyke, 2006). Public investments are generally supported by complex contracts and this complexity in public procurement significantly affects the capability of delivering the expected benefits in a costly and timely manner (Bajari & Tadelis, 2001). Renegotiation of contracts is normally the method used to overcome such issues, albeit with an extra cost and longer execution times than initially forecasted (Bajari, Houghton, & Tadelis, 2006).

In this research, we will first focus our attention on cost deviations and overruns in a general study that analyses information regarding public projects from all sectors and all levels of government. This will be analysed in Subsection 5.1. Furthermore, to continue investigating cost deviations and overruns we will additionally focus on two relevant subsets of public projects: public transport infrastructures and local government infrastructures. We have chosen to focus in these two specific projects type for the following reasons: i) the transport sector is the most studied sector in the literature, which allows us to draw conclusions and to compare our results and conclusions with the existing literature. It is also a very relevant sector in public investment in Portugal. This will be analysed in subsection 5.2, and; ii) local government projects, which have been chosen based on the fact that local governments are responsible for the provision of a substantial part of public services and infrastructures, ranging from roads through to schools and other social and economic facilities. We also aim to analyse whether the potential negative consequences of a lower level of sophistication of local governments (smaller budgets, smaller staff, and lower expertise) are less than the benefits of having overall project management on a smaller scale. We go on to analyse this central versus local public investments dichotomy in Subsection 5.3.

Next, we shift our attention to the time deviations and overrun problem, in the form of a general study which analyses information regarding public projects from all sectors and level of government. Due to the lack of information available for projects' execution time, we concluded that it was not possible to also analyse time deviations and overruns from any subsample. Time deviations and overruns will be analysed in Section 6. Finally, and again based only on a general study due to the same limitation, we conclude by studying the effect of time deviations and overruns on cost deviations and overruns. This will be analysed in Section 7.

1.2. Literature Review synthesis

1.2.1. Overview

Once a project is completed, three different situations with respect to its final cost and time to be delivered can manifest themselves. The project can experience a cost/time deviation which can be a positive deviation (i.e., the project cost is higher than and/or the project took longer to complete than initially scheduled), have no deviation (i.e., the project was completed in the forecasted cost and time), or be a negative deviation (i.e., the cost is less than initially forecasted and/or the project was completed ahead of schedule). The academic literature focuses on positive deviations, represented by cost overruns or cost escalation when referring to a project's financial impact (Cantarelli, Flyvbjerg, & Buhl, 2012; Flyvbjerg et al., 2004; Morris, 1990), or time overruns or time delays when referring to a positive deviation from a project's plan (Bhargava, Anastasopoulos, Labi, Sinha, & Mannering, 2010; D'Alpaos, Moretto, Valbonesi, & Vergalli, 2013; Dosi & Moretto, 2015). This research focuses on the three above-described types of cost and time deviations.

Academic research is largely motivated to analyse the causes for overruns to exist. Nevertheless, it is not only academics who are interested in this phenomenon. (Siemiatycki, 2009) shows that independent and governmental auditors are also among the most interested, although they have different mandates, goals, and access to the most recent data. Furthermore, despite the consistency in the finding by academic researchers and public auditors that projects regularly experience costs and time overruns, they diverge when it comes to providing explanations. Auditors tend to focus on technical and managerial explanations (Siemiatycki, 2009), while researchers, who are mainly focused on political, economic and psychological explanations, tend to prioritize much of the academic literature (Cantarelli, Flyvbjerg, Molin, & van Wee, 2010; Flyvbjerg, 2005). The high level of public resources allocated to infrastructure expenditures, along with concerns regarding the efficiency and value of these projects, has created an increasing concern with regards to project deviations (D'Alpaos et al., 2013).

Furthermore, there is still limited academic research in this field, when compared with the relevance of the problem, the main reason being the lack of available data (Macdonald, 2002; Williams, Klakegg, Magnussen, & Glasspool, 2010). Most of these studies focus on no more than one or two sectors separately, which, per norm, are in one geographical location and are based on a lower number of cases, as noted by Siemiatycki(2009). Sun & Meng (2009) added that most of the studies published are single-country studies and are based on project documentation and database records. These authors also compared the perspectives of academics and auditors regarding transportation projects cost overruns and reviews studies from 1973 to 2008, finding that only 11 academic studies provided a quantitative analysis of cost overruns.

Additionally, most studies only analyse one individual case (or a small number of cases), which raises questions about the generalisability of their conclusions (Sarmento & Renneboog, 2016b). For example, Verweij, van Meerkerk, & Korthagen, (2015, p. 15) state in their conclusions and limitations remarks that "*First, there is the relative small sample size, which partly explains the relatively low number of significant relationships and the rather descriptive nature of the study. It is hard to get big datasets in this field of research, and we encourage future research to make the effort*".

It is rare to find literature that includes some degree of statistical analysis and which focuses on two issues, i,e., the level of deviations and the main internal determinants of the deviations (cost overruns or time delays). As mentioned in Cantarelli, Chorus, & Cunningham (2013, p. 4) "*Little work has been done to explain misleading forecasts from a political-economic view. To the authors' knowledge, an explicit application of a theory that illustrates the behaviour of parties leading to cost underestimation has not yet been conducted".* For instance, De Jong, Annema, & Van Wee (2013) found only 28 studies that are focused on cost and time deviation. The main study in this area is that of Flyvbjerg et al. (2002), which covers 254 projects with financial data on roads, railways, and bridges in the US, Europe, and Japan, for the period between 1910 and 1998.

The main findings of the literature on overall public projects is that cost overruns are very frequent. The studies show that most projects (80%-90%) tend to have cost overruns (Flyvbjerg et al., 2002, 2004). The level of cost deviation is less consensual. Some studies have found low levels (less than 10%) of cost deviations (Cantarelli, van Wee, Molin, & Flyvbjerg, 2012b; Creedy, Skitmore, & Wong, 2010; Magnussen & Olsson, 2006; Odeck, 2004), whereas others have found evidence of cost deviations above 30% (Flyvbjerg et al., 2002; Morris, 1990; Sarmento & Renneboog, 2016b). Cost deviations over 100% are uncommon (Ansar, Flyvbjerg, Budzier, & Lunn, 2014) and are usually related to specific and non-recurrent events and mega-projects, such as the case of the Olympic Games (Flyvbjerg & Stewart, 2012).

The previous studies are mainly focused on the endogenous motives for cost deviations at the project level. The main findings identify the following main motives for cost overruns in public projects: imprecise project concept design planning; risk management and implementation, and; poorly-organised bidding processes (Lee, 2008). There is also a certain degree of consensus that public projects forecasts tend to have some over-optimism ("optimist bias") (Siemiatycki, 2009), particularly because there seems to be no evidence that greater experience in managing public projects (the passage of time yields better experience) produces fewer cost deviations (Aibinu & Pasco, 2008).

Despite the research of Flyvberg having been used as a basis for the literature in this field, recent criticism has emerged with Love & Ahiaga-Dagbui (2018) arguing that the psychological effect behind optimism bias is overstated in the past literature (nevertheless the debate created by Love & Ahiaga-Dagbui(2018) was contradicted by Flyvbjerg et al. (2018). In the next subsections, we will focus on the already-identified two relevant subsets of public projects: public transport infrastructures and local government infrastructures.

1.2.2. Transport sector

Despite the increasing relevance of private sector participation in transport infrastructure (Sarmento & Renneboog, 2016a), most projects are still developed and operated by the public sector. In the specific case of road infrastructures, while highways have been more susceptible to the use of concession models (Cruz & Marques, 2012; Cruz & Sarmento, 2017c), secondary road systems are still predominately developed and operated by public entities, similar to many railway systems. The case of ports and airports is different, whereby the involvement of the private sector has been increasing more rapidly, mostly due to privatisation processes (Cruz & Sarmento, 2017a; Zhang, Geerlings, El Makhloufi, & Chen, 2018).

Besides the general reasons for public sector intervention in infrastructure projects, there are also specific reasons for public sector intervention in the construction and operation of projects in the transport sector (Bertoméu-Sánchez & Estache, 2017). Such reasons include the fact that investment in the transport infrastructure often comprises a significant level of risk and long-term exposure (Goldmann, 2017), although there are also historical reasons, one being that the public sector has always had a pivotal role in the development of public infrastructures. Furthermore, most transport projects, despite not being financially profitable on a stand-alone basis, are justified by social and political reasons, and they therefore require some type of direct or indirect government subsidy. This is mainly for reasons of positive externalities, such as the reduction of time travel, accidents, and environmental benefits (Debande, 2002; Laird, Nellthorp, & Mackie, 2005; Levkovich, Rouwendal, & van Marwijk, 2016).

However, the demand for transport infrastructures is growing, and this is now one of the sectors with larger developments. At the same time, public resources available for investment have diminished, as fiscal constraints are forcing governments to reduce public investment and to be more concerned about the efficiency of the use of public funds. (Cruz & Sarmento, 2017b; Sarmento, Renneboog, & Verga-Matos, 2017). In the face of this, concerns about public investment in transport projects have increased, examples being that there are doubts about the economic and social benefit of new infrastructures (Proost et al., 2014), together with the inaccuracy of traffic forecasts (Bain, 2009).

The literature on cost deviations in the transport sector has come to two main conclusions: first, despite the large variance of cost deviations, cost deviations in the transport sector tend to be around 20%-30%, with almost all projects tending to have cost overruns, and; second, with regards to the cost deviation determinants, the literature has focused mainly on project endogenous motives (such as scale, ownership, or concept and planning), and less on the exogenous reasons. Political context tends to create the incentive for public decision makers to underestimate costs in order to ensure that a project is approved (Flyvbjerg, 2007a). Later on this leads to additional funding when cost deviations occur.

1.2.3. Local government

In most countries, local governments are responsible for the provision of a substantial part of the public services and infrastructures, ranging from roads through to schools and other social and economic facilities (Bovaird, 2014). Two main trends are evidenced regarding local infrastructure management. On the one hand, there is a strong tendency for an increased participation by the private sector in the delivery of public services at the local level (Bel & Fageda, 2007, 2010; Carrozza, 2010; Citroni, Lippi, & Profeti, 2013), and, on the other hand, there is an increasing degree of decentralisation in the management of these services (Burns, Hambleton, & Hoggett, 2001; Peckham, Exworthy, Powell, & Greener, 2008), particularly in the infrastructure sector (Bel & Fageda, 2013).

The literature on cost deviations in public projects is still limited, particularly regarding research at the local government level. In fact, most studies focused on public projects of central governments, not just because they are usually larger, but also because there is more data available for these types of projects. However, some studies have compared the cost deviations of the central government with those at the local government level. The literature concludes that local governments tend to perform better than central governments in controlling project costs (NAO, 2007b; Sarmento & Renneboog, 2016b). In other words, cost deviations tend to be smaller in local government projects. With regards to cost deviation determinants, the literature has again mainly focused on project endogenous motives (such as scale, ownership, or concept and planning) (Flyvbjerg et al., 2002, 2004), and less on the exogenous reasons, such as political, legal, governance, or economic determinants.

But what is it that drives this (albeit weak) evidence that local governments are more efficient? What are the motives for local governments to ensure lower levels of cost deviation in infrastructure projects? Furthermore, with regards to local government projects, what determinants can be found to have an impact on increasing, or decreasing cost deviations and overruns? Local government is characterised by low levels of governance when compared with the central government (Andrew & Goldsmith, 1998; Bardhan & Mookherjee, 2000). Nevertheless, the potential negative consequences of a lower level of sophistication of local governments (smaller budgets, smaller staff, and lower expertise) are surpassed by the benefits of having overall project management on a smaller scale.

1.3. Research Methodology

We collected information from 4,323 public projects, of which 4,305 are public projects (the cost deviations complete sample) which contained financial information that allowed us to calculate the project cost deviation as a percentage of the initial cost, in order for projects to be comparable. The initial budget cost of all those 4,305 projects amount to 9 billion Euros. Such projects have registered 967 million Euros in deviations, which accounts for a weighted average of 10.7% deviation from the initial forecasted costs. Average cost deviation is 225,000 Euros. If we just consider the overruns in these observations (1,829 observations), then we achieve a weighted average of 18.7% deviation from the initial forecasted costs. Cost deviations now amount to 1.093 billion Euros from a total initial budget of 5.840 billion Euros.

From the 4,323 public projects analysed, we also collected information from 250 public projects (the time deviations complete sample) where we were able to observe completion time information for such projects. Those 250 public projects (the time deviations complete sample) amounted to 87,663 days of forecasted initial time to achieve projects completion, whereas they took an additional 85,757 days to be completed, which accounts for a weighted average of 97.8% deviation from the initial forecasted time. Average time deviation is 343 additional days to complete the analysed public projects. Furthermore, if in those observations, we only consider the time overruns (207 observations), then we reach a weighted average 109.8% deviation from the initial forecasted time and an average time deviation of 128.6%. The average time deviation now reaches an amount of 415 days.

These two samples also provide 232 observations which contain both time and cost deviations information. These public projects amounted for 2.100 billion Euros of initial budget cost and have registered 690 million Euros of deviations, which accounts for a weighted average of 32% deviation from the initial forecasted costs. The same projects accounted for 84,782 days of forecasted initial time to achieve project completion and they took an additional 80,355 days to be completed, which accounts for a weighted average of 94.8% deviation from the initial forecasted time, with a 100.3% average time deviation. Average cost and time deviations are 3 million Euros and 346 days, respectively. Both weighted average cost deviation and average cost are much higher than when analysed without the time information, which makes this dual-focused analysis relevant for the understanding of the occurrence of such overruns and the identification of the management decisions needed to help diminish such impacts, both for the decision-making process and the development of relevant public policy decisions and their evaluation.

Finally, if for these observations we only consider the cost overruns, we then achieve a weighted average 35,5% deviation from the initial forecasted costs and a weighted average 96.2% deviation from the initial forecasted time. This makes the average cost deviation attain an amount of 3.5 million Euros out of a total initial budget cost of 2 billion Euros. The average time deviation is 383 days. Once again, these figures, help to corroborate the magnitude and relevance of our research problem.

1.4. Research questions, hypotheses, and their objectives

Our research covers the aspects of management related to public organisations and the functional areas of business, such as the financial management (finance) and political and governance impacts in the public sector. It thus promotes the understanding of management decisions at a public level and provides especially strong implications for management practice. Through a field context, we target, with a joint theoretical and empirical contribution, a research scope focused on the management issues of public sector institutions. These management issues are then analysed both for different administrative levels of power (central, local and regional) and sector (education, transport, economic and social). The aim was to detect how they interact with a multitude of exogenous occurrences.

The developed model aims to adopt a multidisciplinary approach which will have an empirical and theoretical impact that may be used for several purposes. The theoretical relevance of our research can be divided into two major achievements: management theory and management practice, which we were able to put together. In first place, this research extends management theory by using a new approach to a well-known problem which analyses cost and time deviations and overruns in public projects. This research has a direct impact on several areas of management theory, namely, public management decision process, project management of public investments, contracts management, and stakeholder relationship management. The relevance of management practice arises from the opportunity we had to collect a unique and an unusual size sample of public projects observations. Our database and our conclusions are therefore worthy of study, as they could serve as an orientation for future policy implementation in other countries that are developing, or plan to develop, public infrastructures. Additionally, the number of observations collected is sufficiently large to enable the testing for theories that otherwise could not be tested.

To achieve this, we based our research on a cross-functional and multidisciplinary approach which is based on foundational theories, such as economics and management. The purpose was to create a framework model which would allow us to build a network map of variables that have a higher/lower statistical probability to impact on the final result of a public investment. As stated above, from a normative perspective, overruns are not a desirable outcome for the investments undertaken in the public sphere. Taking a positivist approach, our research aimed to study the impacts of economic, political, and institutional events on the collective public decision-making process. Two primary objectives were targeted: (i) to understand which exogenous variables are the causes of the percentage deviations (cause-and-effect relationships), and; (ii) to determine the nature of the relationship between the causal variables and the effect to be predicted.

When analysing our data, we aim to answer the following research questions regarding cost and time deviations and overruns:

1) What are the main exogenous and endogenous determinants of cost deviations?
2) What exogenous and endogenous determinants impact on the likelihood of a cost overrun?

Furthermore, when specifically, analysing public transport projects and local government projects, we aim to answer two additional questions to fill a literature gap:

3) Do transport projects have lower cost deviations than other sectors projects?
4) Do local government projects have lower cost deviations and overruns than central government projects?

Regarding time deviations and overruns, we consider the following research questions (Research Questions 5 and 6 are similar to those formulated for cost deviations and overruns, although the goal is to analyse time as a dependent variable).

5) What are the main exogenous and endogenous determinants of time deviations?
6) What exogenous and endogenous determinants impact on the likelihood of a time overrun?
7) Does the occurrence of time deviations and overruns in public projects affect cost deviations and overruns?

Lastly, we aim to answer an eighth research question,

8) What policy implications can be drawn?

To answer these questions, we first developed an exogenous theory-based approach through the construction of a theoretical framework that starts with, but then goes beyond the existing literature. To start with, we understood through the literature review which management theories and explanations could be used to support the exogenous independent variables being tested. To do this, we first identified the exogenous explanatory causes in public projects and then established a new empirically-tested explanatory model of exogenous determinants for cost and time deviations and overruns. Some project specific characteristics were controlled for during this exercise. Through this procedure we demonstrated a cause-and-effect relationship between the exogenous variables and the occurrence of cost and time deviations and overruns in infrastructure public projects. Additionally, we also determined the nature of the relationship between the causal variables and the effect to be predicted.

Furthermore, our analysis allows for the separating of endogenous causes which are largely explored in the academic literature, from those exogenous determinants brought to light from our original approach. This shift to exogenous explanations is one of our major contributions to theory. This model will provide a comprehensive understanding on how a set of exogenous variables which are framed in the theoretical explanations for endogenous causes that emerge from the literature review and later extrapolated to this exogenous approach impacts on public projects deviations and overruns behaviour and management practices. The effect of the expected behaviour on public project cost and time outputs from those exogenous variables is a contribution to an increase of such deviations, i.e., larger overruns.

This research also offers a contribution by carrying out an analysis of solid secondary data collected from the Portuguese Court of Auditors. The collected 4,323 observations public projects investments constructed database allowed us to identify and characterise exogenous explanations for the frequency of such overruns with a high level of generalisation. The constructed database covers both cost and time deviations, which is not always the case in literature. This has allowed us to address both cost and time overruns problems. In addition to this data, we have applied a quantitative research approach in order to determine the relationship between the explanatory variables and the cost and time deviations. For this purpose, the research questions and hypotheses were formulated to determine the nature of the relationship between causal variables and the effect to be predicted, which makes this study, in terms of purpose, an explanatory research.

As previously mentioned, this study intends to play an instrumental role in identifying political, institutional, and economic explanations for public investments overruns (cost, time and cost, and time joint effect) from an exogenous perspective, as well as assessing the impacts of changes on existing processes. As this study is an explanatory one, our aim is to find explanations for the nature of certain relationships. Based on the existing literature, this research identifies and analyses the main determinants of cost and time deviation and overruns and identifies which motives can be attributed for increases in the final cost or execution time of public projects. Explanatory variables for exogenous and endogenous regressors are also examined. Exogenous variables related to political, economic and institutional motives are used, and specific variables associated with each project are used for the endogenous variables.

In this research, four hypotheses are presented to test the determinants of cost and time deviations and overruns:

Hypothesis 1 – Political determinants: how political and electoral cycles contribute to the increase in cost and time deviations and overruns;

Hypothesis 2 – Governance determinants: the impact of a worst institutional and regulatory framework on the increase of cost and time deviations and overruns – in which governments with worse corruption and rule of law indicators will be less capable of enforcing contracts, which leads to an increase in cost and time deviations and overruns;

Hypothesis 3 – Economic determinants: if better economic cycles increase cost and time deviations and overruns – governments tend to spend more money on the reduction of expenditure control mechanisms, which also leads to an increase in cost and time overruns;

Hypothesis 4 – Project determinants: as a control factor, using an endogenous approach, the impact of higher uncertainty, measured by determinants such as project size (larger projects are more complex, which leads to higher uncertainty regarding project completion, which in turn also leads to an increase in cost and time deviations and overruns), project ownership, or sector, all of which can affect cost and time deviations and overruns.

All four hypotheses were tested for a set of three different dependent variables, namely, (i) percentage of cost deviations; (ii) percentage of time deviations, with each one being considered individually, and; (iii) percentage of cost deviations, this time also considering time deviation percentage as an independent variable. Each one of these studies had the purpose of answering different questions, which thus makes them independent studies. Additionally, all four hypotheses were also tested for five different datasets from the same general database. At any time, all the collected observations were always considered, as a means of coming to a conclusion regarding the validity of general public investments deviations. The data sets used are the following:

i. A subset of the collected data, where all public projects that had a cost deviation were considered (for all sectors and for all government levels).
ii. A subset of the collected data, where only transport sector projects observations with cost deviation were considered.
iii. A subset of the collected data, where only local government projects observations with cost deviation were considered.
iv. A subset of the collected data, where all public projects that had a time deviation were considered (for all sectors and for all government levels).
v. A subset of the collected data, where all public projects that had both a cost deviation and a time deviation were considered (for all sectors and for all government levels).

The various hypotheses, the variables used, and the econometric tests are all detailed in Subsection 4.3.

By adopting this new perspective to empirically test deviations and overruns in public investments, we aim to extend the known theoretical framework that explains such occurrences. To conclude, this PhD thesis aims to be an incremental contribution to the cumulative work in the field of public investment deviations and overruns, whereby we focus our analysis on the pillars of project financials (cost deviations and overruns) and time deliverability (time deviations and overruns). Our analysis focuses on cost and time deviations and overruns, both from an individual perspective and also with regards to the combined effects of how time deviations can affect cost deviations, from an exogenous determinants perspective. The findings of this research also contribute to establishing future policy implications which aim to reduce cost and time overruns through better management decisions.

1.5. Conclusion and policy implications

We reach six main conclusions. First, this research enhances past research by analysing a new database of 4,323 public projects, and, most importantly, by testing and confirming the effects of political, regulatory and legal, and economic determinants. It is important to note that past studies have been biased towards endogenous determinants, however, our research concludes that exogenous determinants are also important for enhancing or mitigating cost and time deviations and overruns, both with regards to their statistical significance and also with regards to the size of the impact. Second, this analysis also provides valuable insights into the influence of exogenous determinants (political, governance, and economic) on the likelihood of cost and time overruns. This research shows that other critical elements exist, which, to date, have been left out of the literature on cost and time overruns. In particular, election period, type of government, and the regulatory and legal/governance environment were proven to all play a fundamental role in cost and time overruns.

Third, project size has little or no influence on the level of deviation, neither on the probability of cost and time overruns. The results did not confirm that larger projects tend to have larger cost deviations. Fourth, the research proved that transport projects do indeed perform better than other sector projects (education, social and economic facilities projects), as they have less cost deviations and a lower likelihood of cost overruns. Furthermore, the results also provide evidence that the exogenous determinants studied influence cost deviations and overruns, as well as that the size of the transport projects has no impact on cost deviations and overruns and that transport projects developed at a local government level (usually with a smaller scale) tend to be less efficient in reducing cost deviations and overruns than transport projects developed at a central government level. Fifth, the results show that local government projects tend to perform worse than central government projects in reducing cost deviations. Interestingly, local government projects tend to have higher cost deviations, but they present a lower likelihood of cost overruns. It appears that projects conducted by local authorities are less prone to have cost overruns, although, in the event of occurring, they tend to be higher than those projects developed at the central government level. Sixth, we conclude that time deviation leads to more cost deviations, i.e., the presence of time overruns in public projects increases the likelihood of the occurrence of cost overruns.

Our policy implications show that that public organisations need to be appropriately structured to succeed as sponsors of public projects. With the right information and policy leadership, public investments costs and time deviations can be successfully overcome. This would allow for future infrastructure investment plans to successfully support stronger economic growth and better well-being for the populations. Construction knowledge and management skills in establishing the correct organisational structures for developing critical tasks are also both essential. This includes, but is not limited to, being able to establish strong relationships with the main stakeholders, with contractors being all-important, and with stronger legal framework agreements being adopted which bring clarity to each party's responsibilities.

Furthermore, at the local level, and despite some governance issues, decentralisation is a critical factor for improving the efficiency of the use of public resources. Even when considering the low level of capacity of local governments, this is overcome by the benefits of having overall project management on a smaller scale (with more detailed knowledge and a higher proximity to the project users and beneficiaries). Furthermore, with regards to the transports projects sector, we show that good project management of those public-sector departments and agencies involved is becoming a pertinent topic.

This research is organised as follow: Section 2 presents a literature review on both cost and time overruns, focusing on its causes and explanations. The theoretical framework that sustains our research is developed in Section 3 and Section 4 presents the data used and methodology applied. The findings from the statistical and the econometric model and regressions are presented in Sections 5 to 7. Section 8 presents a comparison of the findings from the previous sections Finally, some policy remarks are made in Section 9, based on the results obtained. Finally, Section 10 concludes.

2. Literature Review

2.1. Introduction

The literature on cost and time deviation and overruns in public projects is still limited, mainly due to the lack of available data (Williams et al., 2010). This literature gap is even wider for projects at the local government level. Most of the literature focuses on projects at the central government level and is mainly based on case-studies or descriptive statistics research by country/region and by different sectors, such as transports, energy, education, etc. (Flyvbjerg et al., 2002, 2004). The existing literature is mainly on single-country studies and is based on the study of project documentation and database records (Sun & Meng, 2009). Sun & Meng (2009) extensively review the existing literature on this topic and they found only 11 results of academic studies with robust econometric research on cost overruns. Furthermore, most studies simply analyse an individual case (or a small number of cases), which raises questions about the generalisability of the conclusions (Sarmento & Renneboog, 2016b). The previous studies are mainly focused on the endogenous motives for cost and time deviations - at project level.

2.2. Definition of cost and time deviations and overruns

A cost deviation is the difference, at project completion, between the estimated budgeted cost and the final cost. Consequently, at project completion, three possible outcomes may exist; (i) a negative deviation, i.e., final cost is below the estimated cost; (ii) no deviation, i.e., final cost is equal to estimated cost, and; (iii) a positive deviation, i.e., final cost surpasses estimated cost. In the literature, this positive deviation is usually called a ‘cost overrun’ (Sarmento & Renneboog, 2016b). Due to the concerns raised by cost overruns, the literature focuses mainly on positive deviations. Therefore, cost overruns are generally defined in the literature as being an excess of actual cost over the budgeted cost, meaning that, in these cases, more money was actually spent on a project than was originally planned in the budget, or extra costs were added, especially in the case of government contracts (Cantarelli, 2009; Flyvbjerg et al., 2002; Shrestha, Burns, & Shields, 2013). Cost overruns are typically calculated as a percentage, namely actual cost minus budgeted cost, as a percentage of budgeted cost, as defined in the literature (Nijkamp & Ubbels, 1999; Pickrell, 1990; Shehu, Endut, Akintoye, & Holt, 2014).

Consequently, a time deviation is the difference, at project completion, between the estimated execution time of a project and the final or effective execution time of a project. Consequently, at project completion three possible outcomes may exist; (i) a negative deviation, i.e. execution time is below the estimated execution time; (ii) no deviation, i.e., execution time is equal to the estimated execution time; and (iii) a positive deviation, i.e., execution time surpasses the estimated execution time. This positive deviation is usually called in the literature a time overrun. Due to the concerns raised also by time overruns the literature as focus mainly in these positive deviations (Bhargava et al., 2010; D'Alpaos et al., 2013; Dosi & Moretto, 2015). Therefore, time overruns are defined as the completion excess time of a project that extends further than its contracted initial completion date (Assaf & Al-Hejji, 2006; Shehu, Holt, Endut, & Akintoye, 2015). This definition of time overrun, accounts to any delay in a project completion or any other additional period of time during a construction beyond the contracted completion date (Hamzah, Khoiry, Arshad, Tawil, & Che Ani, 2011; Shehu et al., 2015). The longer the delay, the more relevant will be the effects that arise from its occurrence, which in practical terms brings negative results for construction. This is pertinent because time performance (together with cost, quality, and value-for-money), is one of the main criteria used to evaluate the success of any determined project (Endut, 2008; Holt, 2010).

Similar to cost overruns, time overruns are also a main source of concern and a common occurrence (Anastasopoulos, Labi, Bhargava, & Mannering, 2012), once time delays may also impact considerably in the final cost of the investment. The literature shows that time and cost overruns tend to be positively correlated (Bhargava et al., 2010; Shehu et al., 2015). Hence the delay-cost relation is associated with the importance of jointly analysing the cost overruns with time delays. (Lindhard, Shen, Brunoe, & Larsen, 2016). In a financial perspective, the outcome cost overruns are due to time delays in the construction of the project (Kaming, Olomolaiye, Holt, & Harris, 1997; Shehu, Endut, Akintoye, et al., 2014).

Overall, it may be said that a cost overrun occurs when the expenses required to complete a project or one aspect of a project, exceed the amount budgeted, and a time overrun when the time required to complete a project exceeds the forecasted initial completion time. This generally accepted definitions will allow in future research to compare the results of the current study with other relevant studies. This will be possible wherever those studies are produced, the source, the sector or dates of the data being generated.

Both overruns can happen for several reasons, emerging from the literature, numerous studies in which the focus is observing which specific and own project's characteristics have a larger effect on overruns occurrence (Chan, Scott, & Chan, 2004). Those studies although come to an agreement on an absence of unanimity on the magnitude of their influence on cost overruns (Doloi, 2013; Fidan, Dikmen, Tanyer, & Birgonul, 2011; Hinze & Selstead, 1991; Love, Sing, et al., 2015) and time overruns (Chan & Kumaraswamy, 1997; Kaming et al., 1997; Shing-Tao Chang, 2002). Overruns are a constant rather than an occasional event, mainly in public investments and are known to be related to some well-known endogenous (own project) variables (Walker, 1994).

Public investments have a problem, which is independent of the project to be built, is that cost and time overruns are normal (Flyvbjerg et al., 2002; Magnussen & Olsson, 2006). Even in projects that are similar and where contractors have knowledge about construction, for example, in the case of transport infrastructures, such as roads, there are several common and generally accepted reasons for this to happen (Flyvbjerg, Skamris Holm, & Buhl, 2003). These reasons include poor planning, which leads to unbalanced contract terms and conditions, which, in turn lead to poor project execution (Mackie & Preston, 1998). If we add to these reasons poor business environment, inadequate controls, and lack of proper risk management. then we are probably facing a wider problem that needs to be studied further (Hufschmidt & Gerin, 1970).

According to data from IHS Global Insight analysed by McManus (2016), construction productivity in many areas has declined over the last 10 to 15 years. The IHS Herold Global Projects Database estimates that, on average, large infrastructures projects cost 80% more than initially forecasted and they take 20 months more to be concluded that initially forecast (McManus, 2016). An example of this are the Olympic Games infrastructures studied by Flyvbjerg & Stewart (2012) for the period of 1960 to 2012. The Olympic Games are major events that have to start on time, but usually have cost overruns. Flyvbjerg & Stewart (2012) concluded that all Olympic events in time frame analysed have cost more than the original projections, and that all had larger cost overruns than normal megaprojects (between 20% and 45%), with an 179% average cost overrun. Infrastructures associated with this type of large events are riskier, due to the complexity of their organisation, as they have to be terminated in time for their inauguration ceremony.

2.3. Cost overruns literature patterns

Across the literature we have identified certain patterns for cost overruns. A first pattern is that the majority of studies focus on transport infrastructure projects as one of the sectors which is predominant among academics in the literature. The seminal papers on cost deviations in transport public projects are by Flyvbjerg et al. (2002, 2004) and Flyvbjerg, Skamris Holm, et al. (2003). Using a database of 254 projects in the US, Europe, and Japan, these studies found an average cost deviation of 28%. They also found a deviation of 20% in roads, 34% in bridges and tunnels, and 45% in railways. It was also found that 90% of projects have cost deviations. Furthermore, cost deviations do not reduce over time, and larger projects tend to have a higher percentage of cost overruns. This was later expanded by Flyvbjerg (2004, 2007c, 2007a, 2008), confirming these results and conclusions.

However, there are only a limited number of studies on transport projects cost deviations, mainly due to the lack of data available. Most studies look at a single project (or a small number of them) and provide limited conclusions. Nevertheless, the literature on cost deviations in the transport sector has come to two main conclusions: first, despite the large variance of cost deviations, they tend to be around 20%-30%, with almost all projects tending to have cost overruns, and second; regarding the cost deviation determinants, the literature has focused mainly on project endogenous motives (such as scale, ownership, or concept and planning), and less on the exogenous reasons. Political context tends to create the incentive for public decision makers to underestimate costs in order to ensure that a project is approved (Flyvbjerg, 2007a). This leads to the necessity for additional funding later on, when cost deviations occur. There is also some evidence of a lack of learning experience in the public sector. Finally, the economic cycle, and in particular inflation, is perceived as being a main determinant of cost deviation.

Furthermore, among transport projects, the major focus of the literature is on road construction projects, which are presented in Table 1. Here, some trends are exposed. For example, lower average cost overruns, in a range from 4,5% to 9%, are presented in projects developed in the USA, whereas in Europe as a region, or just European countries individually, cost overruns are higher, with a range of between 9% and 24%, and they reach 47,5% in a sample of large projects in Norway. Taking into consideration the last year of the sample period, no time improvements were possible to discover in the Europe samples, whereas in the USA samples, a degradation of the situation is highlighted - with an increase in the average cost overrun. This gives support to the idea that no improvement has been derived from accumulated experience when dealing with this type of investments.

[Insert ***Table 1*** here]

Furthermore, with regards to road projects, we can conclude that there is a large variance in average cost deviation. Some studies have found low levels of cost deviation of below 15% (Bordat, McCullouch, Labi, & Sinha, 2004; Ellis, Pyeon, Herbsman, Minchin, & Molenaar, 2007; Odeck, 2004). On the contrary, other studies found cost deviations of above 30% (Blanc-Brude, Goldsmith, & Valila, 2006, 2009; Odeck, Welde, & Volden, 2015). With regards to rail projects, other studies seem to confirm the results of higher cost deviations when compared with roads (Dantata, Touran, & Schneck, 2006; Lee, 2008; Pickrell, 1990, 1992). Furthermore, there is a common pattern of cost deviations in transport projects. Flyvbjerg et al. (2002), Odeck (2004), and Dantata et al. (2006) found that almost every project (9 out of 10) has cost deviations. Therefore, the literature on the distribution of cost deviation appears to be skewed to the right.

Investments in rail infrastructures, bridges, and tunnels were also covered in the reviewed literature (Table 2). Rail projects (including urban rail) perform generally better in Europe than in the US, with lower average cost overruns occurring in the Netherlands and Sweden than in US projects. Comparing Table 1 and Table 2, it is not possible to conclude which type of investments – be they roads or other transport investments – have a better average cost overrun. Nevertheless, it is of major importance to conclude that overruns are present in all the data considered in the different academic studies, and therefore it is important to study such phenomena.

[Insert ***Table 2*** here]

When considering the main determinants of each study and the conclusions presented in Table 1 and Table 2, we can observe that the literature on the determinants of cost deviation in transport projects focuses mainly on two areas: endogenous (project characteristics such as size, sector, type of procurement, etc.) and exogenous determinants (related with the overall political context, economic context, or governance issues, etc.). Most of the research has been primarily concentrated on the endogenous determinants regarding project characteristics. Despite the use of some explanatory variables, there is a lack of analysis of the exogenous determinants concerning the political, economic, and governance environment. In fact, although many authors have identified planning and optimistic bias problems as being critical drivers for cost overruns (e.g., Skamris Holm & Flyvbjerg, 1997; Creedy et al, 2010; Odeck et al., 2015), planning problems can be a consequence of external effects, such as political context, government efficiency, and governance issues, etc.

Other studies were grouped as "other sectors", as they do not focus particularly on any specific sector (***Table 3***). Cost overruns diverge from sector to sector (roads, transports, and other sectors) and from the geographical location of the investments.

[Insert ***Table 3*** here]

Studies also focus on comparison methodologies, namely international comparative studies. Those that exist focus yet again on transportation projects. In addition to those mentioned above, which had a statistical approach (Ansar et al., 2014; Flyvbjerg, 2004, 2005; Flyvbjerg et al., 2002; Flyvbjerg, Skamris Holm, et al., 2003; Leavitt, Ennis, & McGovern, 1993; Sovacool, Nugent, & Gilbert, 2014), Bruzelius, Flyvbjerg, & Rothengatter (2002) also produces a case study on a two-country approach (Denmark and Germany) over a trans-national infrastructure investment (transport link). Bruzelius, Flyvbjerg, & Rothengatter (2002) assess and measure accountability in the decision-making process and conclude suggesting and detailing corrective measures. Furthermore, Nijkamp & Ubbels (1999) concluded, also based on a two countries analysis (Netherlands and Finland), that, overall, cost estimations tend to be fairly reliable. Underestimations are mainly the result of further political demands, in the form of modifications or delays forced upon projects during the preparation and implementation stage, which lead to cost overruns.

In addition, Flyvbjerg, Holm, & Buhl (2006) compare the causes of inaccurate forecasts for rail and road projects and conclude that political causes play a large role in the differences between these two kinds of transport infrastructure. Pickrell (1990) and Skamris & Flyvbjerg (1997) conclude that cost overruns of 50–100% are common and that overruns above 100% are not uncommon. Flyvbjerg, Bruzelius, & van Wee (2008) develop a European comparison study on the unit cost of urban rail projects, using a simple comparison of the unit costs of urban rail projects, without any statistical inference. Although a small number of projects have been considered in the research, they were sufficient to come to the conclusion that differences exist depending on the countries, which may allow further developments in the forecasting and political decision processes.

Furthermore, Blanc-Brude et al. (2006) compared the construction costs of road projects in Europe between public-private partnership (PPP) projects with traditional public funded projects. The authors tested the existence and magnitude of the differences between PPP and fully-public projects and concluded that the *ex-ante* cost of a PPP road was, on average, *ceteris paribus*, 24% more expensive than a public one. Additionally, Wood (2010) made a comparative study of the cost overruns in Australia, focusing on the infrastructures delivery strategies. Yet another comparative relevant study on the planning process was presented by Hall (1982), who reviews some large well-known public project, such as San Francisco’s subway, the Concorde airplane, or the Opera House in Sydney, all of which are considered by the author to be disasters, due to the volatile triangle of community-bureaucracy-politicians.

Lastly, regarding the group of literature focusing on comparative analysis, one study exists which does not specifically focus solely on the transportation sector, which was carried out by Magnussen & Olsson (2006), using data from 31 major public projects in Norway (12 transport infrastructures, 9 building facilities, 8 defence procurement, and 2 information technology projects). The authors compare the costs estimates and the relation with the introduction of quality assurance schemes and conclude that this new scheme brought about an improvement (reduction) of the proposed estimates costs. Nevertheless, the relatively small number of cited articles, together with the importance that comparative analysis has in benchmarking different comparable realities, we strongly believe that there is room to develop future research work comparing the results of our current analysis with different countries or regions.

When considering the conclusions presented in Tables 1, 2 and 3, we can observe that the literature on the determinants of cost deviation in transport projects focuses mainly on two areas. The research has been primarily concentrated on the endogenous determinants of project characteristics. Despite the use of some explanatory variables, there is a lack of analysis of the exogenous determinants concerning the political, economic, and institutional environment.

In the next section, we provide a more in-depth literature review, to provide a better understanding of both cost and time overruns in public sector investments, focusing on the data, scope, main conclusions and supporting explanations that are reached.

2.4. Analysis of the main determinants of cost overruns in public investment

This subsection focuses on the main causes and determinants. It contains a description of the most common causes that have emerged for cost overruns in public construction projects, based on the research literature on the topic.

Although many studies use more than one variable, we have tried to point out examples according to the relevance of the identified cause of cost overruns. For example, in a qualitative study, Dlakwa & Culpin (1990) surveyed 175 public sector agencies members in Nigeria, as well as contractors and construction industry members and identified 6 reasons for financial overruns (fluctuations in prices, time delays, inaccurate pre-planning, inefficient forecasting process, out-of-control circumstances, and others). More recently, using a qualitative methodology that covered 160 project managers of infrastructure projects, Allahaim & Liu (2015) updated the main determinants for cost overruns in Saudi Arabia, the most relevant being market conditions, changes to the initial project, the practice of assigning a contract to the lowest bidder (which is not commonly mention in other studies and a country specificity), delays and design error. Beside this major five determinants, other causes have contributed to cost overrun, amongst which we highlight: lack of contractor and consultant planning before the project; poor coordination with government agencies, and; parallel contracts and stakeholders' lack of participation during the conceptual phase.

In the same path, other recent studies start with a large list of determinants and then using questionnaire/survey methodologies for project-related individuals they try to conclude which of these are the most relevant, using some type of statistical analysis. Examples include: Doloi (2013), who investigated 73 characteristics related with cost overruns and with multivariate regression analysis reach out to 5 significant factors and Abdul Rahman, Memon, Azis, Asmi, & Abdullah (2013), whose method tried to relate them to each other, rather than solely focus on identifying the causes for cost overruns for large construction projects in Malaysia. Recent researches focus on the statistical characteristics of cost overruns and whether or not these characteristics may be used to standardise the determinants of cost overruns (Cantarelli, Molin, van Wee, & Flyvbjerg, 2012; Love, Sing, Wang, Edwards, & Odeyinka, 2013).

Nevertheless, in all the projects, independently of any other characteristic that they may possess, there are always unpredicted and unmanaged factors that impact on their final cost. Morris & Hough (1987), in their study concluded that overruns are affected by circumstances outside the area of control of projects. These authors state that many deviations from the initial budgeted cost arise due to elements such as price escalation, government action and strikes, amongst other reasons. In the same tone, Bhargava et al. (2010) investigated these out-of-project control variables, paying special attention to weather conditions, as the effect of adverse weather conditions on cost overruns is due to the negative effects during the initial project planning and the fact that forecasters do not include a weather variable in their estimations. The same conclusion had been reached by Kaming et al. (1997) a few years earlier, when they pointed out weather influence resulting in worker's fatigue during the hot season, alongside Kaliba et al. (2009), who reached a similar conclusion when assessing cost escalation in road projects in Zambia. Another out-of-control circumstance is unexpected site conditions, as argued by (Arditi, Akan, & Gurdamar, 1985).

Nevertheless, even though some determinants have more references and appear more often in the literature, this does not indicate that they are more significant in determining the extent of cost overruns. It can only be interpreted that one particular determinant can be more easily measured and studied as having a greater influence on the final result (Cantarelli et al., 2010; Odeck, 2004). We were able to identify the following determinants: (i) scale; (ii) project ownership; (iii) concept, planning, forecast, changes, and the duration of the project, and; (iv) location. Regarding the exogenous explanations, the following were found to be determinants: (v) time effect; (vi) political context, and; (vii) inflation.

(i) Scale

Does size matter? The dichotomy between the analysis of small and larger projects has been one of the most-discussed determinants explored to explain cost overruns (Cantarelli, van Wee, Molin, & Flyvbjerg, 2012a). Project dimension is also one of the less unanimous determinants in the literature, with studies pointing in both directions. Three main approaches emerge from the literature: those that argue that large projects tend to increase cost deviations, as they are more complex and have greater uncertainty (Flyvbjerg et al., 2002); one that supports the hypothesis that large projects have more resources available for planning and monitoring and are also subject to greater public scrutiny, and thus will lead to a lower level of cost deviation (Aibinu & Pasco, 2008; Odeck, 2004), and, lastly; those that state that no correlation exists between cost overruns and project size, i.e., that project scale has no impact on cost deviations (Creedy et al., 2010; Lundberg, Jenpanitsub, & Pyddoke, 2011; Magnussen & Olsson, 2006; Makovšek, Tominc, & Logožar, 2011).

Is not totally clear whether cost overruns occur more predominantly in small or larger projects. It is understood and generally accepted in the literature that larger projects have higher deviations from their initial budget cost - mainly due to project complexity. This was confirmed by Morris & Hough (1987), which indicates that although larger and complex projects are critical for the development of countries, they are frequently badly designed and managed. Among other reasons, Jahren & Ashe (1990) researched the influence of project size on cost overruns, concluding that overruns happened more often in larger projects. This was also confirmed by Shrestha, Burns, & Shields (2013), whose 363 project analysis concluded that cost overruns increase as project size increases and they pointed out complexity as being positively correlated with size determinant. In this sense, it is possible to identify in the literature a group of studies that have size has their primary driver of study and also studies that have focused both on large projects or megaprojects (Table 4).

[Insert ***Table 4*** here]

From Table 4, it is possible to conclude that a clear definition of large projects or mega projects does not emerge from the literature, with multiple studies using different thresholds. For example, in Macdonald (2002), large projects are considered to be projects with investment expenditures higher than £40 million in 2001 prices - approximately 45.5 million Euros. Bruzelius et al. (2002) and Han et al. (2009) consider megaprojects to be projects with investment expenditure that equals or surpasses US$1 billion (around 890 million Euros), with more than five years construction schedule, an expected lifetime of at least 50 years, and considerable uncertainty regarding demand and cost forecasts.

Nevertheless, megaprojects can have different characteristics, according to the geographical context where they are developed. Their relevance in the literature comes from the fact that megaprojects are politically-attractive and are political-driven, due to their greater impact on the populations that will benefit from such investments. Megaprojects are also economically driven, due to the economic impact and the vast sums of money involved. Lastly, easier access to data exists for such projects – which is easier to recoup than for smaller project – at least for most of the time, as they are subject to greater scrutiny and have a more substantial impact on communities (Flyvbjerg, Bruzelius, & Rothengatter, 2003).

On the contrary, Odeck (2004) found that cost overruns seem to be more predominant in smaller projects than in larger ones when compared. This conclusion asserts that the highest potential for cost savings is in the control of costs for smaller projects. According to Odeck (2004), this is because larger projects have more public visibility and more available resources (both in the forecast and implementation processes) and a significant fiscal impact on yearly budgets, resulting in higher fiscal risk, which makes them more sensitive to budget overruns.

Additionally, Aibinu & Pasco (2008) used a multiple regression analysis to analyse 56 projects in Australia and they found that project size influences the accuracy of estimates and that the estimates of smaller projects are more biased than the estimates of larger projects. Additionally, a very recent study by Odeck et al. (2015) states that the implementation of a quality assurance regime in Norway for cost estimates above 500M Norwegian Krones (large projects) was successful in decreasing cost overruns. These authors further conclude that such a type of frameworks should also be implemented for smaller projects, where accounted overruns have been very large.

(ii) Project ownership

We found evidence in the literature of a double approach regarding project ownership, namely: (i) from public versus private ownership, or; (ii) regarding the level of governance of the project owner – central versus regional/local government. In the first pair of reviewed articles (Flyvbjerg et al., 2002; Shaoul, Stafford, & Stapleton, 2006) focusing on private versus public projects, we conclude that there is no significate evidence that one has lower cost overruns (Flyvbjerg et al., 2002). Shaoul, Stafford, & Stapleton (2006) reached similar conclusions when analysing information from the UK Highways Agency - that no justification exists for using private funding instead of public funding, as the authors found no evidence of cost deviations being higher in the case of public projects.

Using a different approach, but still under the dichotomy of private versus public funding, Blanc-Brude et al. (2006) and Blanc-Brude et al. (2009) focused their studies on the construction cost of roads under Public-Private Partnerships - investment structures where the responsibilities of the project being developed are divided between the public and private sectors (Sarmento & Renneboog, 2016a). Blanc-Brude et al. (2006) and Blanc-Brude et al. (2009) reached the conclusion that these are normally more expensive than traditional public procurement projects. This is mainly due to the risk transference that exists from the public to private sphere.

The literature on cost deviations in public projects is still limited, particularly regarding analyses at the local government level. In fact, most studies focused on public projects of central governments, not just because these are usually larger and more visible projects, but also because more data is available for these types of projects. However, some research has compared cost deviations at the central government with those at the local government level.

The literature concludes that local governments tend to perform better than central governments in controlling projects costs (NAO, 2007b; Sarmento & Renneboog, 2016b). This is to say that cost deviations tend to be smaller in local government projects. In these studies, local government cost deviations were below those of both the sample average and the central government cost deviations. Sarmento & Renneboog (2016b) found that local governments have a better control over costs when compared with central governments (even after controlling for project size, time period, or election years). Based on the Italian experience, Gori et al. (2017) found that at the local government level, there are higher-than-expected levels of expertise and experience in the management of public projects.

This greater efficiency could be due to the fact that local decision-makers have a closer knowledge of the projects and also of the local communities and the specificities of the area where the project is being developed. This knowledge is particularly relevant, given that many cost overruns arise from *a posteriori* changes due to public contestation and environmental impacts. Local governments can also have a better contact with populations and may be seeking more political consensus (Coviello & Gagliarducci, 2016). Regarding the effects of decentralisation, although subject to controversy, Ebinger, Grohs, & Reiter (2011) and O'dwyer & Ziblatt (2006) show that the effects of decentralisation on efficiency tend to be low. There is also some evidence that decentralisation to local governments may have an impact on reducing inefficiency and corruption at the public level (Shah, 2006). As shown by Turyna, Kula, Balmas, & Waclawska (2016), fiscal autonomy can lead to a more efficient use of public resources. It could be the case that this decentralisation reinforces government accountability (Assche & Dierickx, 2007). Citizens could be more involved in monitoring government performance and in demanding corrective actions, which could bring decision-making closer to people and their problems and needs (Fisman & Gatti, 2002).

(iii) Concept, planning, forecast, changes, and duration of projects

Cost deviations and overruns can also be the result of weak conceptualisation and planning of a project, which leads to both inaccuracies in the budgeted costs, as well as errors (along with technical difficulties) in the forecasting of costs (Flyvbjerg, 2004). Additionally, accurate forecast project costs is of primordial importance for the financial success of any infrastructure contract. Success is measured by the absence of cost overruns. Jahren & Ashe (1990) found evidence that overruns were more likely to occur when the contract value (bid made by the winning contractor) was inferior to that which public decision-makers had initial forecasted (government estimates). This can indicate an incorrect understanding of the correct scope of works needed for completion, which could lead to additional works and consequently to cost overruns. This conclusion was also confirmed by Kolltveit & Grønhaug (2004), who argue that the quality of the execution of a project starts during its early stages and that it will critically impact a project's future performance. Poor planning mechanisms are therefore one of the main causes for cost overruns (Cantarelli et al., 2010), or, in other words, poor project planning and management skills (Morris, 1990).

Bent Flyvbjerg (2008) defines estimates accuracy in terms of optimism bias and strategic misrepresentation in the case of the forecast of the costs. Despite this being sometimes natural, optimism bias is mainly found in the case of the public sector, which usually accepts a lower probability of an adverse event occurring. As political decisions favour certain projects, this can result in more favourable assumptions and forecasts. Most of the studies did not find evidence to support the notion that experience in public projects leads to more accuracy in forecasting cots for new investment projects, see, for example, Aibinu & Pasco (2008)).

Furthermore, a study by Trost & Oberlender (2003) found an objective way to assess the accuracy of early phase estimations through the use of a quantitative approach (factor analysis and multivariate regression). The authors concluded that 5 out of 11 factors were statistically significant (basic process design, team experience and cost information, time allowed to prepare the estimate, site requirements, and bidding and labour climate), while the remaining six factors were not statistically significant (technology issues, team alignment, owners' costs, contingency and reviews, formal estimating process and money issues). In a more broad scope study, but with relevance for estimate accuracy, Samset, Berg, & Klakegg (2006) state that the focus must be on: (i) front-end governance for major public projects, and; (ii) the need to implement strong governance regimes, in order to force these new investment to meet stakeholders' expectations, which is what is not occurring.

Every project has its specificities that change accordingly with the project own characteristics (type, country, and time) but every project has a specific moment in time in which the decision to build is taken (Flyvbjerg et al., 2002). This moment will be used to measure projects' final success or flaw (Becker, Jaselskis, & El-Gafy, 2014). Therefore, estimation inaccuracies take a central stage in the buildup or avoidance of cost overruns. This was argued by Skitmore & Picken (2000) in their study of pre-tender estimating performances in the USA. The authors investigated the effect that four independent factors (building type, project size, project sector, and year) had on accuracy, on a sample of 217 projects in the USA and concluded that bias and inconsistency in project estimation are influenced by the size and year of projects. Furthermore, consistency in estimates is influenced by project type, size, and year. This evidence regarding estimation inaccuracies is also confirmed by Kaming et al. (1997), who state that accurate estimates depend on reliable data.

Several authors have been studying which factors affect estimation accuracy. Gunner & Skitmore (1999) collected several previous studies and summarised several factors that influence the accuracy of an estimation process, such as building function, type of contract, conditions of contract, contract sum, price intensity, contract period, number of bidders, good/bad years, procurement basis, project sector (public, private or joint), number of priced items, and number of drawings. They concluded that most of these factors have an influence on the estimation process and its accuracy. These conclusions were corroborated by the study on improving the accuracy of approximate estimates by Ling & Boo (2001), who investigated the level of accuracy in Singapore during the 1990's and found that a smaller margin of errors in estimations was desirable, outlining 9 methods that effectively improve the accuracy of estimations. Additionally, when studying 161 projects of road, rails, airports, and ports projects, Lee (2008) identified inaccurate estimates as being one of the main reasons for cost overruns, the others being changes in scope, delays in construction, and adjustment of project costs.

In a more recent literature review on how to build major transport infrastructure projects within budget, on time, and with the expected output, De Jong et al. (2013) found that, in general, the more prevalent factors were: (1) improving the cost and benefit estimates of projects; (2) containing the risks involved in these projects; (3) increasing accountability, and; (4) maintaining a clear scope and objectives, which clearly states the importance of a clear and accurate estimate process. In a different direction, the study by Nijkamp & Ubbels (1999), which although it only focused on the analysis of cost overruns in the transport sector, concludes that cost estimations are in general terms very reliable, which is contrary to the broad conclusions of the reviewed literature.

Additionally, the length (duration) of a project has an impact on increasing cost deviations (Odeck, 2004). One of the reasons for this is the relationship between project complexity and length (Bordat et al., 2004). Accordingly, the longer the construction takes, the more expensive it gets. Completion time indeed has a positive relationship with how much more money is spent on projects, as suggested by (Odeck, 2004). One of the main factors for this to happen is the binomial relationship between project complexity and project duration, which has been confirmed in the research of Bhargava et al. (2010); Bordat et al. (2004), and; Jahren & Ashe (1990). Furthermore, Akintoye (2000), when analysing the major factors that influence project cost estimating practice, considers project duration to be one of the key factors that should be considered by contractors in their cost estimation procedures.

In Akintoye & MacLeod (1997) the authors consider risk variables associated with project construction as having a material impact in the time, cost and quality performance of the project. Furthermore, Ahiaga-Dagbui & Smith (2014a) analysed the relation between the cost and duration of the projects starting from the perspective that much of the financial decision-making was taken in high uncertainty environments. This uncertainty is one of the causes that originates from a project cost growth, as well as in the case of the unavailability of information. Furthermore, Ahiaga-Dagbui & Smith (2014b) also focus in their research on inadequately-managed risk and uncertainty as one source of cost growth in large public projects. The authors mainly consider that the effects of risk and uncertainty through the analysis of non-controlled events and total project duration. Another study (Park & Papadopoulou, 2012) found a notably strong statistical relationship between project duration and cost overruns in transport infrastructure projects in Asia (harbours and marines). The main reason being that harbour and marine projects normally have longer construction periods, which result in a larger exposure to more uncertainty (e.g., adverse weather) and more risks.

Additionally, Park & Papadopoulou (2012) confirmed a moderate statistical relationship between cost overruns and construction periods with short and long projects, resulting in higher cost overruns. It can be argued that long projects tend to be more susceptible to unforeseen events and changes to their original design due to technological advancements. Furthermore, Shrestha et al. (2013) performed a long-term (1991-2008) study on public works projects developed in the United States of America (Nevada). This study concluded that larger projects (size) and long duration projects (duration) accounted for higher cost and time overruns than small size projects and short-duration projects. A contrary conclusion is reached by Odeck, (2004, p. 8) who found "that cost overrun tends to be higher the shorter the completion time is expected to take". Additionally, Senouci, Ismail, & Eldin (2016) concluded, with a statistically-based study using the ANOVA method for a sample of public construction projects, that cost overruns were not statistically significant with respect of project duration.

However, some authors have argued that technical failures in the planning and construction stages may not be the main motive for deviations. The explanation for this finding is that if cost deviation was a result of technical failures, then two patterns should emerge from the literature. The first pattern is that the distribution of these deviations should follow a normal distribution near to zero, and the second is that there should be an improvement over time, as experience and the learning curve starts to produce better results (Siemiatycki, 2009). None of these patterns is observed.

(iv) Location

Does it matter where the project is built? Flyvbjerg et al. (2002) and Flyvbjerg, Skamris Holm, et al. (2003) claim that it does matter. More developed regions, such as Europe and the US, perform better in terms of reducing cost deviations. The authors computed data from Europe and from the United States of America (each one classified as a geographical region) as well as from what they called "other geographical areas", which comprises a group of 10 developing countries and also Japan, which is classified as a third geographical region. Evidence was found that there was a higher difference between estimated and actual cost in the "other geographical areas" region when compared to Europe or North America. The authors conclude that lower overruns appear to be more prominent in developed countries (Europe and North America) than in developing economies. These regions have developed better procurement systems, together with better finance, control, governance, and accountability for public projects (Kaliba et al., 2009; Lee, 2008).

Furthermore, Cantarelli, Flyvbjerg, & Buhl (2012) studied project cost performance for transport projects, namely roads, tunnels rail and bridges projects in the Netherlands and found no significant difference between Dutch projects and those of the rest of the world. Nevertheless, Dutch rail and bridges projects perform considerably better than other Northern West European countries and other geographic areas. The authors further conclude that location matters, depending on project type and it can be used to setup reference classes.

With diverging results, Flyvbjerg (2007a) analysed and compared data for 258 projects of rail, bridges and tunnels, and road projects, which were also classified by Europe, United States of America, and "other geographical areas". This time no large differences were found in terms of cost increase between geographical regions. The low number of observations, especially in Europe, may have contributed negatively to a low comparison between the stated regions.

Furthermore, Pickrell (1990, 1992) studied 10 urban rail projects in the United States of America between 1980 and 1990. These 10 projects had a 50% average cost deviation, with 86% of projects having cost overruns. Although the main problem was an imprecise cost estimation of the projects, the author found that cost deviations were similar across different projects and locations. Creedy et al. (2010) also found no statistical evidence of a correlation between cost overruns and project location in a study on the risk factors on the delivery of highway construction projects.

(v) Time effect

There is also a certain degree of consensus that public projects forecasts tend to have some over-optimism, which is also called "optimist bias" (Siemiatycki, 2009), particularly because there seems to be no evidence that more experience in managing public projects (the passage of time yields better experience) produces less cost deviations (Aibinu & Pasco, 2008. Sarmento & Renneboog (2016b) reached the conclusion that estimates accuracy is a critical factor for the appearance of cost overruns, and we would expect that improvement in the most-recently-awarded projects to have been introduced. Additionally, we also expected that when comparing older projects with the most recent ones, that accuracy has improved and that overruns have been widely reduced. However, this does not seem to be the case, as noted by Flyvbjerg et al. (2002), who verified no learning curve in the public sector that leads to the reduction in the underestimation of costs or which, at least, minimises the occurrence of cost overruns. Costs underestimation has not improved over the last 70 years. The conclusion that no improvement of the estimation accuracy process has taken place is supported by a number of papers that cover several projects data during a window of time that allows the comparison between results obtained at the beginning and end of that time lapse (Flyvbjerg, 2004, 2005; Flyvbjerg et al., 2002; Flyvbjerg, Skamris Holm, et al., 2003; Lundberg et al., 2011). These studies conclude that almost no improvement has taken place in terms of estimation accuracy and that the information being transmitted to those who need to make an investment decision is misrepresentative (Flyvbjerg, Skamris Holm, et al., 2003; Macdonald, 2002; Pickrell, 1992).

With regards to inaccuracy in forecasts, Bent Flyvbjerg (2008) also concludes, that, despite all the declared developments in forecasting models and better sets of data, among other factors, that no improvements have been noticed. The author gives the example, that during 70 years of available data on forecasted costs for transportation infrastructure projects, the inaccuracy of cost forecasts has not improved over time.

On the contrary, Dantata et al. (2006) compared results from a previous study regarding cost overruns of transit projects completed before 1990 and after 1996 and found some evidence (albeit weak) that evidence exists that supports that cost overruns have become smaller for projects completed after 1994 (compared to those before 1990). However, as a limitation, Dantata et al. (2006) indicate that they do not have sufficient data to statistically prove this at a level of significance of 5%. Furthermore, Makovšek et al. (2011) also found evidence of improvements in reducing cost deviation over time, and they conclude a positive improvement exists (meaning smaller cost overruns).

Furthermore, Odeck et al. (2015) also confirm the idea of an improvement over time, concluding that implementation of strategies of quality assurance has led to a reduction in cost overruns. Although the implementation of these quality assurance strategies did not lead to a better accuracy of the estimates provided by the authorities, the quality assurance regime achieved the purposes of reducing project cost overruns.

(vi) Political context

Exogenous explanations are mainly based on the political context. However, this determinant must not be confused with data inaccuracy. The reach of the political context is wider, as here the data was, on purpose, erroneously transmitted in order to achieve some political gain or advantage, thus allowing investments to move forward in hypothetically-better conditions than the ones that existed in reality. Nevertheless, several authors (Flyvbjerg, 2007a; Mackie & Preston, 1998; Wachs, 1982, 1987, 1989) conclude that assumptions chosen with the intention of producing manipulated forecasts to defend projects can also be favoured on the basis of political criterias. Furthermore, Buchanan & Tullock (1962), Downs (1957) and Mueller (2003) agree that political agents need to be modelled as proceding their personal interests in a rational form, meaning that politicians and political parties depend on electoral results to gain or retain power and that for this reason they design strategies to achieve that particular goal. The same is true for contractors that diminish project risks and costs by hiding them, or simply by ignoring them, in order to make the overall investment appear lower (Cantarelli et al., 2010; Pickrell, 1990; Wachs, 1989, 1990).

The latter is also called "strategic misrepresentation, i.e., 'lying', by Flyvbjerg et al. (2002), or as stated by Flyvbjerg (2007c, p. abstract) "*it explores the causes of misinformation and finds that political-economic explanations best account for the available evidence: planners and promoters deliberately misrepresent costs, benefits, and risks in order to increase the likelihood that it is their projects, and not those of their competition, that gain approval, and funding. This results in the 'survival of the unfittest', in which often it is not the best projects that are built, but the most misrepresented ones*". The concept is that a deliberate underestimation of the cost is carried out to achieve a lower budget for the project and/or to improve the results of the cost-benefit analysis (Wachs, 1989). The motive for lowering the budget is to ensure that the project is selected in a limited resources environment. Competition between projects creates political and organisational pressures to emphasise future benefits and to play down the costs and risks (Flyvbjerg, Bruzelius, et al., 2003).

Additionally, it is unlikely that a project, once approved and started, will be cancelled due to the occurrence of cost deviations during the construction stage, as political and interest groups exist that will exert pressure (Priemus, 2007). It is more likely that projects will receive additional funding to compensate for a positive cost deviation. The result is that non-viable projects continue to be implemented, which leads to an inefficient allocation of resources. Furthermore, Kain (1990) mentioned the use of unrealistic assumptions by political interference in the preparation of forecasts or in the misrepresentation of forecast results. In this paper, the author describes the misuse of land-use and ridership forecasts by Dallas Area Rapid Transit in the USA. Furthermore, Wilkinson (2006) also covered this matter by analysing how political competition leads to distortions in projects final cost.

In summary, strategic misrepresentation", which is related to the above-mentioned "optimist bias", is the political incentive to lower the budget costs of a project, even when it is known that it will lead to cost overruns. This incentive is based on two aspects (Sarmento & Renneboog, 2016b): firstly, in the case of limited public resources, the project may be rejected if the real cost is perceived, and; secondly, as a lower cost increases the chance of the project being approved and launched, a posterior cost overrun is unlikely to cancel the project once it has started. In the face of a cost overrun, the most likely scenario is the reallocation of funds from other sources for the project, due to pressure from political or interest groups (Priemus, 2007).

Furthermore, Kaliba et al. (2009) conclude that the use of proper legislation and the ability of governments to approve and enforce adequate, updated and appropriate laws allows the establishment of correct conflict resolution mechanisms. Such enhanced corporate governance procedures benefit the potential for the completion of projects on budget, providing fair disputes between all project stakeholders, e.g. strikes and labour disputes.

(vii) Inflation;

Some cost deviation is also explained by the effect of inflation (Siemiatycki, 2009). Inflation can impact on costs both by causing an increase in the price of materials and also by putting pressure on wages. Using the high-speed train in France and the US as an example, Leavitt et al. (1993) found that inflation is one of the primary drivers of cost overruns. As a consequence, price increases are, intuitively, perceived as being one of the most relevant variables for higher-than-expected budget cost. This fact has been largely pointed out in the existing literature with a very wide range of influence that ranges from the relevance given by public auditors (Siemiatycki, 2009) and government bodies (Adam, Josephson, & Lindahl, 2015) to a wide range of academic researches.

In Table 5, we present the more relevant studies on inflation with the indication of the main drivers for price changes. Within price changes three main drivers are identified, namely: (i) material price variations; (ii) inflation, acting individually (material prices fluctuation) or inflation acting jointly (material cost increases due to inflation), and; (iii) labour costs increases. Material price variations and inflation are intimately linked. Price material increases only caused by inflation is also mentioned in the literature as being one of the main cost-control drivers, especially in high inflation countries or for projects contracted through a lump-sum agreement. Lastly, labour cost increases, namely wages increase, which is referred to as a cause throughout the cost overrun literature, as presented in the aforementioned Table 5.

[Insert ***Table 5*** here]

As a complement to Table 5, it should be noted that Morris (1990) sustained in his research that around 20-25% of cost overruns can be accredited to increases in project material prices. Arditi, Akan, & Gurdamar (1985) indicate increases in material prices and inflation as being the two main reasons for the occurrence of projects cost overrun. The authors also indicate that material prices are the only reason that ranked more than 20% for relative % weights for respondents in their survey on both contractors and public agencies.

In the next subsection, we focus on the type of delays and the main determinants that have been studied in academic research, which will help us in the construction of our model. Additionally, we aim to focus on founding and establishing correspondences and patterns between the prevalent causes that origin time deviations and overruns and how these causes interconnect with cost deviations and overruns.

2.5. Analysis of the main determinants of time delays in public investments

Cost overruns are the additional public institutions' money and taxpayers' money that is required to complete a public work. However, a time overrun will additionally have a social price, which can go further than the extra money charged by the contractors, as it can create spill overs of negative externalities and give rise to dissatisfaction among populations (and voters), normally in a collective way (Gori et al., 2017; Lewis & Bajari, 2011). Time overruns are also referred to in the literature as 'time delays' (Hamzah et al., 2011)

Similar to cost overruns, decision-makers and managers involved with them must be able to know and control which main factors originate time overruns in order to be able to diminish the probability of the occurrence of such delays. As presented by Adam et al. (2015), this also needs to be a central procedure in public procurement policies. These procedures will help management decisions to be more suitable for all stakeholders involved in the decision making and approval process of the projects, or they will create higher social costs and lower social benefits, due to the extra burden needed to complete such public investments. Ultimately, these procedures will also lead to better contractual structures that are less prone to time and cost overruns (Singh, 2010).

Records show that both delays and cost overruns are common events in construction projects. Morris & Hough (1987) assessed records from 1959 to 1986 which covered more than 4,000 construction projects and they reached the conclusion that projects' success rate, as measured by completing the projects on time ("schedule duration"), was very low and that underruns were almost inexistent. This makes time delays another major concern regarding public investment projects, alongside cost overruns. The time taken to build over the initial forecasted time – known as 'time overruns', continue to represent considerable importance and these are still a common occurrence (Anastasopoulos et al., 2012).

A time overrun occurs when a delay during the construction phase happens which produces a change in the initially-established date for the final works to be carried out (Bordat et al., 2004). In an extensive literature review study, Hamzah et al. (2011) identified three types of delays: (i) non-excusable delays, which happen due to the contractor's fault, which must try and compensate for the lost time without additional monetary payments or a time extension being granted, whereby no responsibility must be passed on to the project owner; (ii) excusable delays, which can also be divided into two types of delay: compensable and non-compensable delays. Compensable delays are normally attributed to the project owner, while non-compensable delays are caused by factors which cannot be attributed either to the contractor or to the project owner and which are normally caused by third parties or 'acts of God', which cannot be attributed to any specific party, and; (iii) concurrent delays, where the responsibilities are shared by the contractor and the project owner. Such a delay normally occurs during the critical path of the project development (Alaghbari et al., 2007; Hamzah et al., 2011; Majid & McCaffer, 1998). The literature on time deviations has focused commonly on pre-execution stages, or execution stages that prevent the project owner from correctly predicting the necessary time for the works' schedules (Gori et al., 2017).

The study of Chan & Kumaraswamy (2002), which cites several examples ranging from projects sponsored by the World Bank to UK government projects, concludes that construction delays are events that happen in almost every country, with greater evidence for public projects. Additionally, S. Morris (1990) considers that from a long way back in time, projects delays and the associated cost overruns have been experienced as a regular feature of public sector projects. Time overruns often lead to cost overruns and the combined adverse effects impact on project quality (Akintoye & MacLeod, 1997). Similar to cost overruns, there are also several reasons for time overruns (Chan & Kumaraswamy, 1997; Han et al., 2009; Majid & McCaffer, 1998; Sweis, Sweis, Hammad, & Shboul, 2008). The more evident these causes are, the better are the possibilities that in the future their existence will be minimised, or completely removed (Alaghbari et al., 2007).

Another source of time deviations are reworks (Iyer, Chaphalkar, & Joshi, 2008). Reworks are the unnecessary effort of correcting construction errors and rework costs are the total cost resulting from problems that occur before and after project delivery (Love, Smith, & Li, 1998, 1999). Josephson, Larsson, & Li (2002) analysed rework and rework costs in the construction industry. The authors reached the conclusion that for the analysed cases, a value of 4.4% of reworks costs were recorded, which correspond to 7.1% of the total work time required to correct them.

In the 2,879 observations analysed, Josephson et al. (2002) identified six categories of reworks, namely: (i) client; (ii) design; (iii) production management; (iv) material; (v) machines, and; (vi) workmanship, whereas design causes represented the most significant percentage of contribution to the overall rework costs. Regarding those causes that lead to reworks, the principal one was erroneous workmanship, followed by inadequate or faulty design, lack of coordination in design, late delivery of materials, mistakes in planning, and faulty manufacturing, with contributions varying between 8.1% and 5.1%. Other causes that scored less than 5% impact were considered less significant and were consequently omitted. In Table 6, we present a summary of such classifications and their causes. One of the findings suggests that "*a delay of more than 3 weeks was expected for a 1 year project, irrespective of other causes of delay such as bad weather and waiting for materials. Again, the delay caused by rework reinforces the need to determine the causes of rework in order to find preventive actions for reducing the amount of rework*" (Josephson et al., 2002, p. 80).

[Insert ***Table 6*** here]

Adam et al. (2015) focused their work on the causes and impacts of cost and time overruns on large public construction projects. The extended literature review of this study covered predominantly empirical studies. The authors present a list of the more frequent causes for time and cost overruns. Planning (poor planning/change orders) and materially-related factors (damaged goods) were identified as being the most influential factors in causing time delays. These factors, together with the frequency of their appearance and the type of study performed are detailed in Table 7. More recently, those results were confirmed in a new study by Adam, Josephson, & Lindahl (2017). These authors confirm the idea, also stated by Bhargava et al. (2010), that the main causes of cost and time overruns are frequently interconnected.

Furthermore, Adam et al. (2017) also follow Cantarelli et al. (2010) by stating that it is prudent to distinguish between causes and explanations.

[Insert ***Table 7*** here]

Ramanathan, Narayanan, & Idrus (2012) reviewed 41 studies around the world in various project management journals, with the object of categorising the causes that are most responsible for time delays and cost overruns in construction projects. The time frame considered was 15 years, from 1995 to 2010. Although the scope of this research does not focus solely in public projects, it was considered to be of foremost importance, due to its extensive literature review and the fact that the causes are more predominant in the case of public works than for private projects. The main purpose of this paper was to review research which has categorised the causes of time delays and cost overruns.

Furthermore, the authors were able to identify and group together the factors into 18 different categories out of the 113 factors identified. The eighteen categories are: (i) Finance- related; (ii) Project-related; (iii) Project Attributes; (iv) Owner/Client; (v) Contractor; (vi) Consultant; (vii) Design-related; (viii) Coordination; (ix) Materials; (x) Plant/Equipment; (xi) Labour/Manpower; (xii) Environment; (xiii) Contract-related; (xiv) Contractual relationships; (xv) External; (xvi) Changes; (xvii) Scheduling & Controlling, and; (xviii) Governmental relationship. In Table 8 we present a summary of the 18 categories, organised by the type of effect studied, which enables us to conclude that little more than half of the references studied focused jointly on time and cost problems, with the remaining half being focused on time delays/overruns. This organisation shows the correlation already mentioned between delays and cost overruns as being the problem that has been the focus of academic research in this field.

[Insert ***Table 8*** here]

Ramanathan, Narayanan, et al. (2012, p. 55) go on to warn about the generalisation of conclusions, stating that "*This study has identified 113 distinct factors classified into 18 groups responsible for delays through critical review of 41 previous research studies performed in the relevant field. This gives all the combination of factors and categories responsible for construction delays. But this critical review of forty one studies also demonstrates that none of the studies can be generalized and directly applicable 'as is'. This presents a strong case against opinion surveys when as in this case, statistical analyses of actual projects could be done which potentially could generate meaningful answers".* According to these authors, none of the studies is comparable to any other and each study presents different rankings for the causes of the delays and cost overrun. Furthermore, it is worth mentioning that an evolution of the causes has occurred during the time lapse analysed, where the more influential groups of 1995 are no longer present in 2010 as being considered as high risk factors.

Additionally, Sambasivan & Soon (2007) indicate that causes in delays can be country-specific. In a study about contracting in Malaysia, the authors identified 10 more causes of delay from a list of 28 different causes and 6 different effects of delay, these being: (i) contractors' improper planning; (ii) contractors' poor site management; (iii) inadequate contractor experience; (iv) inadequate clients' finance and payments for completed work; (v) problems with subcontractors; (vi) shortage of material; (vii) labour supply; (viii) equipment availability and failure; (ix) lack of communication between parties, and; (x) mistakes made during the construction stage. The 6 main effects of delay were: (i) time overrun; (ii) cost overrun; (iii) disputes; (iv) arbitration; (v) litigation, and; (vi) total abandonment. The authors were also able to establish an empirical relationship between each cause and effect.

With the goal of minimising time delays through a better acquaintance of the factors impacting non-excusable delays (delays where the contractor is responsible for such event) that influence contractors' performance, Majid & McCaffer (1998) reviewed 42 previous works from the existing literature and 25 common factors emerged. When using data from 8 of the above-mentioned 42 studies, which comprised more than 900 contracting organisations from several countries (The United Kingdom, Turkey, Saudi Arabia, Nigeria and the United States of America), with identifiable causes of delays and corresponding contributing factors, the authors listed 25 factors. Late deliveries, damaged goods, poor planning, equipment breakdown, and use of improper equipment were the top 5 ranking factors for causing time delays. The authors concluded that to decrease the impact of the factors a systematic approach needs to be taken to allow decision-makers and construction managers to identify such factors. The identification of those factors that contribute to causing delays, especially the recurrent ones, would allow for better decision-making, thus reducing the recurrence of such events and lower the overruns or make them inexistent.

From the above example of studies that focus on time deviations and overruns determinants (Adam et al., 2015; Majid & McCaffer, 1998; Ramanathan, Narayanan, et al., 2012; Sambasivan & Soon, 2007) we can conclude that the number of determinants is large. Similar conclusion was reached by Hamzah et al. (2011). Nevertheless, we have reviewed further literature and were able to identify the following determinants of time deviations and overruns:

(i) management; (ii) planning; (iii) site conditions; (iv) weather; (v) project-related; (vi) financial; (vii) communication, and; (viii) personnel. In Table 9 we present a summary of the literature that focuses on each one of these determinants.

[Insert ***Table 9*** here]

With specific regard to local government public projects, for a sample of data from Italian public projects, the research developed by Gori et al. (2017) reaches the conclusion that at local government level, there are higher-than-expected levels of expertise and experience that have a determinant role in speeding up the conclusion of public projects. The authors additionally conclude that lack of experience is an issue that needs proper policy remedies, as it brings about the probability of higher delays and a longer duration of delays. Regarding size, Bordat et al. (2004) conclude that the more expensive projects have a higher probability of the outcome resulting in a time overrun.

Similar to cost overruns, it is also possible to identify the transport sector as being one of the most studied, with several publications focusing on this specific type of infrastructure, although contrary to cost overruns, in this case the outputs are more focused on the causes of time overruns, with insufficient data to enable quantitative studies. In their literature review paper, De Jong et al. (2013) searched publications that clearly discussed cost, schedule, and output forecast and found 21 scientific journal articles, 1 dissertation, 5 books, and 2 reports on transport infrastructures. The reviewed publications covered the period from 1980-2014 and were on how to build infrastructure projects within budget, on time, and within the expected output. 27 journal articles and books focused on cost, and only 12 focused on schedule issues. All of the 12 schedule-related publications also focused on cost issues and not one was solely related to schedule problems. It is possible to identify the main causes and recommendations that emerge from the analysed articles as being: (i) improving cost and benefits estimates; (ii) risk containment; (iii) accountability measures; (iv) clear scope and objectives; (v) involving private capital; (vi) organisation and management; (vii) political situation/government and (viii) market conditions/stable economy.

Of the twelve papers analysed by (De Jong et al., 2013) that focus on time overruns, half make references for clear scope and clear objectives, risk containment, and organisation and management. This percentage is aligned with the percentage of articles for cost overruns that make the same references for the same factors, which demonstrates the close relation of cost overruns to time overruns. Regarding the applied research type, more than half of the publications focused on the statistical analysis of cases, with the remaining being split equally between case studies and interviews and discussion and literature.

Another transports study on the causes and factors of time overruns is that of Love, Smith, et al. (2015), which concludes that a balanced approach is necessary to understand overruns, especially for the complex system of transportation infrastructures. To obtain a better understanding of overruns, it is necessary to construct an outside (economic, political, psychological, and technical explanations) and inside view (overrun causes, such as scope changes, optimism bias, errors and omissions, change order, etc.). This view must also be considered jointly and together with other areas, such as engineering, management, political characteristics of the projects, complexity and localisation of the projects. The objective of the authors was to provide policymakers, industry, and the general public with a greater understanding about both time and cost overruns. Improvements to reduce overruns were identified and discussed, such as: (i) the use of relationship contracting, namely Integrated Project Delivery – IPD, and; (ii) technology advances, which have enabled Building Information Modelling-BIM to become a central topic for improving a project's whole-life-cycle costs.

In Love, Sing, Wang, Irani, & Thwala (2014) the authors analysed 58 transportation infrastructure projects located in several regions of Australia, using data collected through questionnaires, which aimed to study cost and schedule overruns and reworks together. Specifically, with regards to the schedule, the percentage of overruns for each project type were as follows: Bridges, 8.99%; Road construction (elevated highways), 12.51%; Road construction (incl. upgrades), 8.59%; Tunnel and subways, 6.58%; Total (mean), 8.91%. As main conclusions, the authors state that project type and contract value did not influence the amount of rework and cost and schedule overruns. Cost and schedule underruns were also observed in some cases, although rework occurred in all the projects sampled. They further conclude that 6 projects were delivered on schedule, which account for approximately 10% of the total, and that 1 project was delivered 4 weeks before the contractual date for project termination.

Another transports study, which focuses solely on road construction was carried out by Kaliba et al. (2009). Once again, a questionnaire survey was used, which nevertheless pointed out 14 major causes for schedule delays in road projects in Zambia. The major cause for schedule delays was delayed payment, with a 75% weighted percentage of occurrence, followed by financial process of the client organisation (67%) and financial difficulties (60%). Other major causes of schedule delays were: contract modifications; economic problems; material procurement; changes in drawings; staffing problems; equipment unavailability; poor supervision; construction mistakes; poor coordination on site; changes in specifications, and finally; labour disputes (which was the least, with 50%).

3. Theoretical Framework

3.1. Introduction

In this thesis, we aim not only to test specific determinants, but also to provide each determinant and formulated hypothesis with a specific theoretical framework, in order to give credibility and general acceptability to our conclusions. To achieve our goal of contributing to management theory, we present a model, a theoretical framework, hypotheses, research questions, and the variables to be tested. The specific theoretical framework will be developed in this current section.

All levels of government (central, local, and regional) operate in a private ecosystem which is dominated by private for-profit organisations. Contrary to public administrations, these have a consistent purpose of generating larger profits and maximising shareholders' wealth (Wenming, Landell-Mills, Jinlong, Jintao, & Can, 2002; Witesman & Fernandez, 2013). Whereas in private firms, the profit maximisation theory is largely accepted and predominant through the literature, public organisations have a large number of goals and purposes, which makes it more difficult to define predominant theories. Furthermore, public administrations usually rely on private for-profit firms to build, operate, maintain, and renovate a growing number of infrastructures (Edler & Georghiou, 2007).

Therefore, the efficient management of financial resources must be a pre-existing condition for all public sector organisations, even if measuring government or other public authorities' performance is known to be extremely complex (Da Cruz & Marques, 2014; Osborne, 2006). The emergence of the New Public Administration trend (Bel, Hebdon, & Warner, 2007; Hefetz & Warner, 2011) has raised concerns about the efficiency of the use of public resources (Bovaird, 2014; Quirk, 2005). The literature also focuses on the necessity for governments to be accountable and for their performance to be measured correctly (Hood, 1991). The public sector, mainly in advanced economies, struggles both with fiscal pressures (Casal & Gómez, 2018) and the need to be more efficient and effective in order to reduce the taxpayers' burden (Brignall & Modell, 2000).

In the case of infrastructures projects, the main concern is with regards to cost and time deviations and overruns (Cheng, 2014; Flyvbjerg et al., 2002, 2004; Guccio et al., 2014; Shehu, Endut, Akintoye, et al., 2014). Cost and time overruns represent a failure in planning and an inefficient use of public resources (Gori et al., 2017), because they represent an increase in planned expenditure, for the same benefit, i.e., for the same infrastructure and/or public service.

Nevertheless, Khan & Hildreth (2004, p. preface) point out that "*Public financial management lacks coherent framework. To an extent, this is not at all unexpected given the diverse interests governments serve. Financial management decisions are needed in government to promote efficiency (such as lowest cost, highest return, positive net present value, etc.), as they do in the private sector. Achieving an efficiency goal, however can bet at variance or even in conflict with other policy goals, such as conducting affairs within budget consensus, avoiding unnecessary risks, and complying with control systems and debt covenants. Finance decisions also rest on human behaviour, but choices are often colored by personal and institutional biases and imperfections. Furthermore, resources are limited, although the claims on those resources are endless. Yet decisions must be made to preserve prescribed schedules*".

Therefore, which theoretical explanations of such cost and time deviations and overruns make public projects more expensive than initially expected and keep the project from delivering the expected benefits to the populations during the delay period? Consequently, this section intends to investigate these theoretical management explanations, in order to provide proper theoretical support for the exogenous causes of cost and time deviations and overruns under investigation. We started by examining the existing academic literature and the theories and causes that are empirically analysed.

From the literature, two possible approaches emerge for mapping cost and time deviations and the occurrence of overruns. A more exogenous approach is taken, focusing on the economic, political, managerial, and psychological explanations. This exogenous approach contrasts with an endogenous approach, which is based on project management factors and is focused on technical issues. An endogenous approach is mainly determined by changes in projects scope, changed orders, planning mistakes, and errors or omissions in contract documentation (Love, Smith, et al., 2015; Siemiatycki, 2009).

We follow the exogenous approach more closely, to address a strong gap in the management literature, and to contribute to both management theory and practice (making use of the large number of public projects observations collected). Our developed theoretical framework builds on existing theories but provides a more ambitious (and innovate) approach. This is achieved by creating a combined framework that incorporates exogenous determinants from several types of explanations, namely political, governance, and economic. The analysis suggests that these exogenous variables have been under-valuated in the existing literature, and that, indeed, they play a relevant role in understanding cost and time deviations.

Therefore, properly framing the explanations and understanding their theoretical support is of major importance to better understand and test for cost and time deviations and overrun causes. In Cantarelli et al. (2010, p. 15), it is mentioned that "*Considering the wide variety of explanations and theories, we recommend focusing on the type of explanation before applying a specific theory to better understand the cost overruns in projects. Each type of explanation requires the use of a different theory to understand the way in which cost overruns appeared*". In this case, the authors have prepared an extensive literature review that assesses the different basic explanations for cost overruns, framing these explanations with the appropriate supporting theories. Figure 1 resumes the conceptual theoretic framework presented in Cantarelli et al. (2010), which starts from the supporting theories and evolves into four groups of explanations on which cost overruns are based (political, economic, technical, and psychological explanations). The authors argue that the acceptability of each explanation arises from its theoretical embeddedness. Cantarelli et al. (2010) further conclude that a consensus exists which points out political explanations as being the prime origin for cost overruns. Furthermore, it is worth mentioning that cost underestimation and forecast manipulation were included in this category.

[Insert ***Figure 1*** here]

The reviewed literature has in common the fact that, despite the base explanation and theory used, all quantitative articles and studies point to project related/endogenous causes to justify the overruns. In Cantarelli et al. (2010, p. 15), the authors conclude that "*Therefore, the recommendation is to search for other promising theories that can help bring about a better understanding of cost overruns. Theories in the fields of political science, economics or institutions are considered useful. In addition, research into the explanations of cost underestimation with respect to contingencies and explanations regarding demand forecasts is considered valuable*".

Overall, causes for cost deviations and overruns can be attributed to political, economic, technical, or psychological explanations, with each category having a different descriptive narrative. Therefore, each should be dealt with by a different and suitable theoretical model. In short, while political explanations can be supported by the Machiavellian concept (which focuses on power and influence) or the Agency theory (which focuses on motives generated by self-interest). Technical explanations can be addressed from end to end by planning and forecasting theory. Similarly, economic explanations for demands economic theories, such as neoclassical economics or the rational theory, while psychological explanations fall under the prospect theory (Cantarelli et al., 2010).

Recently, Love, Smith, et al. (2015) conclude that political, economic, psychological, and managerial factors may also lead to the generation of what the authors call "pathogens", which emerge in the projects. Love, Smith, et al. (2015, p. 554) have continuously promoted a "balanced approach" to help understand overruns occurrence "*taking into account both the inside and outside view together with recognition of the engineering, management, complexity, geographic, and political characteristics of projects, will provide a better understanding of cost and time overruns. Explicit strategic decisions made by policy makers can have an adverse impact on governance and delivery strategies for a project. Evidence suggesting that optimism bias and strategic misrepresentation are the sole explanations for overruns is misleading, although transactional evidence indicates that they do account for a significant contribution to time and cost overruns of transportation infrastructure projects*".

Furthermore, Love, Ahiaga-Dagbui, & Irani (2016, p. 185) examine the complexity of the causes of cost overruns. They divide the sources of overruns into two "schools of thought", namely: (i) "*Evolution Theorist*", were overruns are a result of changes in scope and definition between the inception stage and eventual project completion, and; (ii) "*Psycho Strategists*", which are, according to the authors, "*a combination of psychological contributors and business strategy*" for which overruns are a result of "*deception, planning fallacy and unjustified optimism*" of the initial forecasted costs.

Another interesting study was carried out by Ahiaga-Dagbui & Smith (2013, 2014b, 2014a), who used data mining, which is a computational procedure that tries to find patterns through the use of large sets of data to improve prediction models which reduce project cost deviations. The authors presented a conceptual model which aims to separate the concepts of cost underestimation and cost overruns. For this, they seek theoretical support in the prospect theory, with political (strategic misrepresentation) and psychological (optimism bias) explanations for cost underestimation in the project definition phase, with mainly technical explanations for cost overruns which occur during the project construction phase.

Later on, Cantarelli et al. (2013) focus on the strategic behaviour with non-symmetric information between owner and contractor, supported by the agency theory. The authors used a signalling game - a game with two players, one being the sender and other the receiver, where both have incomplete information and try to anticipate other parties' behaviour, which leads to cost overruns due to incorrect signalling. Odeck et al. (2015) focuses their study on technical, psychological, and political-economic explanations. The authors confirm the success of the implementation of a quality assurance regime for cost estimates above 500 million NOK in the early 2000's as an effort to fight cost overruns in Norway.

Additionally, Lind & Brunes (2015) tried to explain overruns by developing a new theory-based framework for infrastructure investments. For this, the authors designed a questionnaire for project managers in Sweden and concluded that the most relevant explanatory factors were lack of competence and optimism bias. Additionally, they concluded that overruns mainly arise during the initial phases of the projects, due to changes in the initial project and an increase in the amount of inputs caused by administrative and technical complications.

In the following subsections we present the supporting theories that sustain each one of our formulated hypotheses in our theoretical conceptual model. Such theoretical explanations emerge from the revised literature. We start with the agency theory and information asymmetry and end with the opportunistic behaviour theory to ascertain how political and electoral cycles contribute to the increase of cost and time deviations and overruns. Following this, we will use the institutional theory as the supportive theory to study governance in public projects, namely the impact of the institutional and regulatory framework and how such factors can impact cost and time deviations and overruns. Later, we make use of the political economic cycles theory to assess the way that economic cycles also impact cost and time deviations and overruns and to see if there is a relation between the health of a country's public finances and the propensity for the occurrence of overruns due to weaker expenditure control mechanisms. Lastly, we make use of incomplete contracts theory to support the impact of higher uncertainty, as measured by project size. Larger projects have more complex contractual frameworks which ultimately lead to higher uncertainty for the completion of contracts, which in turn also lead to an increase in cost and time deviations and overruns.

For all the supporting theories we focus primarily on the way that each one relates to the existence of deviations and overruns in public projects, and at the same time we justify why we consider these theories to be appropriate for the objectives of our research.

3.2. Political Explanations

In this subsection we develop opportunistic behaviour (agent opportunism) as our main theory to support our political explanations. However, this would not have been possible without first presenting the agency and information asymmetry problems that lead to such opportunistic behaviour problems. As presented in Subsection 2.4, political explanations have as their main cause strategic misrepresentation when forecasting the final cost of a project (Flyvbjerg et al., 2002). A few other sub-explanations also exist which may be included in this larger explanation, namely deliberate costs underestimation and the manipulation of projected forecasts, whereby such behaviours are attributed to facts such as increasing the chances of project approval for costs underestimation and attempts to promote projects which may lead to a lack of objectivity for the manipulation of projected forecasts. The reasons for such strategic behaviour can be resumed as the following: the motivation for managers to present “better” projects in order to potentiate project selection; the absence of consequences for projects with underestimated costs; forecasts distortions due to information asymmetry between those responsible for decision-making and other project stakeholders; badly-defined financing and funding structures, and; organisational and political pressures to build such projects (Cantarelli et al., 2008). The political theory can explain cost overruns in terms of strategic behaviour (Flyvbjerg, Bruzelius, et al., 2003; Hall, 1982; Kahneman & Lovallo, 1993; Lovallo & Kahneman, 2003; Pickrell, 1992; Wachs, 1989).

Political explanation in the literature has its origins in the existence of many stakeholders who gravitate around the political system, each one with their own purposes and objectives. This normally results in additional project requirements and consequently more-than-expected costs. Furthermore, moral hazard, which is interpreted as being the absence of norms and values from the forecasters who do not value the importance properly when accounting for all project details must be considered to be a political explanation, which is supported by political theories, the ethical theory and the agency theory (Cantarelli et al., 2008). The ethical theory sustains that cost overruns occur by the manipulation of forecasts (Flyvbjerg, Bruzelius, et al., 2003; Wachs, 1989). The lack of the attribution of importance to values and norms by forecasters when making accurate forecasts can be explained by the ethical theory.

3.2.1. Agency Theory

The agency theory (Arvan & Leite, 1990; Flyvbjerg, Bruzelius, et al., 2003; Wachs, 1982) supports strategic behaviour and why it is a consequence of asymmetric information, which means the lack or incompleteness of information that the person responsible for taking decisions encounters when facing a project selection or a project approval issue. Accordingly to Jensen & Meckling (1976, p. 310), an agency relationship is "*a contract under which one or more persons (the principal(s)) engage another person (the agent) to perform some service on their behalf which involves delegating some decision making authority to the agent. If both parties to the relationship are utility maximizers, there is good reason to believe that the agent will not always act in the best interests of the principal. The principal can limit divergences from his interest by establishing appropriate incentives for the agent and by incurring monitoring costs designed to limit the aberrant activities of the agent. In addition in some situations it will pay the agent to expend resources (bonding costs) to guarantee that he will not take certain actions which would harm the principal or to ensure that the principal will be compensated if he does take such actions. However, it is generally impossible for the principal or the agent at zero cost to ensure that the agent will make optimal decisions from the principal's viewpoint. In most agency relationships the principal and the agent will incur positive monitoring and bonding costs (non-pecuniary as well as pecuniary), and in addition there will be some divergence between the agent's decisions and those decisions which would maximize the welfare of the principal*".

This concept was later used by Fama (1980) and applied to the specific case of the separation between ownership and control. Furthermore, Fama & Jensen (1983, p. 330) applied the agency theory to a problem of the separation of management and finance functions, by defining agency costs has those that "*include the costs of structuring, monitoring, and bonding a set of contracts among agents with conflicting interests, plus the residual loss incurred because the cost of full enforcement of contracts exceeds the benefits*".

In Cantarelli et al. (2013, 2010, 2008), the authors state the agency theory as the evident theory to support political explanations and point out that it can cover cost overruns in a properly specific way, and that attempts have been made to comprehend overruns using such theory. In our explanatory study, in order to capture for the exogenous causation effects that we are trying to test for, and despite the comprehensiveness of agency theory, we needed to go further than the agency theory. To this end we used the opportunistic behaviour theory when researching how political and electoral cycles contribute to the increase of cost and time overruns and incomplete contracts theory was used when trying to make use of a control factor for our model. For the latter purpose, an endogenous approach was used with intrinsic project-related independent variables, such as the sector where such projects were developed and the impact of higher uncertainty, which was measured by projects size, where larger projects are more complex, leading to higher uncertainty regarding project completion, which in turn leads to an increase in cost and time overruns, as evidenced in the reviewed literature.

The agency theory makes use of a number of disciplines, ranging from politics and economics through to sociology, which make it a fairly complete theory (Eisenhardt, 1989; Kiser, 1999). From a public decision model based on a human rationality perspective and expected utility maximization, the principal-agent theory (PAT) is based on transaction costs and problems of information asymmetry. This provides support, in a proper and efficient way, for the contracts relationship between the principal (public level of government) and the agent (private for-profit firm) and aims to avoid opportunistic behaviour. PAT was originally used in economics studies, although at the same time it makes use of other disciplines, such as sociology and politics, which thus makes it an accurate and complete approach (Ross, 1973; Sappington, 1983; Shavell, 1979; Spence & Zeckhauser, 1971; Stiglitz, 1989).

The basic problem that the principal-agent theory addresses is the relationship structure that must exist between the principal and the agent in order to assure that the agent will always, or at least for the majority of times, act in the best interests of the principal and therefore it mainly applies to the public sector. Noreen (1988) considers that people act in their own specific self-interest with, if necessary, astuteness and dishonesty (opportunistic behaviour). A study by Arvan & Leite (1990) which focuses on large-scale government-sponsored procurement also used agency theory to support their conclusions when providing an explanation for cost overruns, assuming that the principal cannot pre-determine a compensation to be paid to the contractor when the latter has some private cost information which is not fully disclosed to the principal.

In his research, Wachs (1982, 1987) reviewed numerous forecasting models for the transports sector, finding that forecasts are frequently inaccurate, underestimating costs and overestimating traffic demand. He also concluded that forecast errors always tended to overestimate traffic demand and underestimate costs, which led him to conclude that "*travel and cost forecasting is deliberately slanted to produce figures which constitute technical justification for public works programs favoured on the basis of political rather than economic or technical criteria*" and he further concludes that "*the competitive, politically charged environment of transportation forecasting has resulted in the continuous adjustment of* *assumptions until they produce forecasts which support politically attractive outcomes*" (Wachs, 1987, pp. 63–65).

Furthermore, Ascher (1987) concluded on politics and policy formulations/implementation and their consequences. The author identifies three major causes for cost errors in forecast procedures, namely: changes of scope; lower than reality rates of inflation, and; delays, concluding that around 40-90% of the total cost overrun can be described by such factors, although a considerable part remains unaccountable. Other possible causes of error are attributed to the specific funding procedures for rail transit projects, where an incentive exists to draw a more favourable forecast for the estimation of project costs. Additionally, recent studies on infrastructure investments have focused on the principal-agent issue and misplaced political incentives, which have been responsible for a weak and imperfect decision-making process.

In Flyvbjerg (2008), the author started to develop an explanatory framework for cost overruns, where the political-economic explanation (one out of three explanations presented) is grounded in the strategic misrepresentation, meaning that there is a deliberate and strategic overestimation of benefits and an underestimation of costs, in order to enable projects to be more easily-approved by the competent authorities.

In Flyvbjerg, Garbuio, & Lovallo (2009), the authors develop two explanatory models: the first, "delusion", covers psychological explanations (which is not covered in our research), and; "deception", which covers the imperfect decision – which applies to the planning process, in terms of political, organisational, and agency questions. The authors describe the principal-agent problem and the sources of "strategic deception". A qualitative statistical research from Ansar et al. (2014) reaches similar conclusions when showing that construction cost are continually biased through consistent forecasting errors. This theoretical framework was also applied by Lawrence (2004) for both public service delivery contracting and performance-based contracts.

Furthermore, Leruth & Paul (2006) studied and produced an approach of the principal/agent theory for public expenditure management systems, analysing the benefits derived from the use by the Ministry of Finance of two control instruments to assess their value in terms of their ability to detect cheating: ex post audits and ex ante controls. Later on, when analysing the theoretical support for cost overruns in large-scale transportation infrastructures, Cantarelli et al. (2010) consider that the agency theory and the principal-agent problem is frequently used to address the strategic behaviour for political explanation, and they recommend PAT as a basic theory to understand cost overruns. Additionally, in Page 15, the authors clearly state "*Agency theory can explain why strategic behaviour is made possible by the concept of asymmetric information. It is also used in the context of possible institutional set-ups between parties to guide the decision-making on projects. The asymmetric information makes it possible for an agent to take strategic advantage of the set-up of the funding process to deliberately under-budget their projects in order to see them realised.*"(Cantarelli et al., 2010, p. 15).

The principal-agent theory argues that the source problem in circumstances where principals (government organisations) direct the behaviour of agents (for-profit firms) begins with information asymmetries and goal incompatibility between these principals and agents (Miller, 1992). The less that principals are able to monitor the agents' performance, the more problems they will have in applying corrective measures.

3.2.2. Information Asymmetry

Rarely does a principal have all the information needed to make a rational choice. The difference of information that exist between the principal (organisation from any level of government) and the agent (private contractors) is referred to in the literature as information asymmetry - a conception related to the "bounded rationality" of Simon (1976, 1979, 1982). Contractors normally possess a deeper knowledge of a project's planning and construction details than the public organisation that has taken the decision to invest in such a project, which may lead high inefficiency when it comes to contracting. This fact can only be mitigated through contract monitoring tools that need to be enforced, preferably during a project's implementation (planning and execution phases), as argued by Lawrence (2004), or ultimately, at the final delivery of the project, through compliance audits performed by the government's competent body (which, in Portugal is the Court of Auditors, whose data we used for our research, which is presented in Subsection 4.1).

Leruth & Paul (2006) also used information asymmetry to explain an advantage over the principal which leads to a "rent" that the agent charges, which can be interpreted in a broader definition made by the authors for the occurrence of corruption events due to the absence of governance. Such interpretation enables the linking of such an approach to the literature on corruption, as pointed out by the authors. Furthermore, Hansen, Hoskisson, & Barney (2008) also sustain that information asymmetry can be the origin of considerable gains and generate dangerous opportunism behaviours at the same time, which ultimately can lead to adverse selection and moral hazard issues.

The issue with information asymmetry is that it produces two additional problems for managing investment contracts, namely: incomplete contracts problems and agent opportunism problems.

3.2.3. Agent Opportunism – opportunistic behaviour

The first issue that information asymmetry[1] raises is agent opportunism, which is when agents (contractors) pursue their own interest instead of the interests of the principals (government organisations). Kavanagh & Parker (2000) use the example of a private firm that delivers lower-than-expected results, with the purpose of reducing their costs and increase their profitability. It is important to refer that agents for-profit private firms are more prone to opportunism than other forms of organisations, such as non-profit firms and governmental organisations (Light, 2011; Wise, 1990).

Furthermore, Vining & Boardman (2008) state that public decision-makers are exposed to opportunistic behaviour when entering into a transaction with a private agent, particularly at government level where there are low contract management skills (both at project and contracts level) and they conclude that, ironically, the most complex and uncertain projects are those where the government relies the most on private entities. According to Lawrence (2004), "*Agent opportunism is also the primary reason that "cost plus a percentage of cost" are no longer used by most governments; these types of contracts create perverse incentives, in that contractors increase their profits by increasing their costs.*". Nevertheless, according to the principal-agent theory, agent opportunism can be eliminated through the implementation of *ex ante* conditions (penalties and/or incentives), which are conditioned by *ex post* monitoring control procedures (Bajari & Tadelis, 2001; Kettner & Martin, 1985).

Furthermore, Vining & Boardman (2008) also sustain that public and private participants have conflicting goals with an impact on transaction cost economics. Trailer, Rechner, & Hill (2004) reach a similar conclusion, concluding that this disagreement of goals tends not only to raise transaction cost, but also to drive the reduction of the quality of the final outputs and/or undesirable negative externalities. Previous research has demonstrated that whenever inter-organisational conflicting goals structures are put in place, higher contract costs often occur, as a result of the adoption of opportunistic behaviour by at least one of the negotiation sides, with

[1] The other issue is incomplete contracts problems, which will be discussed below in Section 3.5

a failure to accomplish the purposed goals (Boardman & Vining, 1989; Brown & Potoski, 2003; Eckel & Vining, 1985; Hansen et al., 2008).

D'Alpaos et al. (2013) consider that uncertainty in forecasted investment costs may produce material risks and opportunities, which can prompt contractors to adopt opportunistic behaviour, such as time overruns. Such opportunistic behaviour can be understood in this context to be the strategic behaviour by the contractor in face of an irreversible investment to delay the deliveries of such a contract if they found an increased economic value that increases their payoff. This said, carrying out such an opportunistic behaviour to strategically delay works and produce time overruns is sometimes due to incomplete contracts that have no embedded penalty clauses. Similar conclusions were reached by other authors (Chapman, Ward, & Bennell, 2000; King & Mercer, 1985; Lo, Lin, & Yan, 2007; Yiu & Tam, 2006), which all added to time overruns under-pricing behaviours.

In addition, Guccio, Pignataro, & Rizzo (2014) found a positive correlation between subcontractors and legal disputes with project delays, when the contractor is simultaneously in charge of the project's design and execution, which, accordingly to the authors, implies a greater possibility for opportunistic behaviour to occur. The utilisation of competitive tenders by governmental decision-makers as selection mechanism focused on prices is also the focus of the research developed by Diekmann & Nelson (1985); Hinze & Selstead (1991), and; Love et al. (2014), who concluded that contractors adopt opportunist behaviours to win public tenders by lowering their initial bidding prices and then later enter into claim disputes.

In a study that involved the analysis of 45 projects from transportation infrastructure in the Netherlands, Verweij et al. (2015) found no evidence of opportunistic behaviour from the contractors, although the small number of observations is believed to have limited, and to a certain point biased the conclusions of such research, as the authors themselves state. Furthermore, Flyvbjerg et al. (2009) add that, in order to prevent the occurrence of cost overruns, measures to address opportunistic behaviours need to be implemented during the biding phases, citing the example of the construction of the Sydney Opera House, where during the bidding, the contractual framework imposed by the local authorities allowed bidders to act in an opportunistic manner and bid with the lowest underestimation costs possible in order to be awarded the tender. Accordingly, the underestimated price would be compensated by overpricing during construction. The literature also approached the issue of claims submission for project overcharges through the perspective of incomplete contracts, especially through the project documentation containing errors and/or omissions (Cheung & Yiu, 2006; Love, Edwards, & Wood, 2011).

Additionally, Siemiatycki (2009) approaches opportunistic behaviour when describing the increasing role of private agents (planning and engineering consultants) during project design phases and the incentives that they believe they have to deliver better conclusions in order to ensure that a project is approved and hence to improve their chances of winning further contracts (and gains) within the project. The author clearly distinguishes such behaviours from any form of a deceptive behaviour, contrary to the example of politicians, whom the author describes as being those known to intentionally omit technical details, especially when addressing parliament or the media, citing the example of traffic forecasts to justify new investments.

Lastly, Shah (2006, p. 11), in a paper that approaches the conceptual and empirical basis of corruption, presents neo-institutional economics (NIE) as being "*a refreshing perspective on the causes and cures of corruption*" and continues further to state that the neo-institutional economics approach "*argues that corruption results from opportunistic behaviour of public officials as citizens are either not empowered or face high transaction costs to hold public officials accountable for their corrupt acts. The NIE treats citizens as principals and public officials as agents. The principals have bounded rationality – they act rationally based upon the incomplete information they have. In order to have a more informed perspective on public sector operations, they face high transaction costs in acquiring and processing the information. On the other hand, agents (public officials) are better informed. This asymmetry of information allows agents to indulge in opportunistic behaviour which goes unchecked due to high transactions costs faced by the principals and a lack of or inadequacy of countervailing institutions to enforce accountable governance*". This allow us to make the connection with the governance problem that we also address, which will be discussed next.

In the next subsection, we address our second exogenous explanation- the governance explanation, where we aim to measure the impact of the worst institutional and regulatory framework on the increase of cost and time overruns. In more detail, our object is to see whether worse corruption and rule of law indicators, governments are less capable of enforcing contracts, which will lead to increased cost and time. For this purpose, we rely on institutional theory to provide the necessary theoretical support.

3.3. Governance Explanations - the Institutional theory

Institutional theory provides a framework that enables the identification of the project context and provides a way to investigate corruption as an institutional/organisational, or social phenomenon. Henisz, Levitt, & Scott (2012) and Scott (2005) agree that institutions can be theorised, assuming three major perspectives: regulative; normative, and; cultural-cognitive. These perspectives enable the identification of collective rules, norms, values, beliefs, and understandings which characterise institutions. Similar to Locatelli, Mariani, Sainati, & Greco (2016) our research also assumes that corruption is institutionalised at the country-level as a social phenomenon, due to the stability and uniformity of rules, cultural values, and shared beliefs inside a country. Accounting for country-level is consistent with other research (Jensen & Smith, 2000) and is valid for assessment for the project context. There are several examples in the literature that confirm the use of a country as a reliable institutional context (Bologna & Del Nord, 2000; Bremer & Kok, 2000; Winch, 2000).

Another characteristic of public investment is that the decision to invest is normally a collective decision, which is rather more complex than the normative analysis may suggest. Although many decisions are taken by one individual agent (may it be a minister, regional leader, or a city mayor), most of these decisions are decided by collectives of people – a collective choice - which normally means that an institutional process of transformation is agreed on from multiple individual preferences, in order to achieve a single collective decision (Mueller, 2003). In Table 12, a summary of studies reviewed which focus on the impact and importance of political decisions and electoral cycles which add to the problem of project overruns. The "Key Ideas" column lists the key elements that have emerged from each paper, with the purpose of enhancing the identification of the critical aspects of each study. The "Expected Signal" column corresponds to the overrun of the expected signal due to the impact of the key idea elements on public projects.

[Insert ***Table 12*** here]

Cantarelli et al. (2010) consider institutional theory as an interesting theory when approaching cost overruns issues, since the poor institutional/governance framework of those organisations responsible for both the decision process to build and also to contract the private contractors who are sub-contracted to develop such public infrastructures. The authors also sustain that overruns can arise due to non-optimal behaviours that are the consequences of the cited inadequate institutional ambience, which can lead to an underestimation of costs with the aim of easily approving such investments. This decision-making problem is of high relevance in terms of management theory and management practice, as it brings into consideration various multiple decisions that are needed to be taken by individuals acting alone or grouped in an organisational structure (public institutions). Such decisions are expected to be rational, sustained, and to be taken in accordance with the environments where such individuals are embedded (Dunleavy, 1992).

As it is one of the classifications used in our collected data, the level of government impacts on the occurrence of overruns, which, although already-mentioned, is of utmost importance. Once again, this is a relevant management topic, as understanding whether there are substantial organisational differences and outputs arising from the level of government commissioned to take charge of the decision to invest and whether the results may justify adopting different management structures, decision-making processes, and governance frameworks. Bird (1994) sustains that as public investments are normally expected to have significant social and economic impacts on the local populations that surround such investment, either direct or indirect the delivery (design, funding, applicable legislation if needed and the operation and management) of such investments could be adjusted in terms of the level of government that provides them. For this reason, we approach the specific topic of level of government in the next paragraphs.

The set of results in the conclusion section will be of relevance to understand whether political decentralisation has been successfully in managing tax payers' money and whether any other form of decentralisation (e.g. regional) has obtained better results and whether a regionalisation reform would be useful to obtain better results. This point makes the approach of our research not only relevant, but also highly actual in terms of public discussion. A better understanding of the optimal level of government required to deal with the execution of public projects in general, and overruns in particular, are of high importance, with huge policy implications for the way that organisations deal with such investments.

The authors Guccio et al. (2014) researched the problem of time performance for the realization of public projects, based on the level of government of the contracting authorities responsible for the decision-making process and the consequent management of the contracts with private operators and they reached the conclusion that local governments appear to be less effective in the management of such processes, as longer delays are encountered when compared with central government. The authors further add that the smaller the municipalities, the greater the overrun, especially when external funding resources were used.

Many of these issues arise from the fact that local policy-makers are more likely to suffer some type of pressures from local interest groups to defend their specific interests. Public investments can be a considerable trigger for obtaining political gains, such as retention or further development, or simply the protection of a local industry or business. This will lead to significant spill overs for job creation or job maintenance among other social and economic benefits. As pointed out by Coviello & Gagliarducci (2016), the local decision-maker potentially attempts to try to seek a political consensus which allows them to remain in charge. Even if it is to defend such public interest, the local decision-makers do not always take the most efficient decisions, such as selecting the proper service-provider. The authors reached the conclusion that a relation exists between the number of years in power and worse results for the public procurement process, an example being less competition between firms with a preference for local firms, with the same firm being awarded contacts several times and higher costs.

Due to this proximity between decision-makers and local interests at a decentralised level of government, it is normal to bring up the issue of corruption and lobbying into the discussion. As pointed out by Durante, Labartino, & Perotti (2011), the relation of corruption or its variation with decentralisation is an issue that has not been extensively covered in the literature. Furthermore, when studying whether centralisation affect the number and size of lobbies, Redoano (2010) reaches the conclusion that the connection between decentralisation and lobbying activities is uncertain. Nonetheless, this association between corruption and more decentralised levels of government is not completely clear in the literature, as corruption is a difficult social phenomenon to capture and measure, mainly when we try to isolate it from the institutional framework for which decisions are made. On the other hand, Shah (2006) concludes that a decentralised local governance is favourable for a reduction in corruption in the long term, as the authors conclude that localisation reinforces government accountability, by involving citizens in monitoring government performance and by demanding corrective actions, which ultimately help to break the monopoly of power at a central level and to bring decision-making closer to people.

Fan, Lin, & Treisman (2009) warn about generalisations regarding the linkage between level of government and corruption, which always must take into consideration geography and the proper context. Using a cross-national data set from 80 countries, Fisman & Gatti (2002) concluded that decentralisation has a relationship with lower levels of corruption, using time-series data. Additionally, when researching the time it takes for government decentralisation to affect corruption, but now using time-series for 24 countries for the period of 1995-2007, Fiorino, Galli, & Padovano (2015) conclude the same way as before, which is that countries with less-centralised fiscal powers have lower levels of corruption. In the conclusion section, and accordingly to the available data, our proposed research questions and hypotheses contribute to the discussion, at least for the specific case of Portugal, where we present a path which is easily replicated by other researchers, which may account for other results for different countries.

Another topic on the subject of decentralisation is the less-used practice of putting into practice approved public policies and administrative procedures that need to be fulfilled to decide and execute public projects, which is mainly due to the lower number of public investments procured when compared with central government (Besfamille, 2004; Boadway, Horiba, & Jha, 1999; Reinikka & Svensson, 2004). At the same time, this set of reviewed authors also suggest that topics such as incentive contracts, asymmetric information, and lack of accountability has weaken the potential benefits of a more decentralised approach to the provision of public investment.

Using a case study of the Italian high-speed railway system Locatelli et al. (2016) leverage the institutional theory to present the concept of "corrupt project context", namely for megaprojects. The authors identify several characteristics that augment the probabilities of a project being involved in corrupted actions. These characteristics include "*project size, uniqueness, heavy involvement of the government and technical and organizational complexity. We observed that megaprojects match all these characteristics. Furthermore, projects delivered in "corrupt countries" or "corrupt project contexts" are more likely, ceteris paribus, to suffer corruption than in less corrupt contexts. Project context matters: discretionary power of officials, economic rents of policy/decision makers and weak institutions make a country ideal for corruption"* (Locatelli et al., 2016, p. 264). Consequently, the authors conclude that corruption is harmful for project management, as cost overruns and time delays are registered during the construction phase and corrupted infrastructures do not achieve their expected economic purpose and social benefits.

Lastly, due to its complementarity to our ground theory, it is also important to mention neo-institutional economics (NIE), which present a new and advanced perspective on the reasons and remedies of corruption, which fits plainly with our research goals. This theory argues that "*corruption results from opportunistic behaviour of public officials as citizens are either not empowered or face high transaction costs to hold public officials accountable for their corrupt acts. The NIE treats citizens as principals and public officials as agents. The principals have bounded rationality – they act rationally based upon the incomplete information they have. In order to have a more informed perspective on public sector operations, they face high transaction costs in acquiring and processing the information. On the other hand, agents (public officials) are better informed. This asymmetry of information allows agents to indulge in opportunistic behaviour which goes unchecked due to high transactions costs faced by the principals and a lack of or inadequacy of countervailing institutions to enforce accountable governance. Thus corrupt countries have inadequate mechanisms for contract enforcement, weak judicial systems and inadequate provision for public safety. This raises the transactions costs in the economy further raising the cost of private capital as well as the cost of public service provision."* (Shah, 2006, p. 11).

Furthermore, Lambsdorff (1999) and Lambsdorff, Taube, & Schramm (2004) confirm this understanding that to fight corruption, policy makers should adopt various behaviours according to the NIE. Examples include promoting discord and disloyalty between corrupt parties, undermining corrupt deals, and creating mechanisms that prevent corrupt contracts from being enforced, whilst at the same time help regulate conflicts of interest.

Corruption is very difficult to measure and to make a proper assessment of, which is the reason why, in this research we use the World Bank - World Governance Indicators (Subsection 4.4 and Appendix A). However, we go beyond analysing just corruption, and do not limit our analysis to corruption, but extend it to five other dimensions of governance, namely: voice and accountability; political stability and absence of violence; government effectiveness; regulatory quality; rule of law, and; control of corruption. These indicators give us the perception on a country by country basis of the traditions and institutions by which authority is exercised, including: the process by which governments are selected, monitored and replaced; the capacity of governments to effectively formulate and implement sound policies, and; the respect of citizens and the State for the institutions that govern economic and social interactions among them (Kaufmann, Kraay, & Mastruzzi, 2011).

Similar to Locatelli et al. (2016), our research assumes that at the country-level, corruption is institutionalised as a social phenomenon inside one country. Accounting for country-level is consistent with other research (Jensen & Smith, 2000) and is valid for assessment in the project context. There are several examples in the literature that confirm the use of a country as a reliable institutional context (Bologna & Del Nord, 2000; Bremer & Kok, 2000; Winch, 2000). Furthermore, Henisz et al. (2012) and Scott (2005) agree that institutions can be theorised from three major perspectives: regulative; normative, and; cultural-cognitive. These perspectives allow for the identification of collective rules, norms, values, beliefs, and understandings that characterise institutions. The institutional theory provides a framework which enables the identification of project context and provides a way to research corruption as an institutional/organisational or a social phenomenon.

3.4. Economical Explanation – the Economic Cycles theory

The authors of this research know and understand that there is little difference between economic explanations and political explanations in the classification of the supporting explanation theories used for explaining the occurrence of overruns. The same conclusions were reached by Cantarelli et al. (2010) who affirmed that both explanations try to understand behaviours (including strategic behaviour) using utility as a basis, but using different starting points. While political explanations focus on interests and power, the economical approach focus on the problem of the lack of incentives and resources which are required to reach utility maximisation. The same authors concluded in their literature review paper that economic explanations were mainly based on: (i) neoclassical economics, which understands overruns as a problem of scarce resources allocation, whereby incentives and costs play an important part in influencing the decision-making process, and; (ii) the rational choice theory, which focuses on understanding social and economic behaviour, giving support to the idea that it can be rational to have overruns, as they result in higher-than-expected profits.

Once again, without diverting from the basic framework of the existing literature, we needed to advance a little further ahead of the existing literature to challenge the problem of how to measure whether better economic cycles have an impact on increasing cost and time overruns from a project exogenous perspective, in the sense that when money is available for governments to spend, this tends to reduce expenditure control mechanisms, which consequently leads to an increase in cost and time overruns. For this purpose, we used the economic cycles theory, which surmises that economic, or business cycles are repeated in alternating sequences of expansion (growth) and contraction (recession) of economic activity. Such activity in measured by factors such as gross domestic product (GDP), employment levels, interest rates, and consumer spending. Accordingly, an economic cycle is the fluctuation of the aggregated economic activity of a country (which is mainly produced by businesses, and thus there is ambiguity between economic and business activity), which is measured by the time period between two inflection points (two lows or two highs). Therefore, a cycle is a sequence of changes, recurrent but not periodic, which consists of a sequence of expansions and recessions, which occur at the same time in a large number of countries' economic activity. In terms of its duration, a cycle can last from one to ten or twelve years, and they are not divisible into shorter cycles (Burns & Mitchell, 1938; Greenwood & Hercowitz, 1991; Mascarenhas & Aaker, 1989; Nordhaus, 1975; OECD, 2017; Lucas, 1980).

The analysis carried out is to test whether an increase in GDP (measured as a percentage) or an increase in annual inflation may lead to higher and/or more frequent overruns, as higher inflation reflects a general increase of prices in the economy, which may leave to an increase in project costs through increases in work costs and construction materials. To test for this research hypothesis, we defined the following to be independent variables: GDP growth; public investment in % of GDP, and; annual inflation, both of which are measured as a percentage. We use GDP growth as a proxy to help identify the point in the business cycle where the overrun occurs, and annual inflation to try to capture the increase of prices (work and materials) which may lead to an overrun, as we already know that inflation and growth are negatively associated (Barro, 1995; Fischer, 1993).

In Kerzner (2005), a system of planning, scheduling, and controlling, which are the foundations of project management, indicated that cost overruns are incidents with a noticeable occurrence during any phase of project development. The prevailing causes include: misunderstanding of project requirements; incorrect evaluation of in-house capabilities; underestimating the time and cost necessary to complete the project; inaccuracy of budgets and forecasts; the use of inappropriate techniques/approaches for the project; incorrect identification of cost elements; inaccurate project specification, and other macro-economic conditions that must be tackled and considered at a management level in any effective risk analysis which aims to produce a correct project selection. The level of risk that a project manager is willing to accept in a project is, among others, a consequence of the impact of current economic conditions. Ultimately, the economic climate will also affect the decision-maker management philosophy of assuming the importance of a project during an expansion cycle, which encourages the project manager to adopt a no risk, no responsibility approach, even if virtually, for the execution of such projects, passing on any responsibility higher up the hierarchy (Wilemon & Cicero, 1970).

In Russell (1991) and Russell & Jaselskis (1992), the authors research a predictive 'contractor failure model' which attempts to anticipate the probability of failure prior to the award of a contract to any specific project, as such failure represents huge costs for the construction industry, especially through reduced productivity and time and cost overruns. Increasing costs incurred while attempting to recuperate earlier failures is also a reality which can lead to inflated construction costs. The model is based on the project's own characteristics, such as size, contractors' characteristics and economic-related (macroeconomic) factors which are exogenous to the projects under scrutiny. Other authors aim to explore and identify key risks factors which can be confronted by construction firms and they conclude that, due to their industry-intrinsic characteristics, that these firms, especially the largely fragmented ones, are very competitive, due to the large number and easy access of firms to the market. They are also very sensitive to economic cycles. Such identified risks, together with others that are presented in the study, also lead to time and cost overruns issues (Enshassi, Al-Hallaq, & Mohamed, 2006; Gupta & Sharma, 2015; Patel, Yadav, & Pathak, 2016).

Furthermore, Siemiatycki (2013) considers economic cycles together with technological innovation to be the foundation of a new type of mega-projects, which are more effective or efficient than the earlier ones. Such mega projects are motivated by political and policy attraction of being able to achieve major tangible benefits. Recurrent overruns, namely cost ones, are one of the reasons highlighted for the decline of mega projects, as they are a common challenge for large infrastructure projects, such as power plants and large-scale urban rail lines.

3.5. Project Explanation – the Incomplete Contracts theory

Another consequence which originates from the above-mentioned information asymmetry problems, is that government organisations and contractors are unable to correctly forecast all the issues (which are normally problems which occur during the execution of the contract) that may arise during the completing of a public contract (Kavanagh & Parker, 2000). For this reason, in the principal-agent theory, information asymmetry is said to be the origin of "incomplete contracts".

Regarding incomplete contracts, it is stated in the literature that such contracts lack accuracy, which means that it is difficult to foresee all contingencies during a contract's execution until its completion. Consequently, incomplete contracts need to be updated and corrected, in order to incorporate in their wording and clauses all those unexpected events that could occur or have occurred. In consonance with information asymmetry, all contracts are, to some degree, incomplete. Nevertheless, the principal-agent theory suggests that the lower the degree of incompleteness of a contract, the lower are the related transaction costs (Brown & Potoski, 2003; Brown et al., 2006; Hart, 2003).

Transaction costs, which are an intrinsic characteristic of the principal-agent relationship, can be characterised as being those cost principals incurred to insure that agents act in their best interests (Kettl, 2011; Lawrence, 2004; Sclar, 2001). Furthermore, transaction costs can occur at two levels in any organisation: (i) internally, for example in an employer/employee relationship, or; (ii) externally to the organisation, for example, in a government/contractor relationship (which is the one we focused our research on). Transaction cost analysis based research is mainly attributed to Williamson (1975, 1985), according to whether the cost of producing any good or service is a combination of both production costs and transaction costs.

The literature on incomplete contracts has been centrally focused on the question of which party in a collective organisation should have the right to undertake certain activities for the management of that organisation's assets. In a reality where all contracts are complete, this question would be indifferent for the result of which party has that right, as the contract or agreement should stipulate what the necessary arrangements are as a function of the significant conditions. In such a situation, the distribution of actions to agents is important, due to a gain in efficiency due to a comparative advantage in performing some specific actions, although it would not have any effect on the actions and outcomes achieved. However, if we consider the incompleteness of such contracts, it will start to matter seriously who has the power to intervene, according to the circumstances, as we would assume that such agents act according to their interests. Thus, determining who has the power to act in a contract should, therefore, be a matter of anticipating which of the parties (agents) will supposedly act in such a predictable way. The allocation of powers in a contract then becomes a matter of higher importance, and this becomes more critical when it is impossible to foresee the amount of power that needs to be exercised when a determined circumstance occurs (Aghion & Bolton, 1992; Dewatripont & Tirole, 1994; Grossman & Hart, 1986; Hart & Moore, 1990; Simon, 1951).

In Seabright (1996, p. 61), the author brings to light the problem of the appropriate level of decentralisation of power in government being a problem during the allocation of control rights under incomplete contracts, affirming that his model "(…) *compares allocations of power to local, central and regional government as alternative means of motivating governments to act in the interests of citizens. Centralisation allows benefits from policy coordination but has costs* *in terms of diminished accountability, which can be precisely defined as the reduced probability that the welfare of a given region can determine the re-election of the government. The model is extended to allow for conflicts of interest within regions, and externalities between central and local governments in a federation. It is also applied to determining levels of fiscal transfer between localities, and to circumstances where governments may act as Leviathans appropriating resources for their own use*". The author concludes with the idea that formal, or informal contracts between voters and their political representatives may be considered in many significant ways for incomplete contracts and to formalise the trade-off between centralisation and accountability, which has long been familiar in political theory and political science - "*in a way that defines accountability precisely, by taking a contracting approach to the problem of motivating politicians and applying the notion of contractual incompleteness to the problem of allocating power*" (Seabright, 1996, p. 66).

3.6. The model of Conceptual Analysis

Having a robust management theoretical framework is critical for this research. For this purpose, a deductive approach was taken, as we developed our hypothesis based on the existing literature and used the collected data to accept or reject such a hypothesis. This allowed us to develop a research strategy with several hypotheses based on the existing theories and available data, which has enabled us to test such formulated hypotheses.

Our proposed theoretical framework was built from the identification in the literature of the major theories and explanations that give theoretical support to the occurrence of project overruns in public projects. Based on these theories and explanations, and since we are establishing an explanatory–exogenous approach for the occurrence of overruns in public projects, we identified those management and management-related theories which supported the selected variables with the goal of answering the formulated hypothesis. Simultaneously, we searched for and identified which exogenous variables could be available for testing and which ones could match the base explanations identified in the literature. The aim was to create an exogenous model that helps explain the relationship between exogenous variables and the occurrence of cost and time deviations and overruns in public projects.

However, more than just investigating cost and time deviations and overruns on a standalone basis, we intend to analyse the way that cost deviations causes and determinants share and correlate with time deviations to start to build a unique theoretical framework which supports the exogenous determinants model design developed in this research. The reason for doing this is that most of the substantial literature produced, both for theoretical and empirical studies, has mainly focused on cost deviations and overruns when comparing existing contributions that have focused on study time deviations (Guccio et al., 2014; Lewis & Bajari, 2011). Data availability largely contributes to this disproportion. We believe that the risks and limitations of following this research route are minimal and allow us to focus on the research questions, hypothesis formulation, and objectives, rather than create a dispersion that would not contribute to the benefits and conclusions of this study.

Consequently, this research focus on a political-economic approach, to which an institutional framework is added in order to complete the circle of possible exogenous factors contributing to cost and time overruns. Hence our research, similar to other explanatory studies that search for explanations of the nature of certain relationships, will explore the following:

(i) how political and electoral cycles contribute to the increase of cost and time overruns, sustained by the political economy - opportunistic behaviour theory;

(ii) the impact of a worst institutional and regulatory framework increases cost and time overruns – whether governments with more corruption and less rule of law indicators are less capable of enforcing contracts that will lead to an increase in cost and time deviations and overruns – for this we use the institutional theory;

(iii) using the political economic cycles theory to see whether better economic cycles increase cost and time overruns – enabling more money for governments to spend, which tends to reduce expenditure control mechanisms, which also lead to an increase in cost and time overruns; and also

(iv) use an endogenous approach as a control factor for the impact of whether higher uncertainty, measured by project size – whereby larger projects are more complex could lead to higher uncertainty regarding project completion. This in turn also leads to an increase in cost and time overruns. The supporting theory for this is the incomplete contracts theory.

The following Table 11 summarises the theories that provide theoretical support to the established hypothesis to be tested in this research. From the literature we identified the theories, explanations, and causes and then we have added to the specific explanations that we believe may have an exogenous impact on public investment overruns.

[Insert ***Table 11*** here]

In this research, we go beyond the existing literature, by adding a new approach, using management theories to give theoretical support to identifying new explanatory causes and the new independent exogenous variables to be tested. This approach allows us to contribute to a better understanding of cost and time deviations and overruns in public projects. To do this and also to be able to create a theoretical framework that is both valid for the exogenous explanation of time and cost overruns and their likelihood of occurrence, we needed to merge the main causes into the theoretical explanations presented above.

In Table 10, we present the summary of the merging of the theoretical explanations with the causes for cost overruns determined by Cantarelli et al. (2010) with the group causes that were the result of the extensive literature review work developed by Ramanathan, Narayanan, et al. (2012). We followed the indication of the conclusion from Adam et al. (2017, p. 10) where the authors state that "*In understanding the underlying causes, it may therefore be prudent, like Cantarelli et al (2010), to distinguish between causes and explanations. The former consist of the singular factors resulting in an effect (i.e. cost overruns and/or time delay), whereas the latter attempt to offer a broader and more general description of what may have transpired that led to the subsequent effect. An explanation could therefore consist of several causes.*".

[Insert ***Table 10*** here]

Delays will then impact considerably on both the final cost of the investment (increasing even further the final cost of the investment) and the additional time required to enable a public project to be delivered to the population. Such delays prevent a project form complying with its underlying purpose (Shehu, Endut, & Akintoye, 2014). Hence the delay-cost relation is related with the importance of jointly analysing the cost overruns with time delays (Ramanathan, Narayanan, et al., 2012). Both these overruns are interconnected, as they are the result of similar factors, such as the main characteristics of the investment (e.g., initial cost, initial time to build, sector, and location), which means that producing a complete framework of the overruns analysis is not completed if we do not deal with the delays problem, as well, as all the necessary inputs are not being considered (De Jong et al., 2013). Accordingly, we aimed to create a unique theoretical approach from the explanations perspective, which enables us to jointly analyse cost deviations and time deviations, based on the same supporting theories that emerge from the literature. We base our hypothesis on those supporting theories that allow us to answer our research questions.

In Figure 2, we present the mind mapping of the theoretical path followed throughout this research. The mind map starts with the theories and explanations that emerge from the literature, and it then flows through the definition of the supporting hypothesis to end with the independent variables that were studied.

*[Insert **Figure 2** here]*

We have designed a theoretical framework based on management theories, in order to add a contribution to both management theory and practice, as stated above. Our research investigates potential exogenous factors that contribute to sourcing cost and time deviations and overruns, by looking for a political-economical-institutional explanation.

In this section, we presented the model of conceptual analysis that will be empirically tested in Section 5, Section 6, and Section 7. It was of major importance to establish the relations between the main concepts of the supporting theoretical explanations and those relations that are subjacent to each test to be performed. As mentioned above, we are performing three studies. Firstly, an analysis of the consequences on cost deviations and overruns of a set of exogenous political-institutional and economic variables, whereby the study will be divided into another three sets of results, as we will not only study the overall sample of data, but also we will study two subsamples of the collected data that have particular relevance: the transports sector and local government projects. This will be followed by a study on the consequences for time deviations and overruns for the same set of exogenous variables. In this study, due to the smaller sample, we will only focus on the general sample, without any sector or level of government analysis. Thirdly and lastly, we will study whether time deviations and overrun has any consequence/effect on cost deviations and overruns, by regressing time deviations as an independent variable and cost deviations.

In Figure 3 we present the adopted model of conceptual analysis that will be followed during our research, including all the performed studies.

[Insert ***Figure 3*** here]

4. Data and Methodology

This thesis aims to analyse the main exogenous determinants of cost and time deviations and overruns. Accordingly, we focus our analysis on four hypothesis which will provide theoretical support to our research questions, as presented above, namely: i) a political hypothesis, which aims to identify how political and electoral cycles contribute to the increase of cost and time overruns; ii) a governance hypothesis, which aims to study the impacts of improving institutional and regulatory indicators on the increase of cost and time overruns; iii) an economic hypothesis, which aims to understand whether better economic cycles increase cost and time overruns, and; iv) a project control hypothesis, using an endogenous approach which intends to study the impact of uncertainty (measured by projects size) on the increase of cost and time deviations and overruns.

4.1. Data

We collected a representative sample of public projects developed in Portugal for the period of 1980 to 2014. The data used were collected from the Audit Reports published online on the institutional website of the Portuguese Court of Auditors. This comprises all the available reports issued between 1999 and 2016. The sample is based on all those public projects that have been audited and where a report has been published on the Court of Auditors institutional website. We used all the Court of Auditors reports that were publicly available and where information from completed public projects was also available. Since all publicly available reports on completed public projects were considered for the construction of our database, this means that no public project of the sample was chosen. Furthermore, the dependent variables used in our research were calculated solely using the information from these Audit Reports.

The Court of Auditor was defined in Act 98/97, of 26 August, with subsequent amendments, as being the institution, which is responsible for the examination of the legality and regularity of public revenue and expenditure, assessing sound financial management and enforcing the liability for financial offences. The Court of Auditors has the jurisdiction and powers of financial control within the scope of the Portuguese legal system. At its headquarters it has the following specialised sections: a 1st Section in charge of a priori control, which may, in certain cases, exercise concomitant control; a 2nd Section in charge of concomitant and successive control of verification, control, and auditing, and; two Regional Sections, which operate in the Autonomous Regions of the Azores and Madeira (in this case all the competences of the 1st and 2nd Sections are centralised in this structure). Due to the Court of Auditors' competence overlap and decentralised structure, we opted to collect data from reports from all the specialised and regional sections, which allows us to have a fuller and complete analysis.

We collected information from 4,323 public projects. From these, we collected information from 4,305 public projects observations where it was possible to calculate a "cost deviation percentage", 250 observations where we were able to calculate a "time deviation percentage", and 232 observations where we were able to calculate both a "time deviation percentage" and simultaneously a "cost deviation percentage".

Each project is a single observation, in a repeated cross-section (year), which makes this the research unit of analysis. The difference between the number of observations of cost and time projects deviations arises from the fact that not all analysed reports had all the information needed to calculate both the deviations (cost and time). In no case have we omitted available data.

In order to construct our sample and to avoid any population representation together with randomisation problems, we followed Flyvbjerg et al.'s (2002) approach, and selected all the projects for which information regarding the cost and time was available from the consulted official records. Using the all available data approach and based on the large number of observations collected, we believe that we have surpassed these problems and have built a sample that is a strong representation of the population of public projects contracts in Portugal. Furthermore, only completed and finalised public projects were considered, which means that we had to reject all observations from projects that were still under execution by the time the audit report assessed them, as it was impossible to calculate final construction cost and time deviations.

Our sample contains observations with: (i) negative overruns (final cost or time is lower than the expected cost and time forecasted at the moment of the project investment decision); (ii) no overruns (final cost or time equals the expected cost and time forecasted at the moment of the project investment decision), and; (iii) positive overruns (final cost or time is higher than the expected cost and time forecasted at the moment of the project investment decision). The fact that the choice of public projects to be included is based on the audit procedures of the Court of Auditors make us highly comfortable about the representatively of the collected sample.

For each Court of Auditors report analysed, we collected information for each public project contract, which enabled us to create the following variables: (i) the year of the start of the project (*yearst*); (ii) the year of conclusion of the project (*yearend*); (iii) the initial budget cost (*budgetcost*); (iv) the initial forecasted time for project completion (*budgettime*); (v) the final project cost (*fincost*); (vi) the final duration of the project (*finaltime*); (vii) the project sector – Education (*edu*)/Transport(*transp*)/Economic facility (*econf*) or Social facility (*socialf*), and; (viii) the project´s promoter administrative level of power, i.e., whether it belongs to the central government (*cgov*), or to the regional or local (municipal) government (*notcgov*). From public official records we also collected political, governance, and public finance variables, including: electoral data; voice and accountability; political stability and absence of violence; government effectiveness; regulatory quality; rule of Law and control of corruption indexes, and; GDP growth, inflation and public investment. All these variables will be detailed in Subsection 4.2. Additionally, we also collected information regarding the number and the year of the reports, in order to allow us to identify the source of our data.

All data used have the purpose of studying cost and time deviations and overruns at a specific point in time – the final deviation is measured at the end of the construction – and not its evolution through time.

4.2. Dependent variables

Throughout our study we used two different dependent variables, depending on whether we were studying cost or time exogenous determinants. Firstly, for each project we calculated the cost/time deviation (*cdevp/tdevp*), this being the difference, in percentage, of the project's final and initial cost/execution time. In this way, three categories of projects were identified, namely: 1) projects with negative cost/time deviation; 2) projects with no cost/time deviation, and; 3); projects with a final cost/execution time greater than the initial one. Secondly, we used the *cdevp* or *tdevp* to compute another dependent variable: whether the project had a cost/time overrun (i.e., the *cdevp* or *tdevp* is positive). This variable (*cdevprob/tdevprob*) assumes 1 when *cdevp* or *tdevp* is positive, and zero when *cdevp* or *tdevp* is zero or negative. In the following two subsections we detail the way that these dependent variables were raised.

4.2.1. Cost deviation

To assess the cost deviation of each project, we calculated cost deviation (*cdev*), which is the difference between a project's final cost and the project's initial budget cost. Furthermore, we calculated the cost deviation percentage (*cdevp*) as:

$$cost\ deviation\ percentage\ = \frac{(project's\ \ final\ cost - project's\ initial\ budget\ cost)}{project's\ initial\ budget\ cost}\ (1)$$

To calculate the initial budget cost (*budgetcost)* for each project, we considered the adjudicated price (initial contractual price) communicated by the public project owners to the Auditors Court. Final project cost (*fincost*) was that attained and audited by the Auditors Court in its report. The final cost was considered when the project was formally delivered to its public owner by the private project contractor. In no cases were assumptions made and only public disclosed amounts in the Auditors Court reports were considered. We further create a dummy variable - cost deviation probability (*cdevprob*). This variable is derived from *cdevp*, and it assumes 0 if *cdvep* presents no deviation (deviation being equal or lower than the initial budgeted cost), or 1 if *cdevp* presents a deviation (deviation being higher than the initial budget cost). The number of observations is, therefore, the same between *cdevp* and *cdevprob*. Consequently, cost overruns are commonly perceived as being an excess of actual cost over the budgeted cost, which means that more money was spent on a project than was originally planned in the budget, or the actual extra amount spent, while some may add, especially in the case of a government contract (Cantarelli, 2009; Flyvbjerg et al., 2002; Kaliba et al., 2009; Nijkamp & Ubbels, 1999; Pickrell, 1990; Shrestha et al., 2013).

A common critic in the earlier literature points to a bias in the initial cost which is considered to calculate the deviation. This is due to the fact that in several studies a difference exists between the decision to build (which many times is presented just based on conceptual project designs) and the effective initial cost (Love & Ahiaga-Dagbui, 2018). This represents a difference, which many times wrongly consider pre-construction costs as final costs when further enhancements with material cost increases are still due, which most of the times are caused by changes to the scope. Furthermore, politicians tend to disclose earlier than before any initial costs estimates (at a very early stage of the process) and between that moment and the beginning of works several project variables suffer prices increase, such as labour and materials. (Ahiaga-Dagbui & Smith, 2014a; Love, Sing, et al., 2015; Love et al., 2016). We believe that we have successfully surpassed such a problem, as we have always used as initial cost the contract award price (i.e., the final budgeted cost that is communicated and subject to an *a priori* control by the Court of Auditors, accordingly to Articles 44 to 48 of the Act 98/97, of 26 August which governs the Organisation and Procedural Law of the Court of Auditors). This is a procedure that needs to be completed to allow contractors to start the on-site works. This makes all future price changes accountable for the deviation calculation.

In this research, cost deviation (*cdevp* and *cdevprob*) will be used four separate times as a dependent variable. The first, uses the cost deviations complete sample with two further subsamples being extracted from that cost deviations complete sample database. First, we work with a subsample which considers only observations from the transport sector, which is discussed in Subsection 5.2. We refer to this set of data as our ‘cost deviation transport sector projects subsample’. In Subsection 5.3 we work with a second subsample, which only considers observations from projects developed at a local government level. This set of data is referred to as our ‘cost deviations local government projects subsample’. Finally, in Section 7 we work with a subsample which considers only observations where both a cost deviation and a time deviation information is presented.

4.2.2. Time deviation

To assess the time deviation of each project, we calculated time deviation (*tdev*), which is the difference between a project’s final time duration and the project’s initial forecasted time. Furthermore, we also calculated the percentage of the time deviations (*tdevp*) as:

$$time\ deviation\ percentage\ = \frac{(project's\ \ final\ duration - project's\ initial\ forecasted\ time)}{project's\ initial\ forecasted\ time}\ (2)$$

To calculate the initial forecast time for project completion we considered the initial project execution data at the time of the final decision to adjudicate the project by the body of competent authority (project owner), namely contractual information communicated to the Auditors Court regarding the execution time. Once again, in no cases were assumptions made. Only public-disclosed amounts in the Auditors Court reports were considered. We further created a dummy variable - time deviation probability (*tdevprob*). This variable is derived from *tdvep*, as it assumes 0 if *tdvep* presents a zero deviation (deviation equal or lower than the initial forecasted time), or 1 if *tdevp* presents a deviation (deviation higher than the initial forecasted time). The number of observations is therefore the same between *tdevp* and *tdevprob*.

For final execution time the moment was considered when the project was formally delivered to its owner by the project contractor. This information was that attained and audited by the Auditors Court in its report. Similar to the literature, we define time overrun as being the delay or additional amount of time needed to complete a public works project from its initial forecasted time (Bhargava et al., 2010; Fugar & Agyakwah-Baah, 2010; Kaming et al., 1997).

4.3. Data diagnostics on dependent variables

Multivariate analysis requires a rigorous examination of the data because of the influence of outliers, violations of assumptions, and missing data, which can be compounded across several variables to create substantial effects. Multivariate techniques, such as those applied in this research, try to identify complex relationships, which are difficult to represent in a simple way. Due to the large number of variables being scrutinised, a graphical examination of the data is also carried out, which enables a better control of our data. With this understanding, not only do we present "the big picture”, but our research allows us to know where to look for alternative formulations of the original model which can support model fit, such as nonlinear and interactive relationships. Additionally, it will also be useful for the evaluation and interpretation of the results. For this purpose, several diagnostic tests were performed (Ramsey, 1969).

In this section, we carry out the diagnostic of the dependent variables, to assure that these variables are the best linear unbiased estimator (BLUE), and in order to observe how well the assumptions of the Ordinary Least Square (OLS) in multiple regressions is met, as our purpose is not to just analyse a function of a single explanatory variable, but also a combination of several explanatory variables (Wooldridge, 2015).

4.3.1. Cost deviation

Using a visual examination, we started to test for the normality of the error term of the dependent variable *cdevp,* in order to conclude about the normality of the distribution. From the research literature we know that the dependent variable cost deviation does not follow a complete Normal Distribution, but rather its right skewness distribution is characterised by more positive overruns than projects without overruns, or those with negative deviations (Flyvbjerg et al., 2002; Love, Wang, Sing, & Tiong, 2013; Odeck, 2004; Sarmento & Renneboog, 2016b). Our data follows the same characteristics, which is a limitation that we accept, as it originates from the fact that the Court of Auditors may have selected to audit more complex and troubled public projects, and also because there is a strong generalised conviction that public projects have positive cost deviations, meaning that they tend to have cost overruns.

As mentioned above, we collected 4,305 observations (cost deviations complete sample) where we were able to determine the dependent variables cost deviation percentage (*cdevp*) and cost deviation probability (*cdevprob*), as described above. Our sample seems to present some problems in terms of the residuals distribution (see Figure 4, Figure 5 and Figure 6). Looking at these three figures, we can immediately observe the existence of outliers and that all the points presented in the left-higher or right-lower quadrants of the plot have either high leverage or large residuals, which is an indication of non-normality (Cameron & Trivedi, 2010).

[Insert ***Figure 4***, ***Figure 5*** and ***Figure 6*** here]

Alternatively, to create a histogram which is sensitive to the number of columns and bins, we used a kernel density plot, which is smother and has the additional advantage of being independent of the choice of origin. This plot aims to approximate the probability density of the variable. The plotted kernel density estimates are significantly different from a normal distribution (Figure 5). Additionally, in Figure 6, we plot the residuals against a fit line, in order to obtain the normal probability plot, which is useful to analyse the distribution of variables. Once again, the results indicate non-normality, as they present a residuals distribution which is not linear with a fit line (Adkins & Hill, 2011). After testing for the violation of the normality assumption, we search for remedies that we could apply, and which would better impact the results of the regressions, thus allowing us to maintain the four basic assumptions valid of multivariate regression (linearity, homoscedasticity, independence of the residuals, and normality).

In Figure 7, we plot a boxplot for *cdevp.* Two major contributions arise from the analysis of this graph - the confirmation that *cdevp* is right skewness and that we identify outliers which are known to influence observations, due to the fact that these observations may have a disproportional impact on the regression results. We can observe that the points at the top of the graph indicate such possible outliers. To solve this problem, we dropped all observations where cost deviation is above 50% and below -50% and thus we reached a final number of 4,266 observations, which we refer to as our 'cost deviation final sample'. The same procedure of removing sample outliers was also applied to the transport sector, where we account for 1,091 observations (transport sector projects final subsample) and local government projects, with a final subsample with a final number of 3,338 observations. The descriptive statistics of these dependent variables for both the cost deviation final sample and the transport sector and local government projects final subsamples are summarised in *Table 17*. The results of the studies of these three samples are presented below in Section 5.

[Insert ***Figure 7*** here]

[Insert ***Table 17*** here]

After dropping such outliers, the residuals graphs have the representation presented in Figure 8. Figure 9, presents the kernel density plot after dropping out the outliers. The graph shows that the kernel density continues to be more peaked than the normal distribution. Once again, after checking for the normality of the error term of the variate, in Figure 10 it is possible to observe now that although the values fall more consistently than before along the diagonal line and with less significant or systematic departures, the residuals are still considered not to constitute a distribution close to a normal distribution. Nevertheless, despite the close failure of attaining the normality conditions, all the specifications estimated using our sample satisfied conditions for the OLS method, namely being the best (lowest variance of the estimate, in comparison to other unbiased, linear estimators) linear unbiased estimators (BLUE). In a linear regression model in which the errors have an expectation of zero, are uncorrelated, and have equal variances, the BLUE of the coefficients is provided by the OLS estimator, provided it exists (Wooldridge, 2015).

[Insert ***Figure 8***, ***Figure 9*** and ***Figure 10*** here]

However, the F-statistics allow us to relax the normality assumption, as it is not a condition for BLUE OLS. According to the Gauss–Markov theorem and the generally-referred-to Gauss–Markov assumptions, namely: linearity in parameters; random sampling; no perfect collinearity; exogeneity (that guarantee the unbiasedness of the linear estimators), and; homoscedasticity (which is a safeguard for low variance), which are those necessary to guarantee that the OLS method works under certain BLUE conditions (Aitken, 1936; Wooldridge, 2015). We conclude that the errors do not need to be normal, as the estimation of the coefficients requires that errors only need to be identically and independently distributed (uncorrelated with mean zero and homoscedastic with finite variance).

4.3.2. Time deviation

In the current section, we follow the same approach and follow the same method as in the previous Subsection 4.3.1, in order to conclude whether our data meets the assumption of the OLS in multiple regressions. Although we are carrying out a different study, using a different dependent variable, our purpose is once again to analyse a combination of several explanatory variables and to examine how these affect our new dependent variable. Therefore, to avoid unnecessary repetition of the already-used definitions and the conclusions reached in the previous section, we assume those of the current section, unless we find it necessary to conclude better if a specific point needs to be specifically highlighted, or otherwise whether different conclusions are reached. Consequently, to better control and understand our data, several diagnostic tests were performed of our collect time deviation data.

We again start to test for the normality of the error term with a visual examination, in order to conclude about the normality of the distribution. As mentioned in the previous section, the research literature indicates that dependent variable time deviation does not follow a complete normal distribution, but rather its right skewness distribution is characterised once more by more positive overruns than projects without overruns, or with negative deviations (Love, Sing, et al., 2013; Moret & Einstein, 2016). Our data follows the same characteristics. Once again, this is a limitation that we accept, as it originates from the fact that the Court of Auditors may have selected to audit more complex and troubled public projects, but also because there is a strong generalised conviction that public projects have positive cost deviations.

We initially collected 250 observations (time deviations complete sample) where we were able to determine the dependent variables time deviation percentage (*tdevp*) and time deviation probability (*tdevprob*), as described before. Similar to what happen with cost deviation, our sample seems to present some problems in terms of the residuals distribution (see Figure 11, Figure 12, Figure 13). Looking at these three figures, we can immediately observe the existence of outliers. In the plot that presents the leverage versus the squared residuals of data (Figure 11), similar to the same plot presented for cost deviations, we can observe that all the points presented in the left-higher or right-lower quadrants of the plot have either high leverage, or large residuals, which are both an indication of non-normality (Cameron & Trivedi, 2010).

[Insert ***Figure 11***, ***Figure 12*** and ***Figure 13*** here]

To confirm this non-normality, we also used a kernel density plot, which aims to approximate the probability density of the variable. Similar to cost deviation, this plot once again shows estimates significantly different from a normal distribution (Figure 12). Additionally, in Figure 13 we plot the residuals against a fit line, to obtain the normal probability plot, which is useful for analysing the distribution of variables. Once more, the results present a residuals distribution which is not linear to a fit line, and therefore indicates non-normality (Adkins & Hill, 2011). After testing for the violation of the normality assumption, we again searched for remedies that we could apply, and which better impact the results of the regressions, allowing us to maintain valid the basic assumptions of multivariate regression.

In Figure 14, we again started to plot a boxplot for *tdevp*. As before, two major contributions have arisen, namely the confirmation that *tdevp* is right skewness, and that we have identified outliers that are known to influential observations, due to fact that these observations may have a disproportional impact on the regression results. We can observe that the points at the top of the graph indicate such possible outliers. To solve this problem, we used a similar procedure than that used for dropping cost deviation outliers and we dropped all observations where time deviation is above 100%. We reached a final number of 161 observations, which we refer to as our 'time deviation final sample'. The descriptive statistics of the dependent variables time deviation final sample is summarised in Table 18. The results of the study of this sample is presented below, in Section 6.

[Insert ***Figure 14*** here]

[Insert ***Table 18*** here]

After dropping such outliers, the residuals graphs are plotted in Figure 15, Figure 16, and Figure 17. In Figure 16, we present the kernel density plot after dropping out the outliers. The graph shows that kernel density continues to be slightly more peaked than the normal distribution, albeit in Figure 17 we can observe that the values fall more consistently than before along the diagonal line, with less significant or systematic departures, and the residuals are still considered not to constitute a distribution close to a normal distribution. Notwithstanding the close failure of obtaining normality conditions, all the specifications estimated using our sample satisfied conditions for the OLS method, namely being BLUE. In a linear regression model in which the errors have zero expectation and are uncorrelated with equal variances, the BLUE of the coefficients is provided by the OLS estimator, provided it exists (Wooldridge, 2015).

[Insert ***Figure 15***, ***Figure 16*** and ***Figure 17*** here]

Nevertheless, due now to the smaller sample used in analyses (<2,000 observations) than we usually have, we additionally ran a Shapiro-Wilk W test to test whether our sample comes from a normal distributed population (our null hypothesis). This test assesses the normality of each variable used in our study. We reached a p-value = 0.57, which is higher than our default level for significance of 0.1. This means that we cannot reject our null hypothesis that the time deviation sample data came from a normally distributed population. In conclusion, we found evidence that our sample comes from a normally distributed population (Royston, 1983). Furthermore, we also run a Shapiro-Francia W' test for normality successfully, reaching a p-value = 0.62. Some conclusions applied to Shapiro-Wilk also applied to Shapiro-Francia.

As presented in Subsection 4.3.1, we again assume that in accordance with the Gauss–Markov theorem and the generally referred-to Gauss–Markov assumptions, there is: linearity in parameters; random sampling; no perfect collinearity; and that exogeneity and homoscedasticity are necessary to guarantee that the OLS method works under certain BLUE conditions. Complemented by the F-statistics and the Shapiro-Wilk and Shapiro-Francia tests, this allow us to be comfortable and if necessary relax the normality assumption, as it is not a condition for BLUE OLS, as errors do not need to be normal. Coefficient estimation requires that errors only need to be uncorrelated with mean zero and homoscedastic with finite variance (Aitken, 1936; Wooldridge, 2015).

4.4. Hypotheses and independent variables

Cost and time deviations and overruns are mainly perceived in the literature to be determined by endogenous factors. However, exogenous factors should also be considered. To test for exogenous factors and endogenous determinants (for control purposes), we established several hypotheses based on the theoretical framework formulated in Section 3, which consequently enabled us to select our variables. These variables were then defined to answer the theory-based hypothesis and research questions. Therefore, this explanatory study aims to search for explanations of how exogenous factors contribute to cost and time deviations and overruns. For this purpose, hypothesis tests are used to provide an understanding of the relationships between variables.

The independent variables are divided into four main categories: (i) political and electoral data; (ii) governance and risk indicators; (iii) financial and economic data, and; (iv) project data. For this study, the first three are considered to be variables that are not related to the public projects under analysis, which means that their value or classification takes shape independently of the public project investment's own characteristics, and therefore they are considered exogenous determinants. Theses variables, qualitative characteristics, and method of generation are not determined by anything related to the projects being studied. The last set of variables - project data, as explained in more detail below, is determined within the project characteristics and for this reason they are considered endogenous determinants in the context of this research.

We have select variables which enable the capturing of the effects of the main determinants identified in the literature, although, in some cases, these effects were captured indirectly. For example, many papers frequently mention the poor planning and governance as being motives for cost overruns (Macdonald, 2002; Morris, 1990; Morris & Hough, 1987; Sarmento &

Renneboog, 2016b; Singh, 2010). Nevertheless, a single variable does not capture both causes. Most studies in the reviewed literature do not develop a statistical analysis, but rather analyse case studies or conclude based on average deviations and overruns, without being concerned about trying to capture the statistical effect of such causes. Furthermore, and although many authors have identified planning and optimistic bias problems as critical drivers for cost overruns (Creedy et al., 2010; Odeck et al., 2015; Skamris & Flyvbjerg, 1997), we believe planning problems can be a consequence of external effects, such as political context, experience, government efficiency, or economic conditions, among others. We hypothesise that a less-experienced and efficient government, or a government that is politically driven towards increasing infrastructure expenditure, or even the absence of rigorous public procurement law, can result in higher cost and time deviations and overruns.

Below we present the four-hypothesis that were formulated and the corresponding independent and control variables. We differentiate between exogenous determinants, considering that cost and time deviations and the probability of occurrence of cost and time overruns can be affected by: political determinants (Hypothesis 1); institutional and governance determinants (Hypothesis 2); the economic environment (Hypothesis 3), and; projects' endogenous characteristics (Hypothesis 4). We expect an increase in cost and time deviations to be derived from the formulated hypothesis, as shown in Figure 22, which identifies the independent variables, as well as the overall impact that these variables have on cost and time deviations.

*[Insert **Figure 22** here]*

Additionally, in Table 13, a summary of the supporting theories, explanations and tested hypothesis developed in the current research are presented.

*[Insert **Table 13** here]*

Furthermore, Table 14 summarises both the independent and control variables used in the current research, as well as their expected signals.

[Insert ***Table 14*** here]

4.4.1. Hypothesis 1 – Political determinants

As previously mention, we have defined Hypothesis 1 – Political determinants, as being how political and electoral cycles contribute to the increase in cost and time deviations and overruns. Political cycles and context should impact on cost and time deviation and overruns. As developed in Subsection 3.2, political explanations adopt as its main cause, strategic misrepresentation when forecasting the final cost of a project (Cantarelli et al., 2008; Flyvbjerg et al., 2002). Furthermore, political theory can explain cost overruns in terms of strategic behaviour (Flyvbjerg, Bruzelius, et al., 2003; Hall, 1982; Kahneman & Lovallo, 1993; Lovallo & Kahneman, 2003; Pickrell, 1992; Wachs, 1989).

Furthermore, the agency theory (Arvan & Leite, 1990; Flyvbjerg, Bruzelius, et al., 2003; Wachs, 1982) supports strategic behaviour and why it is a consequence of asymmetric information, meaning the lack or incompleteness of information that the person in charge of taking decisions has when facing a project selection or project approval issue. Alternative political explanation in the literature comes from the existence of many stakeholders who gravitate around the political system, each one with their own purposes and objectives, which normally results in additional project requirements and consequently in more-than-expected costs (Cantarelli et al., 2008). The motives presented above include "strategic misrepresentation" (Flyvbjerg et al., 2002). The decision-making process is expected to be influenced by political decisions regarding elections and votes. We expect to see an opportunistic behaviour from the public sector, driven by the aim to win elections and also by private contractors using elections to increase revenues. Underestimating costs can be a strategy for gaining the approval of projects.

Therefore, in Hypothesis 1, independent variables were defined in order to assess how electoral years affect cost and time overruns in public projects, i.e., whether political cycles increase cost and time overruns. Cost and time overruns are more prone to occur with electoral cycles when political agents try to obtain a better electoral result. The decision-making process at a public level is often carried out after having considered the electoral calendar to increase the incumbent changes of re-election. Therefore, the opportunistic behaviour of public decision-makers who have the aim of winning elections and private contractors that use elections to increase revenues are often-expected behaviours. As projects are approved or announced to match the electoral calendar, cost underestimation can be a strategy which often leads to an inadequate planning process, underestimated budgets, and later on to cost and time overruns. The public announcements of further public investments after the electoral calendar often are considered less important after the elections, as they are no longer urgent, and are therefore prone to time overruns. Consequently, in our models, we used the following independent variables:

Election Year (ely), for whether a project is initiated in a general election year. For *ely*, the dummy variable is 1 if the project is in an election year, and 0 otherwise. *Election Year lag (elylag)* is used if the project is initiated a year before a general election year. Therefore, *elylag* assumes 1 if the project is in a year previous to elections, and 0 otherwise. *Election Year lead (elylead),* is used if a project is initiated a year after a general election year. Consequently, for *elylead*, the variable assumes 1 if the project is in a year after an election, and 0 otherwise. The same applies for *Municipal Election Year (munely),* which applies to whether a project is initiated in a municipal elections year, and *Municipal Election Year lag (munelylag),* if the project is initiated a year before a municipal election year, and *Municipal Election Year lead (munelylead)* if a project is initiated a year after a municipal election year. Lastly, *Regional Election Year (regely)* is used to identify whether a project is initiated in a general election year, and *Regional Election Year lag (regelylag)* is used if the project is initiated a year before a regional election year, and *Regional Election Year lead (regelylead)* if a project is initiated a year after a general election year. All these variables are dummy variables, assuming 0 if the project is not initiated during an election date, and 1 if it does. These variables will only be used for the purpose of endogeneity tests.

In all cases, we expect an increase in cost and time deviations and overruns. For a general election year, we expect the central government to announce more investments, which also allows both municipal and regional governments to announce further investments through budget transfers to the decentralised governments. In a regional or municipal election, we expect the same effect, but that it will now originated in decentralised governments and in political pressure to announce new public infrastructures, which may come directly from local or regional budgets, and also from the central government budget.

Regional and municipal elections only occur every four years, without any exceptions registered up until now. General elections are more due to political cycles, and have many times occurred with a higher frequency than the normal four years term.

To assess the results of these variables, we introduce three variables as control variables, namely: *Political Party in power*, *Majority/Minority Government*, and *Political Stability and Absence of Violence/Terrorism Index.*

Political Party in power (govrw), is a dummy variable, assuming 1 if the centre-right Social Democrat party (Partido Social Democrata) is in power, and 0 if the party in power is the left-wing Socialist party (Partido Socialista). This variable indicates the political party ideological spectrum in government at the time of project initiation. Right-wing governments are normally more conservative, which could tend to be more realistic when forecasting completion costs and time. The expected signal is undetermined.

Majority/Minority Government (govmaj), is a dummy variable, assuming 1 if a majority government is in charge, and 0 if a minority government is in charge. This variable indicates whether the political representation in government is a political majority or a political minority. This variable indicates that governments with political majorities could tend to be less realistic in forecasting completion costs and time, as they are less scrutinised than minority governments. We expect this variable to impact negatively in both cost and time deviations and overruns (less cost and time deviations and overruns).

The data needed for these variables (*ely*, *munely*, *regely*, *govrw* and *govmaj*) were collected from the Portuguese electoral body official records.

Political Stability and Absence of Violence/Terrorism (polstab) is an index that measures perceptions of the likelihood of political stability. Risk ratings range from a high of 100 (least risk) to a low of 0 (highest risk). Each year observation of this variable corresponds to the country (Portugal) percentile rank (0-100, with higher values indicating better governance) regarding the remaining countries. This thus allows us to rank the position of Portugal among all countries worldwide. It is a discrete variable, which indicates that the better ranked Portugal is, the more likely lower cost and time overruns will exist. Therefore, we expect this variable to impact negatively (reduce) on both cost and time deviations and overruns.

Data regarding variable *polstab* was collected from the World Bank´s Worldwide Governance Indicators (WGI), which is a research dataset that summarises the views on the quality of governance provided by a large number of enterprises, citizens, and expert survey respondents in industrial and developing countries. These data are gathered from a number of survey institutes, think tanks, non-governmental organisations, international organisations, and private sector firms (Kaufmann et al., 2011). The methodology of these indicators is presented in Appendix A.

Furthermore, variable *polstab* was only started to be collected by the World Bank in 1996. Consequently, this variable assumes the 1996 value for all 24 public project observations for which construction started prior to that date (1 project in 1980, 1986 and 1991, 2 projects in 1995, 3 projects in 1993, 6 projects in 1990, and 10 projects in 1994). For this variable and for the purpose of our research, we have not used its absolute value, but have rather calculated the yearly variations (delta) of the variable. We believe that these variations are a more accurate representation of the improvements/deterioration of the indicator. We aim to capture such improvements/deterioration in order to assess the impact on cost and time deviations. Therefore, the final variable to be used will be *deltapolstab.*

4.4.2. Hypothesis 2 – Governance determinants

We expect that better public governance, regulation, and legal system will have an impact on reducing cost and time deviation and overruns. Consequently, Hypothesis 2 aims to analyse the capacity of public decision-makers to enforce contracts, i.e., a worse institutional and regulatory framework increases cost and time overruns. It is expected that with a worse legal/institutional environment less capacity for governments to enforce contracts exists, leading us to the conclusion that if the expected governance mechanisms are not in place, thus causing a decision-making problem, then that will give rise to cost and time overruns.

The authors Cantarelli et al. (2010) consider institutional theory to be an interesting theory for analysing cost overruns issues, resulting from a poor institutional/governance framework of the organisations responsible for both the decision process to build and to contract the private contractors in charge of developing such public infrastructures. Consequently, institutional theory provides a framework that enables us to identify project context and provides a way to investigate corruption as an institutional/organisational or social phenomenon. Henisz et al. (2012) and Scott (2005) agree that institutions can be theorised by assuming three major perspectives: regulative; normative, and; cultural-cognitive. Similar to Locatelli et al. (2016), our research also assumes that the country-level institutionalises corruption as a social phenomenon, due to the stability and uniformity of rules, cultural values, and shared beliefs inside one country. Accounting for country-level is consistent with other research (Jensen & Smith, 2000) and is valid for assessment in a project context. Consequently, we defined the following variables, where all these variables are discrete variables where a negative impact on cost and time deviations and overruns is expected. These variables are the following.

Rule of law Index (rlaw), this variable reflects the existing legal environment. The rule of law is measured from 0 (worst) to 100 (better). Each year observation of this variable corresponds to the country (Portugal) percentile rank (0-100, with higher values indicating better governance) regarding the remaining countries, thus allowing us to rank the position of Portugal among all countries worldwide. If a worse legal environment should decrease the efficiency of public projects, this means that the better ranked Portugal is, the more likely lower cost and time is to exist. We expect this variable to have a negative signal for both cost and time deviations and overruns.

Control of Corruption Index (corrp), this variable reflects the level of corruption. It indicates that a high corruption environment decreases public project efficiency. The level of corruption is measured from 0 to 100, the highest being the lowest level of corruption that it is possible to achieve. Each year observation of this variable corresponds to the country (Portugal) percentile rank (0-100, with higher values indicating better governance) regarding the remaining countries, thus allowing us to rank the position of Portugal among all countries worldwide. The lower the corruption index, the more likely lower cost and time overruns exist. We also expect this variable to have a negative signal (less cost and time deviations and overruns).

Government Effectiveness (goveff), this variable index reflects perceptions of the quality of the public and civil service and its degree of independence from political pressures. Each year observation of this variable corresponds to the country (Portugal) percentile rank (0-100, with higher values indication better governance) regarding the remaining countries, thus allowing us to rank the position of Portugal among all countries worldwide. The better ranked Portugal is, the more likely lower cost and time overruns exist. Once again, we expect this variable to have a negative signal (less cost and time deviations and overruns).

Regulatory Quality (regulq) is a variable that reflects the ability of the government to formulate and implement sound policies and regulations. Each year observation of this variable corresponds to the country (Portugal) percentile rank (0-100, with higher values indication better governance) regarding the remaining countries, thus allowing us to rank the position of Portugal among all countries worldwide. The better ranked Portugal is, the more likely lower cost and time overruns exist. Thus, we expect this variable to have a negative signal, contributing negatively (reduce) to cost and time deviations and overruns.

To assess the results for these variables, for control variables we introduce two variables - *Voice and Accountability Index* and *2008 procurement.*

Voice and Accountability (account) is an index which reflects perceptions of the extent to which a country's citizens are able to participate in selecting their government. Each year observation of this variable corresponds to the country (Portugal) percentile rank (0-100, with higher values indication better governance) regarding the remaining countries, thus allowing us to rank the position of Portugal among all countries worldwide. It indicates that the better ranked Portugal is, the more likely lower cost and time overruns exist. Thus, we expect this variable to have a negative sign (less cost and time deviations and overruns).

Similar to *polstab* presented in Subsection 4.4.1, the governance indicators variables presented in the current subsection (i.e., *rlaw, corrp, goveff, regulq* and *account*) have also been collected from the World Bank´s WGI Indicators. Once again, these same variables (*rlaw, corrp, goveff, regulq* and *account*) were only started to be collected by the World Bank in 1996. Therefore, they assume the 1996 value for all 24 public project observations for which construction has started prior to that date (1 project in 1980, 1986 and 1991, 2 projects in 1995, 3 projects in 1993, 6 projects in 1990, and 10 projects in 1994). For all these 5 variables and for the purpose of this research, we have not used their absolute value, but rather have calculated the yearly variations (delta) for each variable. We believe that these variations are a more accurate representation of the improvements/deterioration of each one of these indicators. We aim to capture what the improvements/deterioration are, in order to assess for their impacts on time and cost deviations. Therefore, the final variables to be used will be *deltarlaw, deltacorrp, deltagoveff, deltaregulq* and *deltaaccount.*

2008 procurement (law2008) law is a dummy variable, assuming 1 if the 2008 procurement law was already in force for the public projects legal procurement framework at the time the public investment was initiated, and 0 if the 2008 procurement law was not yet in force. The motive for this dummy is that a new legal framework, based on EU procurement directives, was enforced in 2008. We expect that the legislation has introduced a tighter procurement framework, which should result in lower cost and time deviations and overruns. A better legal procurement framework will enforce higher control mechanisms. Consequently, this variable is expected to contribute negatively (reduce) to cost and time deviations and overruns. This variable derives directly from the year that the law was introduced in the Portuguese legal system.

4.4.3. Hypothesis 3 – Economic determinants

Cost deviations and overruns should be affected by the economic environment (Ahsan & Gunawan, 2010). As better economic cycles increase public revenues, this could lead to a reduction in the efficiency of governments’ control mechanisms for spending. Therefore, Hypothesis 3 aims to analyse the impact of economic cycles on cost and time deviations, i.e., whether a better economic cycle increases cost and time overruns. Better economic cycles, meaning more money for governments to spend, are expected to prompt a reduction in spending controls mechanisms, which will lead to higher cost and time overruns.

An economic cycle is defined above as being the fluctuation of the aggregated economic activity of a country, as measured by the time period between two inflection points. Therefore, a cycle is a sequence of changes, recurrent but not periodic, which consists of expansions and recessions that occur at the same time in a large number of a country's economic activity (Burns & Mitchell, 1938; Greenwood & Hercowitz, 1991; Mascarenhas & Aaker, 1989; Nordhaus, 1975; OECD, 2017; Lucas, 1980). In Kerzner (2005) a system implementation based on planning, scheduling and controlling is presented as the foundations of project management, which indicates that cost overruns are incidents with a noticeable occurrence during any phase of project development. The prevailing causes include, among others, macro-economic conditions that must be tackled and considered at a management level.

Furthermore, in Russell (1991) and Russell & Jaselskis (1992), the authors research a predictive 'contractor failure model', which tries to anticipate the probability of failure prior to the award of a contract to any specific project, with such failure being representative, among others, of time and cost overruns. Increasing costs due to attempts to recuperate earlier failures is also a reality which may lead to inflated construction costs. The model is based on a project's own characteristics, such as size, contractors' characteristics and economic-related factors (macroeconomic factors) that are exogenous to the projects under scrutiny. Consequently, the independent variables are as follows.

Percentage of GDP Growth (gdpg) is a discrete variable which indicates that better economic cycles mean more money for governments to spend, which may lead to the reduction of controls on spending. Thus, this variable is expected to contribute positively to cost and time overruns (more cost and time deviations and overruns).

Annual Inflation (infl), a higher inflation means general increase of prices in the economy, which may lead to an increase of project costs through increases in work cost and construction materials. Inflation is the rise in the prices of goods in an economy, such as defined by Mundell (1961).

Annual Inflation, according to the literature, leads to higher cost deviations, due to the increase in construction material and higher uncertainty regarding the final price of projects (Ahsan & Gunawan, 2010; Alnuaimi, Taha, Al Mohsin, & Al-Harthi, 2010; Ashan & Sakale, 2014; Chileshe & Yirenkyi-Fianko, 2011). Furthermore, a relation between higher-than-expected increases in costs, due to inflation and an increase in time deviations is also established and pointed out as being one of the major causes of construction delays (Sambasivan & Soon, 2007; Senouci et al., 2016).

Public Investment as % of GDP (publicinv) is where the higher the % of money invested in public infrastructures, meaning more money and projects circulating, which may lead to a reduction of controls on spending. We expect a positive signal from this variable (more cost and time deviations and overruns).

Data for the *gdpg*, *infl* and *publicinv* variables was collected from the AMECO database. AMECO is the annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs (DG ECFIN). Since in Portugal national accounts registers only began in 1996, all these variables assume the same 1996 value for all 24 public project observations where construction started prior to that date (1 project in 1980, 1986 and 1991, 2 projects in 1995, 3 projects in 1993, 6 projects in 1990, and 10 projects in 1994).

To assess the results of these variables, we introduce as a control variable, the *financial crisis* variable, which aims to capture the effects of the 2007-2009 financial crisis, namely to measure if the year that the project started in happened before, or after that event (Kelly, 2011). For this purpose, we used a project variable called *yearst* to be able to determine the exogenous *financial crisis* variable. We considered three dummy variables. As it is impossible to determine the exact moment when the 2007-2009 financial crisis effects affected the Portuguese economy, we chose to extend the period of analysis between the years 2007 and 2009, in order to better capture such an effect. Therefore, *Financial Crisis 1 (fincrisis1)* indicates whether the project started before the year 2007. The variable assumes 1 if the project started before 2007, and 0 otherwise. *Financial Crisis 2 (fincrisis2)* indicates whether the project started before the year 2008. The variable assumes 1 if the project started before 2008, and 0 otherwise. Finally, *Financial Crisis 3 (fincrisis3)* indicates whether the project started before the year 2009. The variable assumes 1 if the project started before 2009, and 0 otherwise. It is expected that with the onset of the financial crisis and with the related public budget constraints which results in less money to spend, cost and time overruns have diminished. Multicollinearity problems between those three variables are expected, as this is a sequential variable, which we have constructed for the stated purpose. For this reason, at any time only one variable will be used for each regression.

The other control variable used in this hypothesis is *Troika*. This variable aims to capture the effects of the presence of the Troika in Portugal as a consequence of the financial loans provided by the European Union, European Central Bank, and the International Monetary Fund in May

2011, as a consequence of the external bailout requested by the Portuguese government. This variable intends to measure whether the year that the project started in occurred before, or after the beginning of the financial aid programme. Therefore, *Troika* is a dummy variable which indicates whether the project started before the year 2011, or not. The variable assumes 0 if the project started before 2011, and 1 otherwise.

4.4.4. Hypothesis 4 – Project determinants

A consequence of the above-mentioned information asymmetry problems, is that government organisations and contractors are unable to correctly forecast all the issues (normally problems that may occur during the contract execution) which may arise during the execution of a public contract (Kavanagh & Parker, 2000). For this reason, in the principal-agent theory, information asymmetry is said to be the origin of "incomplete contracts". In the literature, an incomplete contract is said to be one that has a shortage of accuracy, which does not allow it to foresee all contracts contingencies during its execution and up until completion.

The endogenous risk of the project is also an important determinant of cost and time deviations. This can be described as being the risk related to the intrinsic characteristics of the project. Akintoye & MacLeod (1997) consider that the risk variables associated with project construction have a significant impact on the time, cost, and quality performance of a project. Furthermore, Creedy et al. (2010) conclude that risk is not correctly assessed, which has lead us to identify in the literature the following endogenous determinants: (i) scale (Aibinu & Pasco, 2008; Flyvbjerg et al., 2002; Odeck, 2004); (ii) project ownership (Flyvbjerg et al., 2002; Shaoul et al., 2006); (iii) concept, planning, forecast, changes, and the duration of the project (Cantarelli et al., 2010; Flyvbjerg, 2004; Jahren & Ashe, 1990; Kolltveit & Grønhaug, 2004), and; (iv) location (Flyvbjerg et al., 2002; Flyvbjerg, Skamris Holm, et al., 2003).

Therefore, in Hypothesis 4, which is our control hypothesis, we only use endogenous determinants. This hyphothesis aims to investigate whether the impact of higher uncertainty, as measured by determinants such as project size (larger projects are more complex, which leads to higher uncertainty regarding project completion, which in turn also leads to an increase in cost and time deviations and overruns), project ownership, or sector, which can affect cost and time deviations and overruns. We consider that more complex projects lead to an increase of the project's completion uncertainty and consequently to the occurrence of cost and time overruns. The size of the project is taken as a proxy to measure the uncertainty of the project. The independent variables are as follows:

Large projects (largeproj) is a project variable which indicates that larger projects have a higher uncertainty and as a consequence that project size affects cost and time overruns. Projects were divided into small and large projects. The division is set out by EU Regulations No. 2015/2340, 2015/2341 and 2015/2342, which was approved by the European Commission on the 15 December 2015, which fixes the upper limits for a public projects contract amount, which is not subject to an international tender. A large project is therefore one that has an initial cost higher than EUR 5,225,000. We expect this variable to contribute positively to cost and time overruns (increases cost and time deviations), as larger projects have a higher construction completion uncertainty, which may be prone to the occurrence of the cost and time overruns. Due to data limitations in some of the analysed Auditors Court reports, there are some observations where the project deviation was identified, but it was impossible to confirm the initial cost of the project. Therefore, we were not able to collect this variable for our entire sample, but only for 3,486 observations.

According to some of the literature, large projects, are characterised by cost deviations, due to their higher complexity and uncertainty (Flyvbjerg et al., 2002, 2004). However, other authors (e.g., Odeck 2004) state that large projects can also decrease cost deviations, as they are more controlled and have greater public scrutiny and also a higher level of resources. For control purpose, we also run regression replacing the *largeproj* variable by the log of the initial cost of the project (called *loginitialcost*).

Sector is a dummy variable which indicates the investments purpose, namely *education (educ), transports (transp), economic facilities (econf)* and *social facilities (socialf)*. This variable assumes 1 according to its specific purpose, and 0 otherwise. It identifies whether there are some sectors which are more prone to cost and time overruns than others. *Education* represents whether the project is in the education sector, mainly the construction or renovation of a new or older school respectively, or other related education facilities. *Transports* captures the construction of roads, bridges, and railways (subways, light rail, and heavy rail). Economic facilities represent investments related to economic infrastructures, such as markets or industry-related infrastructures, such as industrial parks. *Social facilities* relate to projects in the health, social housing, or cultural sectors. The expected signal of these variables is undetermined, as the literature does not identify any sector as being more likely to present cost and time overruns. Nevertheless, *transports*, due to higher expertise accumulated over the years, may have lower overruns than the remaining sectors.

Regarding the sectors, we verified and concluded that our observations do not have any excessive representation in the sectors under study – transports, education, and social or economic infrastructures. Therefore, we believe we have a robust representation of the public infrastructure projects performed in Portugal for period considered for analysis. Consequently, transport infrastructures account for 25.7% (1,107 observations), while economic infrastructures account for 16.1% (691 observations), while education and social facilities account for 19.6% (845 observations) and 38.6% (1,662) observations, respectively. Although social facilities account for more 555 observations than transport projects, this is to be expected, due to the broader scope of investments captured by this sector, than, for example, the transport sector, which is characterised by larger investments, rather than smaller interventions,

The transport sector is specifically analysed in Subsection 5.2. This choice was prompted by the fact that in the literature review, transport projects is identified as being the most-studied sector, therefore allowing for better and proper international comparisons and a generalisation of our conclusions. Furthermore, out of the sectors studied, the transport sector is the one that presents higher weighted average cost overruns (17.8%). The transport sector also records the highest amount of cost deviations when compared with the remaining sectors, with around 500 million Euros of cost overruns. It represents 49.5% of the total cost overruns in our sample (1 billion Euros).

Regarding the focus on local government projects, we identified that central governments projects have a higher weighted average cost deviation (13.8%) when compared with local government projects weighted average cost deviation (6.5%). The average weighted average cost deviation for all projects is 10.7%. Therefore, local government projects score below average. This below score average, is worth analysing, as the expected low levels of governance, and the higher proximity of the decision-making process with contractors and with the public decision-makers/elected politicians lead to higher cost deviations, especially when compared with central government projects, which tend not to have such described characteristics. Local government sector projects is analysed in Subsection 5.3.

To assess the results for these variables, we introduce two control variables - *Subsector, and Parque Escolar*, as defined below.

Subsector (notcgov) is a dummy variable which indicates the level of government that corresponds to the public investment promoter, according to the three main levels of government that exist in Portugal: (i) the central government (*cgov*); (ii) the autonomous regions (Azores and Madeira) which make up the regional government (*region*), and; (iii) the municipalities (*mun*) that form the local government. This variable assumes 1 if it is a regional or local government project (not central government), and 0 if this a project developed by a central government entity.

As stated by Da Cruz & Marques (2014, p. 94), "*According to the Constitution, the Portuguese local administration is composed of administrative regions, municipalities and civil parishes. However, the administrative regions were not established thus far, and the authorities responsible for delivering local public services to the population are the municipalities (parish competences are limited, mainly consisting in an extra link between the municipality and the population needs). There are 308 municipalities in Portugal, where 30 are on the islands (the two archipelagos are autonomous regions) and 278 in the mainland. The autonomy of municipalities (i.e. of local governments) regarding the management of their responsibilities is a Constitutional principle.*"

Level of government data accounts for 22.1% (953 observations) of central government projects and 77.9% (3,352 observations) of local government projects. Although a wider spread in the number of observations is captured in our local government sample, this is also to be expected, due to the country's administrative organisation and the weight that local and regional structures have in the public infrastructure investments carried out.

We expect that less-centralised levels of government are more likely to present cost and time overruns, as they have less experience and means to award and control the completion of projects. Nevertheless, the potential negative consequences of a lower level of sophistication of local governments (smaller budgets, fewer staff, and lower expertise) is surpassed by the benefits of having overall project management on a smaller scale. The potential reasons for such a difference between local and central governments might be due to a more detailed knowledge of the specificities of the project and the geographical area where it is developed, as well as a higher proximity with the communities and the potential beneficiaries of the project. This proximity can benefit public discussions and consultations, which can anticipate local stakeholders' and lobby groups' expectations and challenges, and it can also identify potential negative impacts and anticipate mitigation strategies.

Parque Escolar (pescolar) is a dummy variable which assumes 1 if the project was part of the Parque Escolar investment programme, and 0 if it was not part of this programme. *Parque Escolar* is a State-owned enterprise for the construction of schools, subject to the supervision of the Portuguese government ministers responsible for the areas of finance and education. Parque Escolar's purpose is the planning, management, development, and execution of the modernisation programme for the public network of secondary and other schools under the responsibility of the Portuguese Ministry of Education. All projects of Parque Escolar belong to the education sector. With this variable, we intend to see whether differences exist in cost and time deviations, based on the fact that these projects were developed under the *Parque Escolar* investment programme, rather than as an isolated investment expense. We expect a negative signal for this variable, as a specific investment programme can be more efficient in forecasting and controlling project costs and delivery times than a single investment, even with the same specific purpose.

The descriptive statistics of all the variables described in Subsection 4.4 are summarised in Table 21 for the cost deviations final sample, and in Table 22 for the cost deviations in the transport sector final subsample, in Table 23 for cost deviations in the local government projects final subsample, and, finally, in Table 24 for the time deviation final sample. In each table the variables are presented according to the research hypothesis (I to IV).

[insert ***Table 21****,* ***Table 22****,* ***Table 23*** and ***Table 24*** *here]*

4.5. Data diagnostics on independent variables

We will now focus on the diagnostic of the independent variables. For this end, we will work under the assumptions of: (i) Multicollinearity; (ii) omitted variable bias; (iii) heteroscedasticity, and; (iv) autocorrelation. Additionally, we will also deal with other issues that have arisen during our analysis which, while strictly speaking are not assumptions of regression, are none the less of great concern to data analysts - such as outlier effects (Chen, Ender, Mitchell, & Wells, 2003).

4.5.1. Cost deviation

We run a multicollinearity test, using the correlation matrix (Table 19), and identified values above 0.6 or below -0.6 as being a potential source of multicollinearity among variables. The correlation between two variables measures the degree of linear association of such variables, which means that two variables that are correlated are treated in a completely symmetrical way. This does not imply that changes in one variable cause changes in the other variable, or the other way around. Instead, correlation merely states that there is evidence of a linear relationship between the two variables, and that changes in the two are, on average, related to an extent provided by the correlation coefficient (Brooks, 2014). Evidence of strong correlations between variable pairs have been detected, which indicates that multicollinearity is likely to lead to estimation problems. For this reason, we removed from the regressions all high pairwise correlations among explanatory variables, which means that we considered only one of such variables, in order to avoid multicollinearity problems. As mentioned earlier in the variables presentation, some of these problems were expected (e.g., financial crisis variables and governance variables). Although not reported, a VIF Test was performed which confirms the results described above.

*[insert **Table 19** here]*

We test for heteroscedasticity by performing a Breusch–Pagan test. We formulated the null hypothesis being constant variance and we rejected the null hypothesis (p-value = 0.0000). This is saying that if the null hypothesis is rejected, then we have significant evidence that there is heteroskedasticity (there is no constant variance). To solve this problem, we use robust standard errors, which is a technique used to obtain unbiased standard errors of OLS coefficients under heteroscedasticity. We regressed using the *vce (robust)* option command in Stata. Using this command is equivalent to requesting White-corrected standard errors in the presence of heteroskedasticity (Cameron & Trivedi, 2010; White, 1980).

Since we are also dealing with both endogeneity models and endogenous regressors, i.e., where the stochastic regressors are correlated with the error term, and a large sample, we run a Wald test, instead of the classic F test. The Wald test is used to test the joint significance of a subset of coefficients, and it tests linear hypotheses after estimation. The result was statistically significant (p-value = 0.0000). The Wald test implies that the regressors have an important collective effect on the sample and it is more appropriate when dealing with instrumental variables, such as in the current case (Gujarati, 2014). We reject the null hypothesis that all regressors coefficient are simultaneously zero. In conclusion, all the regressors have an important impact on the dependent variable. Likewise, we present the p-value for the Wald test for each regression.

We ran the Ramsey test for omitted variables, given that the p-value was higher than 0.1 (Ramsey test p-value = 0.86), so therefore we rejected the null hypothesis, as F is not statistically significant. The result confirms that the model does not suffer from omitted variables, although this does not mean that we have included all the explanatory (theoretical) variables, but it means rather that there are almost certainly no omitted nonlinear variables to include in our model (Gujarati, 2014).

4.5.2. Time deviation

Once more, checking for multicollinearity, we run a test for time deviation using the correlation matrix (Table 20). We identified values above 0.6 or below -0.6 as a potential source of multicollinearity among variables. Evidence of strong correlations between variable pairs has been detected. This indicates that multicollinearity is likely to lead to estimation problems. For this reason, we have removed from the regressions in Section 6 all high pairwise correlations among explanatory variables, which means that similar to cost deviations, we only considered one of such variables, in order to avoid multicollinearity problems. A perfect, or near perfect linear relationship among the variables means that the estimates for a regression model cannot be uniquely calculated. As mentioned above, in the variables presentation, some of these problems were expected (e.g., financial crisis variables and governance variables). Although not reported, a VIF Test was performed, which confirms the above-described results.

*[insert **Table 20** here]*

Regarding heteroscedasticity, we again performed a Breusch–Pagan test. Similar to the cost deviation test, we formulated the null hypothesis to be constant variance. We reached a p-value = 0.5518 higher than our default level of significance of 0.1. Therefore, and contrary to the cost deviation test, we do not reject the null hypothesis. This is to say that if the null hypothesis is not rejected, then we have significant evidence that there is homoscedasticity (there is a constant variance). Homoscedasticity is one of the Gauss-Markov assumptions required for the OLS method to be BLUE. Nevertheless, in the absence of heteroskedasticity, we still use robust standard error in our estimations.

Similar to cost deviation, and since later on in this study we deal with time deviation determinants, both with endogeneity models and endogenous regressors, we run a Wald test to assess the joint significance of coefficients. The result was similar to that reached in the cost deviation study. For a p-value = 0.0001, we conclude for statistical significance, which means, again, that the regressors have an important collective effect on the sample, which is more appropriate when dealing with instrumental variables, such as in the current case (Gujarati, 2014). Therefore, once more we reject the null hypothesis that all regressors coefficients are simultaneously zero, and conclude that all the regressors have an important impact on the dependent variable.

Lastly, we ran the Ramsey test for omitted variables. Given that p-value = 0.40 is higher than 0.1, we have again rejected the null hypothesis that F is not statistically significant. The result confirms that the model does not suffer from omitted variables, which does not mean that we have included all the relevant variables, but it means that there are almost certainly no omitted nonlinear variables to include in our model (Gujarati, 2014).

In the next subsection we detail the econometric tests performed. For the use of the *cdevp* and *tdevp* variables, we used an OLS, a GLM, and a Tobit (censoring the negative values). For *cdevp* and for control and robustness checks of our results, we also run a negative binomial (with *cdevp* above zero) regression. As the *cdevprob* and *tdevprob* variables are binary (zero or one), we used a probit model, measuring the probability of a project having cost/time overruns. To assess endogeneity, and as a robustness test for the formulated hypothesis, we ran an instrumental variable OLS (IVOLS) for the *cdevp* and *tdevp* variables. A probit (IVprobit) was run for the *cdevprob* or *tdevprob* variables. Finally, our last robustness tests (also addressing the endogeneity issue) were a fractional response GLM model, using *cdevp,* a fractional response probit, using the *cdevprob* as a dependent variable, and a SEM to test if our hypothesis exogenous determinants have a direct effect in tdevp and simultaneously exert an indirect effect on cdevp. The reason that some tests were not applicable for time variables (*tdevp* and *tdevprob*), is due to samples dimension.

4.6. Econometric models

We performed our econometric tests on the data collected (presented in Subsection 4.1). Tests were performed on two different datasets, both of which originated in the collected data. Such datasets are a consequence of the information available for each project observation. The first set of data focuses on information on cost deviations and the second on time deviation.

Firstly, we start by analysing in the collected data all public projects observations where it was possible to determine both a *cdevp* and a *cdevprob*. This analysis is presented in Subsection 5.1. From here, two subsets were extracted: i) a subset of public transport sector projects, and; ii) a subset of observations which only considers projects developed by local government entities. This choice is prompted by the fact that in the literature, as stated in Section 2 and Subsection 4.4.4, transport projects and local government projects have characteristics that are worth additional analysis. While transport projects are identified as being the most studied sector, which allows for better and proper international comparisons and a generalisation of our conclusions. Local government projects score below-average cost overruns when compared with central government projects in our sample, which makes this phenomenon something worth analysing, on account of the differences in the levels of governance between those decision-making levels of government (which is higher in central government, which leads to lower cost deviations, which are not the case). Transport and local government projects are analysed in Subsection 5.2 and 5.3, respectively.

The second set of data focuses on time deviations and consists, for the collected data, of all public projects observations where it was possible to determine both a *tdevp* and a *tdevprob*. The lower level of observations where we were able to collect time deviations when compared with cost deviations observations allowed us to divide this sample into additional subsectors. The lower level of observations where it was possible to determine both a *tdevp* and a *tdevprob* is a consequence of the absence of information regarding the completion time of public projects in the Court of Auditors Audit Reports, as presented in Subsection 4.1.

Firstly, for each of the datasets (cost deviation complete sample, cost deviation transport sector sample, local government projects sample and time deviation complete sample) we analysed the impacts of the proposed exogenous determinants (political, governance, and economic) and endogenous determinants (project variables used for control purpose) on cost and time deviations. We started by focusing on cost deviation, using *cdevp* as the dependent variable for our studies. This had the purpose of understanding whether the theories and formulated hypothesis affect cost deviations. The results are presented in Subsection 5.1 (general study), Subsection 5.2 (transport sector projects study), and Subsection 5.3 (local government projects study). Secondly, we move to analyse time deviations effects, which means that we changed our dependent variables to *tdevp*. The results of this additional analysis model are presented in Section 6. Once again, we aim to understand whether an effect from the formulated hypothesis and supporting theories exists, but this time for time deviations. Additionally, in Section 7 we present the results of our last model. In this study, we move back to the first model, but now we add time deviation as an independent variable, together with the remaining exogenous and endogenous determinants.

We started our tests by performing both an Ordinary Least Squares regression (OLS), a Generalised Linear Model regression (GLM), and a Tobit (censoring the negative values), using either *cdevp* or *tdevp* as dependent variable. Furthermore, for *cdevp* we additionally varied out a negative binomial (with *cdevp* above zero) regression. The negative binomial was not used with *tdevp*, due to the smaller number of variables in this data set. OLS is our "simple" test, as it aims to measure the impact of each independent variable on the percentage of deviation. GLM aims to check the robustness of the OLS test, as the dependent variable is a percentage. As we have a dependent variable as a percentage, and we also have outliers (either negative deviation or positive deviation, above 100%), we ran a Tobit with left censoring (negative values) to assess how the model reacts to outliers. In the Tobit model, we also run a censored OLS to test the robustness of the Tobit model.

Furthermore, as mentioned in subsection 2.3, from the literature we learn that the distribution of cost deviation is generally skewed to the right and that the frequency of observations with cost deviations is very large. Furthermore, our samples, even when excluding negative values, have a substantial amount of values equal to zero (no cost deviation). Therefore, even though we have used the Tobit regression to censor the negative values, as mentioned above, for control purposes, we additionally ran a negative binomial. For the test carried out, the command fits a negative binomial regression model for a non-negative count dependent variable. In this model, the count variable is believed to be generated by a Poisson-like process, except that the variation is greater than that of a true Poisson. This extra variation is referred to as 'overdispersion'.

These tests allow us to answer our first and fifth research questions - "What are the main exogenous and endogenous determinants of cost deviations?" and "What are the main exogenous and endogenous determinants of time deviations?" using the following models, respectively:

$$\textit{Cost deviation} = \alpha + \beta * \textit{Political} + \gamma * \textit{Governance} + \delta * \textit{Economic} + \lambda * \textit{Project} + \varepsilon \quad (1)$$

$$\textit{Time deviation} = \alpha + \beta * \textit{Political} + \gamma * \textit{Governance} + \delta * \textit{Economic} + \lambda * \textit{Project} + \varepsilon \quad (2)$$

Secondly, aiming to test the impact of the determinants on the likelihood of cost and time overruns, we transformed dependent variables *cdevp* and *tdevp* into *cdevprob* and t*devprob*. Variables *cdevprob* and t*devprob* are dummy variables that assume 0 if there was no cost/time overrun, i.e., cost/time deviation is 0 or negative, and 1 if there was a cost/time overrun, i.e., cost/time deviation was above 0. Variables *cdevprob* and *tdevprob* are defined in Subsections 4.2.1 and 4.2.2, respectively.

Therefore, to test the impact of the determinants on the likelihood of a cost and time overrun, we started by using a probit model (or Logit, according to the AIC test) for measuring the probability of a project having cost/time overruns. The probit model was used to assess whether each independent variable affects the likelihood of a cost/time overrun (along with marginal effects to assess the magnitude of that probability). Consequently, to determine what drives the probability of a cost overrun and the probability that a cost overrun is initiated by an exogenous variable (as opposed to a project variable), we estimate probit (and logit) models with cross-sectional data. Correctly, we assume that the model takes the form: $\Pr(Y = 1|\, X) = \ \phi\ (\mathrm{X}'\ \beta)$ (3), where Pr denotes the probability, and ϕ is the cumulative distribution function of the standard normal distribution. The parameters β can be estimated by maximum likelihood. It is possible to motivate the probit model as a latent variable model. Supposing that an auxiliary random variable exists of $Y* = \ \mathrm{X}'\ \beta + \ \varepsilon$ (4), where $\varepsilon \sim N(0{,}1)$, consequently Y can be viewed as an indicator for whether this latent variable is positive:

$$Y = \begin{matrix} 1\ if\ Y*>0\ i.e. - \varepsilon < \mathrm{X}'\ \beta \\ 0\ otherwise \end{matrix} \quad (5)$$

These tests allow us to answer our second and sixth research question - “What exogenous and endogenous determinants impact on the likelihood of a cost overrun?” and “What exogenous and endogenous determinants impact on the likelihood of a time overrun?”

Additionally, to assess endogeneity, and as a robustness test for the formulated hypothesis, we ran an instrumental variable OLS (IVOLS) for the *cdevp* or *tdevp*, and a probit (IVprobit) for the *cdevprob* or *tdevprob* variables. Due the importance of endogeneity in our conclusions, we further performed two additional robustness tests to confirm our conclusions: a fractional response GLM model, using *cdevp*, and a fractional response probit, using *cdevprob* as the dependent variable. The fractional response models were not used with *tdevp* and *tdevprob* again, due to the smaller number of variables in this data set.

With these tests, we aim to surpass the possibility of inconsistent parameter estimation, due to endogenous regressors. In this case, regression estimates measure only the magnitude of association, rather than the magnitude and direction of causation which is needed for policy analysis. The instrumental variables estimator provides a way to nonetheless obtain consistent parameter estimates (Cameron & Trivedi, 2010).

While the OLS/GLM regression model specifies that $y = \alpha + \beta * Political + \gamma * Governance + \delta * Economic + \lambda * Project + \varepsilon,$ where ε is an error term, and y can either be cost deviation or time deviation). Regression of dependent variable on independent variables yields an OLS estimate, $\widehat{\beta}\ of\ \beta$. Standard regression results make the assumption that the regressors are uncorrelated with the errors in the OLS/GLM model presented above. Therefore, the only effect of the independent variables on the dependent variable is a direct effect, via the terms β * *Political,* γ * *Governance,* δ * *Economic, and/or* λ * *Project.* The path analysis diagram is:

$$\begin{tikzcd}
\beta * Political,\ \gamma * Governance,\ \delta * Economic,\ \lambda * Project \arrow[r] & y \\
\varepsilon \arrow[ur] &
\end{tikzcd}$$

where no association between β * *Political,* γ * *Governance,* δ * *Economic,* λ * *Project* and the error term ε exists.

Nevertheless, some situations may exist where an association between regressor and errors can occur. In these situations, the error term ε will incorporate all factors, other than that presented in the regressors that determine our dependent variables. Consequently, a more suitable diagram is presented:

$$\begin{tikzcd}
\beta * Political,\ \gamma * Governance,\ \delta * Economic,\ \lambda * Project \arrow[r] & y \\
\varepsilon \arrow[u] \arrow[ur] &
\end{tikzcd}$$

where an association between β * *Political,* γ * *Governance,* δ * *Economic,* λ * *Project* and the error term ε now exists.

With this association, higher levels of β * *Political,* γ * *Governance,* δ * *Economic,* λ * *Project* have two effects on our dependent variables: a direct effect via the regressor and an indirect effect via the error term affecting the regressors, which in turn affects the dependent variable, which are the main consequences of this correlation between regressors and error term.

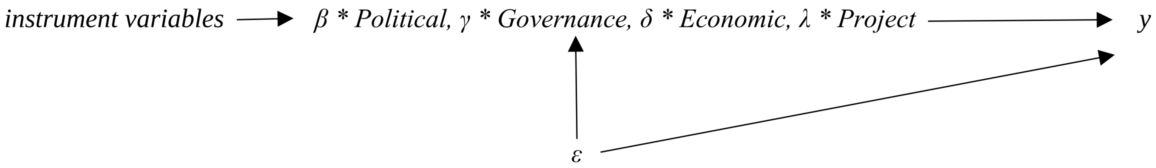
The OLS estimator is therefore biased and is inconsistent for the estimators (β, γ, δ, λ), unless there is no association between the regressors and the error term. This inconsistency of OLS is due to the endogeneity of the independent variables, meaning that changes in the independent variables are associated not only with changes in the dependent variable, but also changes in the error term. Therefore, we needed a method to generate only exogenous variation in the independent variables, which is of utmost importance, as in this research we are working mainly with exogenous determinants and their effects on both cost and time deviations and overruns (Angrist, 1991; Wooldridge, 2015).

When controlling for endogeneity at project level, we aim to confirm the previous results, in order to assure that the evolution of the Portuguese public institutions over the last 30 years (the range of our observations) through the use of the governance indicators is also being considered in the explanatory variables. We ensure that the results of each project are affected by the exogenous and endogenous variables under analysis, as we are controlling the "quality" of the public agent that takes the decision to build the projects.

We therefore used a two-step approach, as it could be possible that one or more of the regressors is correlated with the error term, as derived from the *ex-ante* self-selection problem (Angrist, 1991). Although the treatment of endogeneity in the nonlinear probit models is still open to discussion, we expect this test to control for the self-selection of variables (Wooldridge, 2015). Therefore, the first test was carried out using an IVOLS and an IVprobit, which is the standard test for endogeneity. The second test (not formally reported, but consistent with the findings) consisted of running the previous OLS and probit regressions, and then taking the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables.

Both endogeneity tests were performed, using governance variables as instrumented variables (*rlaw*, *corrop*, and *goveff*). As instrument variables (exogenous variables used with the remaining exogenous variables of our model), we used the variables *troika*, election year (*ely*), election year lag (*elylag*), and election year lead (*elylead).* We aim to confirm that political cycles and governance environment has an impact on the occurrence of cost and time deviations and on the probability of cost and time overruns. We used such variables because election variables (*ely*, *elylag* and *elylead*) are exogenous variables, in the sense that they are determined by the country election law and by political events (rather than by each party involved in each public project). The financial support in the form of the "troika" bailout was also exogenous to each project. The describe endogeneity tests were carried out in order to validate that the independent variables used before are indeed exogenous determinants.

The introduction of such instrument variables is due to the fact that we needed a variable with the property that changes in the instrument variables are associated with changes in the independent variables, but they do not lead to a change in the dependent variables (apart from the indirect route via the independent variable). This originates the following path diagram:



which introduces a instrument variable which is associated with the independent variables, but not with the error term. It is true that instrument and independent variables will be correlated, but now the only source of correlation is the indirect path through the dependent variable showed above. More correctly, a variable is referred to being an instrument variable for the independent variable, if such an instrumented variable is uncorrelated with the error term (which excludes the instrument variable from being a regressor in the model for the dependent variable) and if the instrument variable is correlated with the independent variable regressor (which requires that there is some association between the variables being instrumented).

Furthermore, also addressing the endogeneity issue, we performed two additional robustness tests to confirm our conclusions - a fractional response GLM model using *cdevp* and a fractional response probit, using *cdevprob* as dependent variable. This allows us to relax regarding the issue that our dependent variable may have a skewness to the right (as discussed before, the literature presents evidence that cost deviations are frequent and skewness is to the right). We chose these fractional response models, which are Generalised Least Square models, because we can thus establish the most appropriate type of distribution. Therefore, we were able to statistically reject the possibility of non-normal distribution of errors. This is crucial, as the models used, for instance, the Tobit regression, are based on this normality assumption.

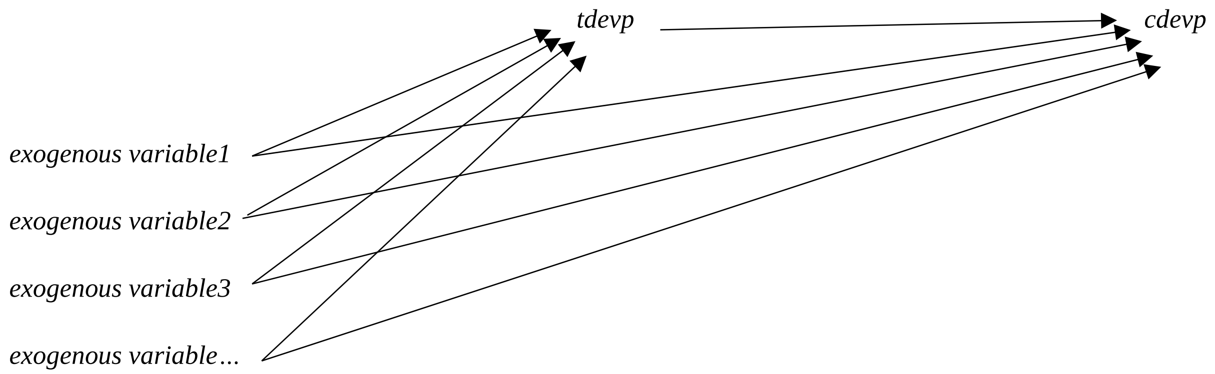
To answer our seventh research question - "does the occurrence of time deviations and overruns in public projects affect cost deviations and overruns?" we will slightly modify equation (1) by adding time deviation percentage (*tdevp*) as an independent variable. We will again run the OLS, GLM, tobit and Probit models, to test the main exogenous and endogenous determinants of cost deviations and the impact of the determinants on whether the likelihood of cost deviations and overruns change when adding *tdevp* as an independent variable. Our model is represented by the following expression:

Cost deviation % = α *+* μ**time deviation % +* β ** Political +* γ ** Governance +* δ ** Economic +* λ ** Project +* ε *(*6*)*

Furthermore, we assess whether time deviation is also an explanatory variable of cost deviation, which is of utmost importance. From the reviewed literature, several studies have emerged which analyse and conclude that time is a critical variable for the completion of infrastructures (Abdul-Rahman et al., 2006; Alaghbari et al., 2007; Ramanathan, Potty, & Idrus, 2012; Sambasivan & Soon, 2007). Furthermore, other studies such as those carried out by Al-Khalil & Al-Ghafly (1999), Al-Momani (2000) and, Chan & Kumaraswamy (1997) not only add contributions to the causes of time overruns, but most importantly they all demonstrate that delays in project completion (time overruns) are expensive and have an impact on the final cost of a project. This confirms the relevance of studying the impacts of time deviations also as an independent variable.

Furthermore, to assess endogeneity, in the model that uses *tdevp* as an explanatory variable of *cdevp*, we will again run IVOLS and IVprobit as the standard test for endogeneity (described above). Our analysis will be completed with a Structural equation modelling (SEM). With SEM, we aim to determine which exogenous determinants affect time deviations and if time deviations affect cost deviations. Structural equation modelling is a multivariate statistical analysis technique used to analyse structural relationships. This technique combines factor analysis and multiple regression analysis, and it is used to analyse the structural relationship between measured variables and latent constructs. SEM is useful since it estimates the multiple and interrelated dependence in a single analysis. Both endogenous variables and exogenous variables are used in this analysis. Endogenous variables are equivalent to dependent variables and are equal to the independent variable (Hox, J. J. & Bechger, 1998).

The longer the time deviation, more costs a project need to incur to reach its completion. Therefore, our goal is to test if our hypothesis exogenous determinants have a direct effect on *tdevp* and simultaneously exert an indirect effect on *cdevp* whether or not it has a distinct effect directly. In casual terms *tdevp* functions as an intervening or mediating variable. Consequently, SEM provides a systematic way to analyse such indirect effects, among other kinds of casual relationships (Hamilton, 2012). To present this, we will build an SEM diagram in which *tdevp* appears as an intervening variable affected by a set of exogenous variables representing some background characteristics, namely *ely*, *troika*, *deltacorrp*, *deltarlaw* and *deltaregulq*, but also as a predictor of *cdevp*.



Our eighth research question - “What policy implications can be drawn?” is answered partly through the joint analysis of all the results reached by the above-described econometric tests. Our third and fourth research questions of “Do transport projects have lower cost deviations than other sectors’ projects?” and "Do local government projects have lower cost deviations and overruns than central government projects?”, will respectively be answered by the same tests carried out to answer research questions one and two, diverging only from the fact that a different set of data will be used, using only local government projects observations.

Table 15 presents a summary of the studies carried out. Table 16 presents a summary of the statistical/econometric tests described above, divided by each of the studies carried out.

*[Insert **Table 15** and **Table 16** here]*

In the following sections we develop and analyse the results of our methodology and econometric tests. Accordingly, in Section 5 we focus on cost deviations results, while in Section 6 we concentrate our efforts in time deviations results. Finally, in Section 7, we advance to a model that conjugates both earlier dependent variables, but this time considering time deviation as an additional independent variable of the variable dependent of cost deviation. This enables us to to analyse how time deviations affects cost deviations.

5. Results for cost deviations/overruns

In this section, we aim to answer the first four research questions. Research Question 1, "What are the main exogenous and endogenous determinants of cost deviations?" and Research Question 2, "What exogenous and endogenous determinants impact on the likelihood of a cost overrun?" are addressed in Subsections 5.1, 5.2 and 5.3. Research Question 3 "Do transport projects have lower cost deviations than other sectors projects?" is addressed in Subsections 5.2, and Research Question 4 "Do local government projects have lower cost deviations and overruns than central government projects?" is answered in Subsection 5.3.

For all used three data samples, we were able to determine either a dependent variable cost deviation percentage (*cdevp*) and a dependent variable cost deviation probability (*cdevprob*). The first set of data is analysed in Subsection 5.1, comprises data from all sectors (social/economic/education/transport) and all levels of government (central, local and regional government projects). This data has already been described as our 'cost deviations final sample'. Additionally, we work with two subsamples extracted from that cost deviation final sample database. In Subsection 5.2, we work with one subsample which considers only observations labelled as transport sector projects. We refer to this set of data as our 'cost deviation transport projects final subsample'. Additionally, in Subsection 5.3, we work with a second subsample which now considers only observations labelled as local government projects. We refer to this set of data as our 'cost deviations local government projects final subsample'.

5.1. Results for cost deviations/overruns - total sample – "The exogenous determinants of cost overruns in public investment projects"

5.1.1. Descriptive results

As mentioned above, the cost deviations complete final sample observations comprise 4,305 projects where we were able to determine both the dependent variables of *cdevp* and *cedvprob.* Regarding *cdevp* specifically, the weighted average cost deviation[2] is 10.7% and the mean cost deviation is 4.5%, with a standard deviation of 15.3%. Minimum and maximum cost deviations are – 91.5% and + 471.9 % respectively. For the cost deviation final sample (4,266 projects after dropping out the sample outliers, as described in Subsection 4.3.1) the weighted average cost deviation is 6.3% and the mean cost deviation is 3.7%, with a standard deviation of 9.1%.

[2] Weighted average cost deviation = Σ (cost deviation) ÷ Σ (initial budget cost)

The minimum and maximum cost deviations are – 46.7% and +49.2%, respectively. We found these results to be consistent with those of the previous literature, which point out that overall cost overruns are very frequent in public projects. Some studies have found low levels (below 10%) for cost deviations (Cantarelli, Molin, et al., 2012; Creedy et al., 2010; Magnussen & Olsson, 2006; Odeck et al., 2015), whereas others have found evidence of cost deviations above 30% (Flyvbjerg et al., 2002; Morris, 1990; Sarmento & Renneboog, 2016b). Cost deviations over 100% are uncommon (Ansar et al., 2014) and are usually related to specific and non-recurrent events, such as the case of the Olympic Games (Flyvbjerg & Stewart, 2012), which represents a one in a lifetime project.

In Figure 23 we present the histogram for *cdevp*, overlaid by the normal distribution of our cost deviation final sample. Here we can observe that the *cdevp* is right skewed. Our cost deviation final sample has 675 projects with negative cost deviations (16%), 1,797 projects without deviations (42%), and 1,794 projects with cost overruns (42%), which means that cost overruns (positive cost deviations) are larger in number that negative cost deviations (where final project costs are lower than budget costs). Cost deviations are largely concentrated between -10.7% and 25.2%. Our results are in line with the results from the previous literature, where cost overruns were also dominant over negative deviations, in term of frequency (Bordat et al., 2004; Moret & Einstein, 2016; Sarmento & Renneboog, 2016b; Shehu, Endut, Akintoye, et al., 2014). A quartile analysis for this final sample indicates that 5% of the projects have negative deviations up to -6.6% of the projects, while 10% of the projects represents also negative deviations of up to -1.9% of the projects. Furthermore, 25% of the projects have no cost overrun (cost deviation equal to or below zero), while 75% of the projects have deviations up to 6.7%. For the 90th and 99th percentiles, deviation reaches 16.7% and 28.4%, respectively.

[Insert **Figure 23** here]

Furthermore, the transport sector has a weighted average cost deviation (17.8% when considering the complete sample, i.e., with outliers, and 10.8% when considering the final sample observations) while education accounts for the lower weighted average cost deviation (2.9% when considering the complete sample, and 2.7% when considering the final sample observations). Economic facilities present a weighted average cost deviation of 17.2% when considering the complete sample, and 7.6% when considering the final sample observations. Finally, social facilities present an 8.1% weighted average cost deviation when considering the complete sample, and 5.1% when considering the final sample observations.

The transport sector has 511 million Euros of cost overruns (out of a total initial cost of 1.95 billion Euros) when considering the complete sample, and 293 million Euros of cost overruns (of a total initial cost of 1.69 billion Euros) after removing sample outliers. This represents 46.8% of the total cost overruns in our sample (1.1 billion Euros), as transport only represents 25.6% of the sample. Social facilities follow with 305 million Euros of cost overruns (out of a total initial cost of 2 billion Euros), which represent 28.0% of the total cost overruns in our complete sample as social facilities represent 38.5% of our sample. After removing sample outliers social facilities, we reach 210 million Euros of cost overruns (from a total initial cost of 1.98 billion Euros).

Whilst economic facilities with 181 million Euros of cost overruns (of a total initial cost of 684 million Euros) represents 16.5% of the total cost overruns in our sample and education projects represent 8.7% of the total cost overruns in our sample, with 95 million Euros of cost overruns (out of a total initial cost of 1.2 billion Euros), economic facilities and education projects represent, respectively, 16.4% and 19.5% of our sample observations. After removing sample outliers, economic facilities account for 78 million Euros of cost overruns, while education projects attained 83 million Euros. Initial costs were 612 million Euros and 1.2 billion Euros, respectively.

Nevertheless, the transport sector is the sector that presents the lowest mean cost deviation (3.2%, when considering the complete sample, i.e., with outliers, and 2.2% when considering the final sample observations). Education public projects follow, which accounts for the second lower mean cost deviation (3.4% when considering the complete sample, and 3.5% when considering the final sample observations). Economic facilities present a mean cost deviation of 6.1% when considering the complete sample, and 3.7% when considering the final sample observations. Lastly, social facilities projects present a 5.2% mean cost deviation when considering the complete sample, and 5.7% when considering the final sample observations.

Regarding level of government, we identified that central governments projects have a higher weighted average cost deviation (13.8%) when compared with local government projects (6.5%). The weighted average cost deviation for all projects is 10.7%, as mentioned above. Therefore, local government projects score below average, which is something worth analysing, as the expected low levels of governance, lack of scale of the projects, and the higher proximity of the decision-making process with contractors and with those public decision-makers/elected politicians lead us to expect higher cost deviations, especially when compared with central government projects that tend not to have the above-described characteristics. We analyse this central versus local public investments dichotomy in Subsection 5.3.

Concerning dependent variable cost deviation probability (*cdevprob*), for the cost deviations complete sample, the percentage of projects with cost overruns is 42.5%, with a standard deviation of 49.3%. For the cost deviation 4,266 observations final sample, the percentage of projects with cost overruns is 42.1%, with a standard deviation of 49.4%. From this final sample, 1,794 projects (out of 4,266) present a deviation.

In Table 25 we present a descriptive analysis of the independent variables. This sample includes all the sectors and subsectors under analysis in our research. Furthermore, the variables were divided by the four hypotheses under study and are always presented in the text, following the same order as presented in the table.

[Insert ***Table 25*** here]

The final sample presents a cost deviation mean percentage of 3.7%, which considers all deviations – both negative and positive. Those variables that surpass this value are from *regelylag* (9.7%), *munely* (4.4%), *govrw* (4.6%), *govmaj* (4.1%), *largeproj* (5.8%), *socialf* (4.7%), and *notcgov* with 3.7%. The *regelylead* variable has the highest cost deviation mean scoring 9.7% (considering all deviations, followed by *largeproj*, which has a cost deviation mean of 5.8%.

The final sample minimum deviation is - 47%. The variables that achieve total sample minimum deviation are *ely*, *regely*, *govrw*, *law2008*, *troika* and *transp.* The final sample maximum deviation is found at 49% and the variables that achieve such maximum deviation are *govrw*, *govmaj*, *largeproj*, *transp* and *econf*. Furthermore, *pescolar* has the lowest maximum overruns, with a 23% overrun project. This was expected, as has been described above, this variable represents an investment programme which is more prone to efficiently forecast and controlled project costs. All other variables present a maximum overrun within a range of 45% to 48%.

If we consider only positive deviations (overruns), we found that our final sample has 1,794 observations from a total of 4,266 observations with overruns, which represents 42% of observations with overruns. From the analyses of the independent variables, we found that the variables *ely* (43%), *regelylead* (80%), *govrw* (47%), *govmaj* (44%), *largeproj* (66%), *edu* (43%), *socialf* (48%), and (49%) all have a higher percentage of observation with overruns (considering only those observations that belong to this subsample) than the final sample. From here we can point out *regelylead* and *largeproj* as being the variables that present higher percentage of overruns when considering each variable individually. On the contrary, *law2008* and *fincrisis1* are the variables with less overruns when analysing their own subsample, recording only 26% of overrun projects. Furthermore, and still only considering observations with overruns, we found that the cost deviation mean rises to 11.04% (from 3.7%) in our final sample. The *regely*, *regelylead*, *govrw* and *transp* variables present a cost deviation mean for overrun observation of 12%, i.e., higher than the final sample mean percentage.

Finally, regarding standard deviation, the *largeproj* variable presents the highest dispersion from the mean, scoring 0.13. The *law2008*, *fincrisis1* and *pescolar* variables all have the lowest dispersion from the mean, scoring 0.07 and all other variables have standard deviations in the range of 0.08 to 0.1.

In order to analyse some relationship between *cdevp* and some explanatory variables, we present some scatter plot graphs. Figure 18 presents the correlation between the years where projects started and the *cdevp*. It is possible to see here that there is some negative correlation, which shows some evidence that the passage of time tends to reduce cost deviations. In Figure 19, we present the scatter plot graph between the budget cost (the log of the values) and the *cdevp* deviation. In this case, in line with some of the literature, there seems to be no evidence that large projects have higher or lower cost deviations (Creedy et al., 2010; Magnussen & Olsson, 2006; Makovšek et al., 2011). Figure 20 presents the *cdevp* for whether the projects belong to the Parque Escolar investment programme, or not. Seemingly, although our further results go on to analyse this in more detail, there is no specific evidence that this specific investment programme was more efficient in reducing cost deviations. Lastly, Figure 21 presents some evidence that the impact of the 2008 financial crisis has decreased cost deviations.

[Insert ***Figure 18***, ***Figure 19***, ***Figure 20*** and ***Figure 21*** here]

We used several hypothesis tests to analyse whether the variables are statistically significant. The T-test and the Mann-Whitney tests confirm such results. In Table 26, we disclose the results for the statistical tests - two-sample T-test (parametric test) and the Mann-Whitney test (nonparametric test). In the T-test, which considers the cost deviation final sample, we tested the significance of the regression parameters for the hypothesis that such parameters are statistically different from the sample´s mean. When we reject the null hypothesis, we assume that the variables deviations are statistically different from the sample´s mean ($H_{0:}$ μ=3.7%). Regarding the Mann-Whitney test, when we reject the null hypothesis, we assume that we accept with statistical significance that a variable has different deviations than the rest of the sample.

[Insert ***Table 26*** here]

We used both tests, namely the Mann-Whitney test, as our data does not follow a normal distribution. Therefore, we use a test that does not assume any properties regarding the distribution of the dependent variable in the analysis. Nonparametric tests, or distribution-free tests are tests that have the advantage of not requiring the assumption of normality, neither the assumption of homogeneity of variance. Nonparametric tests, such as the Mann-Whitney test, compare medians instead of means. This means that if the data has a small number of outliers, then their influence is negated. Likewise, the Mann-Whitney test is more powerful than the T-test, while maintaining a preferred type I error rate (wrongly rejecting the null hypothesis). For both tests, we considered a p-value of 0.1. Regarding the T-test, we found that only *edu*, *econf* and *notcgov* are not significative and for the Mann-Whitney test we found that *largeproj, edu*, *econf* and *notcgov* are not statistically significant. Consequently, we expect that all the significant variables will also be statistically significant in Subsection 5.1.2, where we analyse the results of the econometric tests carried out.

5.1.2. Results and discussion

In this section, with regards to our ‘cost deviations final sample’, we start by studying the exogenous and endogenous determinants of *cdevp* in order to answer our first research question - “What are the main exogenous and endogenous determinants of cost deviations?” This was carried out using the models already described in Subsection 4.6.

Results from the GLM model are presented in Table 27. Despite not being formally reported, we also run the GLM, using year effects with similar results. Table 28 presents the results for the Tobit model. Once again, although not formally reported, the Tobit model with year effects was also used, and the previous results have been confirmed, whereas in Table 29 we present the results of the negative binomial (using the *cdevp* above zero) model.

[Insert ***Table 27***, ***Table 28*** and ***Table 29*** here]

For our first hypothesis (political), in GLM we observe that there is evidence (albeit weak) that majority governments and right-wing government leads to less cost deviations, with Tobit and negative binomial regressions confirming this evidence. Political decisions influence the occurrence of cost deviations. These results are in line with the previous literature (Flyvbjerg et al., 2002; Siemiatycki, 2009).

Regarding the second hypothesis (governance), there is evidence that a better legal and regulatory framework, through independent variables *deltarlaw* and *deltacorrop,* is related with less cost deviations. Nevertheless, the stronger evidence comes from the introduction of a new public procurement law (*law2008*) in 2008 which negatively impacts (reduce) cost deviations and therefore was shown to be effective in reducing deviations, following a EU directive on public procurement. Once again, Tobit and negative binomial regressions confirm this evidence. These results confirm the evidence from the literature that governance influences cost deviations. As documented by Cantarelli et al. (2010), a poor institutional/governance framework for the organisations is responsible for both the decision process of whether to build and to contract to private contractors who will be in charge of developing such public infrastructures. The authors also sustain that overruns can arise due to non-optimal behaviours that are a consequence of the above-mentioned inadequate institutional ambience, which leads to costs underestimation, with the aim of easily approving such investments.

With respect to our third hypothesis (economic), economic growth (*gdpg*) and inflation (*infl*) are relevant determinants of cost deviations. Nevertheless, these independent variables add a different contribution to cost deviations and inflation and growth are negatively associated (Barro, 1995; Fischer, 1993). If on one hand, inflation, as expected, impacts positively (increases) on cost deviations, meaning that the general increases of prices in the economy leads to increase of project costs through increases in work costs and construction materials, the exception on the other hand is the presence of majority governments. When majority governments are significant, inflation has a negative contribution on cost deviations, which allows us to conclude that, despite inflation, majority governments are able to enforce better price control mechanisms for the project contracts, due to their stronger negotiation position with contractors. This may be due to greater political stability, as normally majority governments tend to last longer and are in a better position to be re-elected. Nevertheless, economic growth being a relevant determinant to cost deviations, impacts cost deviations, contrary to what formulated in Table 14 (expected signals), as it impacts negatively (reduces) on cost deviations.

Still regarding exogenous economic determinants, greater public investment is, as expected, related with a higher level of deviations, which means that a higher percentage of money is invested in public infrastructures (more money and projects), leading to a reduction of controls on spending. More money invested in public infrastructures leads to a greater number of projects, due to public administration hiring-constraints and rigid rules governing resources available for projects, which will remain unchanged. Therefore, higher investment leads to more projects with the same control resources.

Lastly, the financial crisis has reduced cost deviations in public projects, due to the situation of pre-bankruptcy of the government, which led to large public budget constraints The financial crisis in effect created a situation where there was less money available, which resulted in an increase of controls on spending and consequently a reduction in cost deviations. These results are in line with the previous literature, as demonstrated by Siemiatycki (2013), who considers economic cycles to be the foundation for projects being more effective or efficient than earlier ones (specially large projects), which were motivated by the political and policy attraction of achieving major tangible benefits. This author adds that recurrent overruns, namely cost ones, are one of the reasons for the decline of such projects.

Regarding our fourth hypothesis (project), transport and economic infrastructure projects are shown to tend to have less deviations than, for example, education projects. Transport and economic infrastructure projects variables impact negatively (decreases) on cost deviations, while on the contrary, for education projects the variable is positive, thus impacting in our model positively (increase) for cost deviations. Local government projects tend to perform worse than projects developed at a central government level and the *notcgov* variable is statistically significant and increases cost deviations.

Lastly, we found no evidence that larger projects are more prone to deviations, either when using the *largeproj* variable or the *loginitialcost* variable, which is in line with the previous literature which states that project dimension is also one of the less unanimous determinants in the literature, with studies pointing in both directions, see for example Aibinu & Pasco (2008), Flyvbjerg et al. (2002), and Odeck (2004). However, it is understood and generally accepted in the literature that larger projects have higher costs due to project complexity (Morris & Hough, 1987) and that larger and complex projects are frequently badly designed and managed, which leads to overruns occurring more often (Jahren & Ashe, 1990; Shrestha et al., 2013). On the other hand, due to their dimension, large projects are more scrutinised and have more control mechanisms in place and larger economies of scale (Flyvbjerg, Bruzelius, et al., 2003).

In terms of the size of the effect, we have found that, for example, that the GLM variables of *law2008* (governance determinant) and *publicinv* and *fincrisis* (economic determinants) had a far greater impact than the other variables. *gdpg* and *infl* (economic determinants) also have a relevant effect, as well as *transp* and *notcgov (*project determinants*)*, while *govrw and govmaj* (political determinants) had lesser effects. These results show that governance and economic and project determinants play a larger role in explaining cost overruns, than political ones.

The results of the probit cost overruns model are presented in Table 30. These results aim to help us answer our second research question - "What exogenous and endogenous determinants impact on the likelihood of a cost overrun?" Following the previous results, we again found evidence that majority governments and right-wing governments reduce the likelihood of cost overruns. Furthermore, these results show that better governance and regulatory framework also lead to a lower probability of cost overruns, which confirms the results of previous tables regarding a better economic cycle, which is represented by growth in GDP, which reduces the occurrence of overruns. Furthermore, greater public investment increases the probability of public projects having cost overruns and the financial crisis also confirms the previous results, as it contributed to a reduction in the likelihood of cost overruns, which again confirms the idea that less money available to spend leads to an increase in controls on spending, and therefore to a reduction in cost overruns.

[Insert ***Table 30*** here]

Furthermore, public projects managed by local governments tend to reduce the probability of cost overruns. We will further develop this topic when we specifically approach local government projects in Subsection 5.3. On the contrary, public projects managed by the Parque Escolar programme present a robust evidence of increasing the probability of cost overruns. Finally, we found that there is no evidence that large projects increase the likelihood of overruns (for both variables *largeproj* and *loginitialcost)*.

In order to further confirm the above results, Table 31 and Table 32 provide the results for the IVOLS and the IVprobit. For instrument variables in the IVOLS, we used electoral dates reference periods, namely the fact if a project was initiated in an electoral year (*ely*), a year before an electoral year (*elylag*), or a year after the election being held (*elylead*). Additionally, in the IVprobit we also used as an instrument variable, the *troika* variable. This variable aims to capture the effects of the presence of the Troika in Portugal by measuring whether the year that the project started occurred before, or after the beginning of the financial aid programme. Consequently, we aim to test the indirect effect of these exogenous instrument variables, together with the remaining exogenous variables on a set of instrumented variables - governance determinants rule of law, control of corruption, and government efficiency.

[Insert ***Table 31*** and ***Table 32*** here]

These results are confirmed by our robustness check. We found similar results when using the predicted values and reintroduced them into the OLS and probit panel, thus estimating new equations with these instrumented variables (not formally reported). In addition, the factional models present similar results, as can be seen in Table 33 and Table 34.

[Insert ***Table 33*** and ***Table 34*** here]

After controlling for endogeneity at project level, we confirmed the previous results regarding our first hypothesis (political), that right-wing governments lead to fewer cost deviations. While for our second and third hypotheses (governance and economic), the results confirm that a better legal environment, together with a better economic situation are shown to have an impact on both reducing cost deviations and overruns. Whilst with regards to our fourth hypothesis (project), the results again show that transport and economic infrastructure projects tend to have fewer deviations than, for example, education projects. Transport and economic infrastructure projects variables impact negatively (decreases) on cost deviations, while on the contrary, the education projects variable is positive, which thus impacts our model positively (increase) for cost deviations. We conclude that election years have an impact on cost deviations and cost overruns. Once again, these results continue to show no impact of the size of the projects.(Large projects either increase or reduce cost deviations and overruns. Overall, we can now state that exogenous determinants (particularly the political, institutional and governance environment) have a strong impact on cost deviations and overruns.

5.2. Results for cost deviations/overruns - transport sector subsample - "The exogenous determinants of cost overruns in public transport projects"

5.2.1. Descriptive results

In this section we focus on a subsample of observations from public projects identified in our process of collecting data as transport projects - ‘cost deviation transport projects final subsample'. From our complete final sample of 4,305 observations, we collected 1,107 observations of public transport projects where we were able to determine *cdevp* and *cedvprob*. Our sample now covers a period of 33 years, from 1980 to 2012. Mean cost deviation is now lower, scoring 3.2%, while in the complete final sample, it attained 4.5%. A standard deviation of 14.4% is in line with the complete final sample (15.3%). In this transport sample, the initial project cost was 2.7 billion Euros, with a total deviation of 480 million Euros. If we only consider projects with cost overruns, then the weighted average rises to 26.2%. Minimum and maximum cost deviation are -79.5% and +136.9%, respectively.

After dropping out the sample outliers using the same assumptions as described in Subsection 4.3, we reach a cost deviation for the transport sector projects final subsample of 1,091 projects. The mean cost deviation is 2.2%, which is again lower than the 3.7% of the complete final sample. A standard deviation of 10.4% is again in line with the 9.1% from the complete final sample. The minimum and maximum cost deviation are now– 46.7% and +48.9%, respectively. We found these results to be consistent with most of the conclusions in the literature on the transports sector (Flyvbjerg et al., 2002; Magnussen & Olsson, 2006; Odeck, 2014; Sarmento & Renneboog, 2016b).

In Figure 24, we present the histogram for *cdevp*, overlaid by the normal distribution of our transport sector final sample. Once again, we can observe that the *cdevp* is right skewed. Our cost deviation final sample has 275 projects with negative cost deviations (25.2% of total), 455 projects without deviations (41.7% of total), and 361 projects with cost overruns (33.1% of total), which means that cost overruns (positive cost deviations) are larger in number than negative cost deviations (where final project costs are lower than budget costs). Cost deviations are largely concentrated between -10.8% and 25.0%. Our results are in line with results from the previous literature on the transport sector, where cost overruns are also dominant over negative deviations in terms of frequency (Blanc-Brude et al., 2009; Moret & Einstein, 2016; Sarmento & Renneboog, 2016b). A quartile analysis for this final sample indicates that 5% of the projects have negative deviations of up to -12.5% of the projects, while 10% of the projects also represent negative deviations of up to -6.6% of the projects. Furthermore, 50% of the projects have no cost overrun (cost deviation equal to or below zero), while 75% of the projects have deviations of up to 4.7%. For the 90th and 99th percentiles, the deviation reaches 16.7% and 36.4%, respectively.

[Insert ***Figure 24*** here]

Regarding dependent variable cost deviation probability (*cdevprob*), for the cost deviations complete transport sector subsample, the percentage of projects with cost overruns is 33.9%, with a standard deviation of 47.3%. This compares with a percentage of projects with cost overruns of 42.5% and a standard deviation of 49.3% for the complete final sample.

For the final 1,091 observations subsample, the percentage of projects with cost overruns is 33.1%, with a standard deviation of 47.1% (49.4%. in the final sample). In this final transport sector projects subsample, 33.97% of the projects present a deviation, which corresponds to 361 of the 1,091 observed transport projects, which is considerably less than the 49.4% of the complete final sample.

In Table 35 we present a descriptive analysis of the independent variables. This subsample only includes observations from transport sectors projects analysed in the current section. Furthermore, the variables were divided by the four hypotheses under study and are always presented in the following text in the same order as presented in the table.

[Insert ***Table 35*** here]

The transport sector projects final subsample presents a cost deviation mean percentage of 2.2%, which considers all deviations – both negative and positive. The variables that surpass this value are *regely* (2.6%), reg*elylead* (8.8%), *govrw* (4.4%), *govmaj* (2.7%), *largeproj* (31.3%), and *notcgov* (23.2%). The *largeproj* variable has the highest cost deviation mean, with 31.3%, although we only have three observations for this variable for the current transport sector subsample.

The final transport sector subsample minimum deviation is - 47%. Those variables that achieve total sample minimum deviation are *ely, elylag, regelylead, munely, govrw, law2008, fincrisis1* and *troika.* All other variables present a minimum deviation in a range between -13% to -45%. The final transport sector subsample maximum deviation is found to be 49%. Those variables that achieve such maximum deviation are *ely, elylag, regelylead, munely, govrw, govmaj,* and *largeproj.* All other variables present a maximum overrun in a range of 36% to 48%.

If we only consider positive deviations (overruns), we found that our final transport projects subsample has 361 observations, from a total of 1,091 observations, with overruns. This represents 33% of observations with overruns. From the analyses of the independent variables, we found that the variables *elylag* (34%), *elylead* (34%), *regelylag* (34%), *regelylead* (75%), *govrw* (42%), and *largeproj* (100%) all have a higher percentage of observation of overruns (considering only those observations that belong to this overruns subsample) than the final transport projects subsample. From here, we can highlight *regelylead* and *largeproj* as being the the variables that present the highest percentage of overruns when considering each variable individually. On the contrary, *law2008* and *troika* are the variables with less overruns when analysing their own subsample, recording only 16% and 13% of overrun transport sector projects, respectively.

Furthermore, and still only considering observations with overruns, we found that the cost deviation mean rises to 12.41% (from 2.2%) in our final transport sector projects subsample, with the variables *regely* (14%), *munelylead* (13%), *govrw* (14%), *govmaj* (13%) and *largeproj* (31%) presenting a cost deviation mean for overrun observation higher than the final transport projects subsample mean percentage.

Finally, regarding standard deviation, the deviation of the *largeproj* and *govrw* variables present the highest dispersion from the mean, scoring 0.18 and 0.1, respectively. The *troika* variable has the lowest dispersion from the mean, scoring 0.07 and all other variables have standard deviations in the range of 0.09 to 0.11.

We used several hypothesis tests to analyse whether the variables used were statistically significant. The T-test and the Mann-Whitney tests confirm such results. In Table 36 we disclose the results for the statistical tests, two sample T-test (parametric test), and the Mann-Whitney test (nonparametric test).

[Insert ***Table 36*** here]

In the T-test, when considering the cost deviation final sample, we tested the significance of the regression parameters for the hypothesis that such parameters are statistically different from the sample´s mean. When we reject the null hypothesis, we assume that the variables deviations are statistically different from the sample´s mean ($H_{0:}$ μ=2.2%). We found that only *govmaj* and *notcgov* are not significant for a 0.1 p-value. Regarding the Mann-Whitney test, when we reject the null hypothesis, we assume that we accept with statistical significance that a variable has different deviations than the rest of the sample. We found all variables to be statistically significant for a 0.1 p-value. Consequently, we expect that all the significant variables will also be statistically significant in Subsection 5.2.2, when we analyse the results of the econometric tests carried out.

5.2.2. Results and discussion

We follow the same steps as those in Subsection 5.1.2, with the difference that in this section we use a transport sector projects subsample, instead of the total sample. Once again, we aim to study the exogenous determinants of *cdevp*, in order to answer our first research question - "What are the main exogenous and endogenous determinants of cost deviations?" We did this using the model described in Subsection 4.6, and, as previously mentioned, the reason we have chosen this subsample is because in the reviewed literature the transport sector is the one that has a broader number of studies. This allows us to draw conclusions between the Portuguese results and the results from other countries and/or regions presented in the literature.

In the results from the previous subsection regarding the cost deviation final sample, transport variable is statistically significant, with a negative signal. Transport sector projects impact negatively (reduce) on cost deviations and overruns, i.e., they have less cost deviations.

The results from the GLM model are presented in Table 37. Despite not being formally reported, we also run the GLM, using year effects. Table 38 presents the results for the Tobit model. Once again, despite not being formally reported, in the Tobit model, year effects were also used, and the previous result have been confirmed. Table 39 presents the results of the negative binomial (with *cdevp* above zero) model. Furthermore, results for this subsample should be read and interpreted independently of the results in Subsection 5.1.2, although with similar results, and we expect independent variables effects on cost deviations to be similar to those reported above.

[Insert ***Table 37***, ***Table 38*** and ***Table 39*** here]

Therefore, for our first hypothesis (political), we can observe that there is evidence that majority governments and right-wing government lead to less cost deviations. Tobit and negative binomial regressions confirm this evidence. Also we can state that political decisions influence the occurrence of cost deviations, with the results being in line with those of the previous literature (Flyvbjerg et al., 2002; Siemiatycki, 2009).

Regarding the second hypothesis (governance), there is some evidence that a better legal and regulatory framework is related with less cost deviations. Furthermore, the introduction of a new law in 2008 (*law2008*), following the EU directives on public procurement, have shown to be effective in reducing deviations. Once again, Tobit and negative binomial regressions confirm this evidence. This result confirms the evidence from the literature that governance influences cost deviations. A poor institutional/governance framework for organisations leads to a weak decision-making process. This inadequate institutional ambience leads to costs underestimation and consequently to cost overruns (Cantarelli et al., 2010).

Our third hypothesis (economic) shows us that economic growth (*gdpg*) and inflation (*infl*) are relevant determinants of cost deviations in public transport investments. Nevertheless, these independent variables again add different contributions to cost deviations, with inflation, as expected, impacting positively (increases) on cost deviations, which means that general price increases in the economy lead to an increase of project costs, whereas greater public investment is related with a higher level (increase) of deviations. This means that a higher percentage of money invested in public transport infrastructures (more money and projects) leads to a reduction of controls on spending. Lastly, the financial crisis reduced cost deviations in public transport projects, and, as expected, budget constraints from the public debt crisis which started in 2007, lead to the double effect of less money being available for public investments and an increase on spending controls. This has consequently led to less cost deviations. These results are once more in line with the previous literature, which states that economic variables help explain cost deviations and overruns (Cantarelli et al., 2008; Siemiatycki, 2009).

Finally, our last hypothesis (project variables), shows that transport public projects developed by local government tend to have less deviations. Furthermore, we found no evidence that larger projects are more prone to deviations, either when using the *largeproj* variable and the variable *loginitialcost*. This is in line with the literature, which affirms that size has no effect on cost deviations (Aibinu & Pasco, 2008; Flyvbjerg et al., 2002; Odeck, 2004).

Regarding the magnitude of the effect, we found, for example, that in the GLM *law2008* (governance determinant) and *publicinv* (economic determinant) had a far greater impact than the other variables. *gdpg* and *infl* (economic determinants) also have a relevant effect, as well as *notcgov* (project determinant), while *govrw* and *govmaj* (economic determinants) had lesser effects. These results again show that governance and economic and project determinants play a larger role in explaining cost overruns than political ones. These results are similar to those reached in Subsection 5.1.2 for the total sample.

In Table 40 we present the results of the probit cost overruns model. These results aim to help us answer our second research question - "What exogenous and endogenous determinants impact in the likelihood of a cost overrun?" Therefore, following the previous results, we found some evidence that majority governments and right-wing governments reduce the probability of cost overruns. Furthermore, these results show that a better governance and regulatory framework also leads to less probability of cost overruns. Confirming the results from previous tables, better economic cycle reduces the occurrence of overruns. Only higher public investment increases the probability of transport public projects having cost overruns. Finally, we found that there is no evidence that large projects increase the likelihood of overruns (for both the *largeproj* and *loginitialcost* variables).

[Insert ***Table 40*** here]

In Table 41 and Table 42, we provide the results for the IVOLS and the IVprobit. Once again, controlling for endogeneity at project level confirmed the previous results. A better legal environment, together with a better economic situation is shown to have an impact both on reducing cost deviations, and also overruns. We conclude that election years have an impact on cost deviations and cost overruns. These results continue to show no impact of being large projects, either for increasing, or reducing cost deviations and overruns.

[Insert ***Table 41*** and ***Table 42*** here]

These results are confirmed by our robustness check. We found similar results when using the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumental variables (not formally reported). Additionally, we performed another robustness check by using the fractional response model for the GLM and Probit regression. The results are presented in Table 43 and Table 44, which confirm our previous findings.

[Insert ***Table 43*** and ***Table 44*** here]

After controlling for endogeneity, we can assess that the previous results are valid. Regarding our first hypothesis that (political) right-wing governments lead to fewer cost deviations, while majority governments lead to more cost deviations. For our second hypothesis (governance), the results confirm that a better legal environment is shown to have an impact, both on reducing cost deviations and the likelihood of cost overruns. The model which instrumented the variables for rule of law, control of corruption, and government efficiency confirmed all these results. Our third hypothesis (economic) also confirms that a better economic situation is shown to have an impact both on reducing cost deviations and overruns. Regarding our fourth hypothesis (project), results continue to present that there is no impact from a project being a large projects, either for increasing or reducing cost deviations and the probability of occurrence of cost overruns. We found similar evidence both when using the l*argeproj* variable and the variable *loginitialcost* one. We conclude that election years have an impact on cost deviations and cost overruns and that election periods increase both the cost deviation and the probability of cost overruns.

Moving on to answer our third research question - "Do transport projects have lower cost deviations and overruns than other sectors projects?" The results show that transport projects do indeed perform better than other sector projects (education, social and economic facilities projects), having less cost deviations and a lower likelihood of cost overruns. We can see that in Subsection 5.1.1 we identified that transport projects have less cost deviations than other sectors and this is confirmed in Subsection 5.1.2, where the transport sector projects variable is negative and statistically significant.

5.3. Results for cost deviations/overruns – local government projects subsample – "The exogenous determinants of cost overruns in local government investment projects"

5.3.1. Descriptive results

Our complete sample of central and local government projects shows a weighted average cost deviation of 11%. Of a total of 4,305 projects, 1,829 had cost overruns (42%, where over 9 billion Euros initial costs resulted in around 1 billion Euros of cost overruns). If we just considered these projects, then the weighted average cost overrun is 19% (6 billion Euros in volume, with a 1 billion Euros overrun). Additionally, 454 central government projects had cost overruns (48%). The weighted average cost overrun is 23% and if we account just for local government projects, then the weighted average cost overrun is 6%. A total of 1,375 projects had cost overruns (41%), with a weighted average cost overrun of 12%. For central government, all statistics are above the sample average, whereas for local government, all statistics are below the sample average. These first preliminary results show some evidence that local government projects perform better than central government ones.

Regarding specifically *cdevp*, the weighted average cost deviation is 6.5%, which means that the cost deviation is 3.8%, with a standard deviation of 9.9%. Minimum and maximum cost deviation are– 91.5% and +93.4%, respectively. Once again, we reach a cost deviation local government projects final subsample of 3,338 projects, after dropping out the sample outliers, using the same assumptions described in Subsection 4.3 (initially we had collected 3,352 local government observations for projects carried out in Portugal between 1980 and 2012, where we were able to determine *cdevp and cedvprob)*. For this local government projects final subsample, the weighted average cost deviation is 5.7%, and the mean cost deviation is 3.7% (similar to the mean cost deviation of the cost deviation final sample described in Subsection 5.1.1), with a standard deviation of 8.7%. Minimum and maximum cost deviations are now– 45.4% and + 48.4%, respectively. We found these results to be consistent with those from the previous literature, where Bucciol, Chillemi, & Palazzi (2013) reached an average cost deviation of 8% when analysing 1,093 Italian projects and Magnussen & Olsson (2006) present a 9% average cost deviation and 74% of projects with cost deviations for their 31 analysed projects. Furthermore, Odeck (2014) also achieved an average cost deviation of 9%, with cost deviations ranging from -59% and 183%. Lastly, Shehu, Endut, Akintoye, et al. (2014) provided conclusions which reveal a 12% average cost deviation, with 55% of projects with overruns.

In Figure 25 we present the histogram for *cdevp*, overlaid by the normal distribution of our cost deviation local government projects final subsample. Here we can observe that the *cdevp* is right skewed. Our local government projects final subsample has 492 projects with negative cost deviations (15%), 1.481 projects without deviations (44%), and 1,365 projects with cost overruns (41%). Once again, this means that cost overruns (positive cost deviations) are larger in number that negative cost deviations (where final project costs are lower than budget costs). Cost deviations are largely concentrated between -10.2% and 24.9%. Our results from the cost deviation local government projects final subsample are in line with results from our cost deviation final sample, which performed in a very similar way (16% of projects with negative cost deviations, 42% of projects without deviations, and 42% of projects with cost overruns). Furthermore our results are likewise in line with the results of the previous literature, where cost overruns are dominant over negative deviations in term of frequency (Bordat et al., 2004; Moret & Einstein, 2016; Sarmento & Renneboog, 2016b; Shehu, Endut, Akintoye, et al., 2014). A quartile analysis for this final sample indicates that 5% of the projects have negative deviations of up to -5.9% of the projects, while 10% of the projects represent negative deviations of up to -1.5% of the projects. Furthermore, 50% of the projects have no cost overrun (cost deviation equal to or below zero), while 75% of the projects have deviations of up to 6.9%. For the 90th and 99th percentiles, this deviation reaches 16.9% and 25%, respectively.

[Insert ***Figure 25*** here]

The final local government subsample presents a cost deviation mean percentage of 3.7%. This considers all deviations – both negative and positive. Those variables that surpass this value are reg*elylead* (10%), *munely* (4.4%), *govrw* (4.3%), *govmaj* (4.2%), *largeproj* (11.9%), and *socialf* (4.9%). The *largeproj* variable has the highest cost deviation mean, with 11.9%, although we only have five observations for this variable for the current local government projects subsample.

In Table 45 we present a descriptive analysis of the independent variables. This subsample only includes observations from local government projects analysed in the current section. Furthermore, the variables were divided by the four hypotheses under study and are always presented in the following text in the same order as presented in the table.

[Insert ***Table 45*** here]

Final local government subsample minimum deviation is -45%. The variables that achieve total sample minimum deviation are *ely, munely, munelylag, govmaj*, *law2008, fincrisis1, transp* and *social.* All other variables present a minimum deviation in a range of between -17% to -39%, not considering *largeproj*, which has a minimum deviation of 8%. The final local government subsample maximum deviation is found to be 48%. Those variables that achieve such maximum deviation are *elylag, elylead, regely, munelylag, munelylead, govrw, govmaj*, and *socialf.* All other variables present a maximum overrun in a range of 16% to 47%. If we only consider positive deviations (overruns), we found that our final local government projects subsample has 41% observations with overruns (1,365 from a total of 3,338 observations). The cost overruns mean percentage is 11.2% (cost deviation mean percentage is 3.7%).

From the analyses of the independent variables, we found that the variables *ely* (42%), *regelylead* (81%), *munely* (51%), *govrw* (43%), *govmaj* (44%), *largeproj* (100%), and *socialf* (48%) all have a higher percentage of observation with overruns (considering only the observations that belong to this overruns subsample) than the final local government projects subsample. From here we can highlight *regelylead* and *largeproj* as being the variables with the highest percentage of overruns when considering each variable individually. On the contrary, *law2008* and *troika* are the variables with less overruns when analysing their own subsample, recording only 23% and 16% of overrun local government projects, respectively.

The variables *elylag*, *regely*, *regelylead*, *govrw*, *largeproj*, *transp*, and *socialf* all have 12%, which present a cost deviation mean for overrun observation higher than the final local government projects subsample mean percentage. Finally, a note regarding the standard deviation needs to point out that the *munely* variable presents the higher dispersion from the mean scoring 0.10 and the variables *troika,* and *largeproj* have the lowest dispersion from the mean, scoring 0.05 and 0.03, respectively. All the other variables have standard deviations in the range of 0.07 to 0.09.

We used several hypothesis tests to analyse whether the variables used were statistically significant. The T-test and the Mann-Whitney tests confirm such results. In Table 46 we disclose the results for the statistical tests, two sample T-test (parametric test), and the Mann-Whitney test (nonparametric test).

[Insert ***Table 46*** here]

In the T-test, considering the cost deviation final sample, we tested the significance of the regression parameters for the hypothesis that such parameters are statistically different from the sample´s mean. When we reject the null hypothesis, we assume that the variables deviations are statistically different from the sample´s mean ($H_{0:}$ μ=3.7%). We found that only *regely, edu* and *econf* are not significant for a 0.1 p-value. Regarding the Mann-Whitney test, when we reject the null hypothesis, we are assuming that we accept with statistical significance that a variable has different deviations that the rest of the sample. We found that only *govrw*, *largeproj* and *econf* are not significant for a 0.1 p-value. Consequently, we expect all the remaining significant variables to also be statistically significant in Subsection 5.3.2 when we analyse the results of the econometric tests performed.

5.3.2. Results and discussion

Following the same steps as those in Subsection 5.1.2, with the difference that in the present subsection we use a local government projects final subsample, instead of the total sample, in this subsample, we now aim to study the exogenous determinants of *cdevp*, in order to answer our first research question - "What are the main exogenous and endogenous determinants of cost deviations?" We have done this by using the model already described in Subsection 4.6.

The results from the GLM and the Tobit regressions are presented in Table 47 and Table 48. Despite not being formally reported, we also run the GLM, using year effects with similar results and the Tobit model with year effects. Previous results have been confirmed. In Table 49, we present the results of the negative binomial (with *cdevp* above zero) model.

[Insert ***Table 47***, ***Table 48*** and ***Table 49*** here]

Concerning the first hypothesis (political), government majority demonstrates an impact on reducing cost deviations. The impact of right-wing local governments is less clear. Although being statistically significant, the contribution to cost deviations assumes both positives and negative contributes to reduce such deviations. Contributions to reduce cost deviation seem to be linked to improvements in governance determinants, namely when improvements in the rule of law indicator impact cost deviations negatively (less cost deviations). The Tobit and negative binomial regressions confirm this evidence and political decisions influence the occurrence of cost deviations. These results are in line with the previous literature (Flyvbjerg et al., 2002; Siemiatycki, 2009).

For the second hypothesis (governance), we found that a better legal and institutional environment is a critical issue for reducing cost deviations. Not only does a less-corrupt and better rule of law reduce our *cdevp* variable, but the introduction of a new law in 2008, based on the EU procurement rules, also had a substantial impact on controlling cost deviations. Once again, Tobit and negative binomial regressions confirm this evidence. This result confirms the evidence from both the literature and Subsections 5.1.2 and 5.2.2, that a poor institutional/governance framework of the decision-making entities influences cost deviations, since a weak governance environment leads to cost underestimations and later to cost deviations (Cantarelli et al., 2010).

Our third hypothesis (economic) is - “economic good times seem to reduce cost deviations”, where the opposite is the case – whereby a larger share of public investment in GDP seems to increase cost deviations. As discussed in the policy implications section, this could be a result of the case of a lack of public resources for controlling projects.

All tested economic exogenous variables are again relevant determinants of cost deviations, even if with different impacts. Similar results were presented in Subsections 5.1.2 and 5.2.2. Both inflation (*infl*) and greater public investment (*publicinv*) contribute to a higher level of cost deviations. While inflation increases cost deviations through the general increase of prices in the economy, leading to an increase of project costs (labour and materials), greater public investment increases cost deviations as more public money is made available to invest and more projects are approved, which leads to a reduction of controls on spending.

Nevertheless, GDP growth (*gdpg*) and financial crisis (*fincrisis*) exogenous variables reduced cost deviations in public projects. The impact of the 2008 financial crisis is straightforward - with less public resources available, cost deviation has reduced substantially. The pre-bankruptcy of the country led to large public budget constraints at all government levels (central and local), creating a situation where there was less money available. These results are in line with the previous literature which considers economic variables and economic cycles as the basis for more effective and efficient projects (Siemiatycki, 2013).

Finally, regarding the fourth hypothesis (project) large projects continue to have no impact on cost deviations, similar results were presented to those of Subsections 5.1.2 and 5.2.2. Once again, we found no evidence that larger projects are more prone to deviations, either when using the *largeproj* variable or the *loginitialcost* variable, which means that when controlling for size of the project, local government remains more efficient than central government.

With regards to the size of the effect, we found, for example, that the GLM variables *govrw* (political determinants), *law2008* (governance determinant), and *publicinv* and *fincrisis* (economic determinants) had a far greater impact, than the other variables. The *govmaj* (political determinant) and *gdpg* and *infl* (economic determinants) variables also have a relevant effect. These results show that governance and economic determinants play a larger role in explaining cost overruns at a local government level. We reached similar conclusions for the complete sample (Subsection 5.1.2) and the transport projects sample (Subsection 5.2.2). The novelty is the role that political determinants play at a local government level, as the size of this effect is larger and more relevant than in the previous sample studies. The decision process to build at a local government level is more susceptible to being influenced by the political context.

The results of the probit cost overruns model are presented in Table 50. Once again, these results help us once more answer our second research question - "What exogenous and endogenous determinants impact in the likelihood of a cost and time overrun?" to which, and similar to what we did for transport projects, we now add - "in local government projects". Results tend to show that variables that increase (or decrease) cost deviations also have an impact on increasing (or reducing) the probability of a project having a cost overrun.

Regarding our first and second hypothesis (political and governance), the results confirm that government majority has an impact, not just on reducing cost deviations, but also on avoiding cost overruns. It is also less likely that projects have cost overruns when institutional and governance improves, particularly after the introduction of the 2008 European Union law. For our third hypothesis (economic), we can also perceive that greater public investment not only contributes to greater cost deviation, but it also increases the chance of a cost overrun occurring. Finally, for our fourth hypothesis (project), no evidence was found that large projects increase the likelihood of overruns (for both variables *largeproj* and *loginitialcost).*

[Insert ***Table 50*** here]

Table 51 and Table 52 provide the results for the IVOLS and the IVprobit tests. After controlling for endogeneity, we can assess that the previous results are valid. Regarding our first hypothesis (political), right-wing governments and government majorities lead to fewer cost deviations. On our second hypothesis (governance) results confirm that a better legal environment is shown to have an impact both on reducing cost deviations and the likelihood of cost overruns. Model instrumented variables rule of law, control of corruption, and government efficiency all confirm these results. Our third hypothesis (economic) also confirms that a better economic situation is shown to have an impact on reducing both cost deviations and overruns. Regarding our fourth hypothesis (project), this result confirms the results of the general sample, where no evidence was also found that large projects contribute to an increase in cost deviations and the probability of cost overruns. We found similar evidence both when using the l*argeproj* variable and the variable *loginitialcost*. We conclude that election years have an impact on cost deviations and cost overruns, as election periods increase both cost deviation and the probability of cost overruns.

[Insert ***Table 51*** and ***Table 52*** here]

These results are confirmed by our robustness check. We found similar results when using the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables (which is not formally reported). Furthermore, the factional models present similar results, as can be seen in Table 53 and Table 54.

[Insert ***Table 53*** and ***Table 54*** here]

Finally, to answer our fourth research question - "Do local government projects have lower cost deviations and overruns than central government projects?" the results show that local governments tend to perform worse than central governments in reducing cost deviations. The results from Table 27 (GLM Results for the final sample study) confirm that local government projects tend to contribute positively, i.e., they have higher cost deviations. Interestingly, the results from the Probit (Table 30) show a lower likelihood of cost overruns in local government projects and it seems that projects conducted by local authorities are less prone to having cost overruns, although in the event of them occurring, they tend to be higher.

6. Results for time deviations/overruns - total sample – “The exogenous determinants of time overruns in public investment projects”

In this section we aim to answer two additional research questions, namely our fifth research question: (v) “What are the main exogenous and endogenous determinants of time deviations?” and our sixth research question: (vi) “What exogenous and endogenous determinants impact on the likelihood of a time overrun?” This is done by using the model described in Subsection 4.6.

In this section research has been developed once again considering the data collected in our database comprising all sectors – social/economic/education/transport projects, and at all levels of government – central, local and regional government projects. The difference from the research developed in Section 5 is that we are now focusing on the time deviation and overruns problem, rather than on the cost deviation and overrun problem. Therefore, we are now considering observations where we were able to collect information to determine both a time deviation percentage (*tdevp*) and a time deviation probability (*tdevprob*). These variables will be our dependent variables for this second study - of the determinants of time deviation and time overruns in public investment projects.

In our study, due to the smaller number of observations collected where *tdevp* was available, we were not able to construct a transport or a local government subsample with a sufficient number of observations that would allow us to produce statistically-significant conclusions. Furthermore, results from this section should be read independently, and should not be compared with the results from Section 5.

6.1. Descriptive results

Time deviations complete sample observations comprise 250 projects where we were able to determine the dependent variables *tdevp* and *tdevprob*. Looking first at *tdevp*, the weighted average time deviation[3] of this variable is 97.8% (i.e., it took approximately 98% more time to deliver a project than the initially forecasted completion time – meaning that, on average, the planned execution time was almost double the planned time, with a mean time deviation of 106.2%, with a standard deviation of 137.1%. The minimum and maximum time deviations are– 44.4% and + 1,224.4%, respectively (the latter being twelve times more time for execution than initially planned). For the time deviations final sample (which consisted of 161 projects

[3] Weighted average time deviation = Σ (time deviation) ÷ Σ (initial forecasted time)

after dropping he sample outliers, as described before), the weighted average time deviation is 42.6% and the mean time deviation is 36.7%, with a standard deviation of 32.9%. Minimum and maximum time deviations are now – 44.4% and + 100%, respectively. We found these results to be consistent with those from the previous literature on time deviations (Bhargava et al., 2010; Bordat et al., 2004; Ramanathan, Narayanan, et al., 2012).

In Figure 26 we present the histogram for *tdevp*, overlaid by the normal distribution of our time deviation final sample. Here we can observe that the *tdevp* is right skewed. Our time deviation final sample has 4 projects with negative time deviations, 39 projects without deviations, and 118 projects with time overruns. Once again, this means that time overruns (positive time deviations) are larger in number that negative time deviations (where final project execution time is lower than initially expected). Time deviations are largely concentrated between 9.70% and 63.9%. Our results are in line with the results from the previous literature, where time overruns were also dominant over negative deviations in terms of frequency (Bordat et al., 2004; Love, Sing, et al., 2013). A quartile analysis for this time deviation final sample indicates that 1% of the projects have negative deviations of up to -5.4% of the projects. Likewise, 10% of the projects have no time overruns (time deviation equal to, or below zero), while 50% of the projects have deviations of up to 35%, and 75% of the projects have deviations up to 60.4%. For the 90th percentile, the deviations attain 83.6%.

[Insert ***Figure 26*** here]

Regarding dependent variable time deviation probability (*tdevprob*), for the complete sample, the percentage of projects with time overruns is 82.8% (8 out 10 projects have time overruns), with a standard deviation of 37.8%. For the final observations sample, the percentage of projects with time overruns is 73.3%, with a standard deviation of 44.4%. In this time deviations final sample, 73.29% of the projects present a deviation, which corresponds to 118 of the 161 observed projects.

In Table 55 we present a descriptive analysis of the independent variables. This sample includes all sectors and subsectors under analysis in our research which were divided by the four hypotheses under study which are always presented in the text in the same order as presented in the table.

[Insert ***Table 55*** here]

Time deviations final sample presents a time deviation mean percentage of 36.7%. This considers all deviations – negative and positive. The variables that surpass this value are *elylead* (40.4%), reg*elylead* (43.1%), *munely* (47.5%), *munelylag* (36.9%), *munelylead* (39.6%), *govmaj* (48.8%), *fincrisis1* (37.3%), *largeproj* (50.0%), *edu* (37.5%), *econf (46.5%)*, and *notcgov* (43.2%). The *largeproj* variable has the highest cost deviation mean of 50.0%, although we only have one observation for this variable for the current time deviation final sample.

Time deviation final sample minimum deviation is - 44%. The variables which achieve total sample minimum deviation are *ely*, *regelylag*, and *econf*. All other variables present a minimum deviation in a range between -2% to -5%, without considering *largeproj*, which has a minimum deviation of 50%. The time deviation final sample maximum deviation is found at 100%. The variables that achieve such maximum deviation are *elylag*, *munelylead*, and *econf*. All the other variables present a maximum overrun in a range of 59% to 99%.

If we only consider positive deviations (overruns), we found that our time deviations final sample has 118 observations, from a total of 161 observations, with overruns. This represents 73% of observations with overruns. From the analyses of the independent variables, we found that all variables, with the exception of *ely* (61%), *regelylag* (65%), *law2008* (69%), *troika* (44%), and *socialf* (65%), have a higher percentage of observation with overruns (only considering the observations that belong to this overruns subsample) than the time deviations final sample. From here, we can highlight *govmaj* and *notcgov* as being the variables that present the highest percentage of overruns, considering each variable individually.

Furthermore, and still only considering observations with overruns, we found that the cost deviation mean rises to 50.5% (from 36.7%) in our time deviation final sample. The *elylead* (51%), *regelylead* (58%), *munely* (57%), *govmaj* (55%), econf (61%), *socialf* (55%), and notcgov (52%) variables present a cost deviation mean for overrun observation which is higher than the final sample mean percentage. Finally, regarding standard deviation, where, with the exception of *troika*, *largeproj*, *edu*, and *transp*, all other variables present the higher dispersion from the mean, with scores between 0.30 (*govrw* and *govmaj*) and 0.35 (*social*).

We used several hypothesis tests to analyse whether the variables used were statistically significant. The T-test and the Mann-Whitney tests confirm such results. In Table 56 we present the results for the statistical tests, two sample T-test (parametric test), and the Mann-Whitney test (nonparametric test).

[Insert ***Table 56*** here]

In the T-test, considering the cost deviation final sample, we tested the significance of the regression parameters for the hypothesis that such parameters are statistically different from the sample´s mean. When we reject the null hypothesis, we assume that the variables deviations are statistically different from the sample´s mean ($H_{0:}$ μ=36.7%). We found that only *ely*, *govmaj* and *notcgov* are significant for a 0.1 p-value. Regarding the Mann-Whitney test, when we reject the null hypothesis, we are assuming that we accept with statistical significance that a variable has different deviations that the rest of the sample. We found that *largeproj*, *edu*, *transport*, and *socialf* are not significant for a 0.1 p-value. Consequently, we expect that all the remaining significant variables will also be statistically significant in the following subsection when we analyse the results of the econometric tests that were carried out.

6.2. Results and discussion

In this subsection, based on our time deviation final sample, we have started by studying the exogenous and endogenous determinants of *tdevp*, in order to answer our fifth research question - "What are the main exogenous and endogenous determinants of time deviations?" This was done using the models described above in Subsection 4.6.

This model, although identical to the ones used in Section 5, diverges from these as the econometric tests were applied to a different set of data. Furthermore, new dependent variables were also used, namely, *tdevp* and *tdevprob*. Therefore, we are now considering the (percentage of and the probability of) time deviation to be our dependent variable, instead of the (percentage of and probability of) cost deviation which is used in Section 5, making this a different study. The importance of analysing time consequences (and not only cost) in the development of public projects is of utmost importance, as time deviations impact on the timely delivery of public infrastructures, creating a social burden and collective dissatisfaction for populations (Gori et al., 2017; Lewis & Bajari, 2011). This allows us to design a framework of the impact of the analysed exogenous determinants on the completion of public projects. This will be later be completed in Section 7, when we considered time deviation to be a dependent variable of cost deviations, which allows us to conclude whether time has an impact on cost deviations, and consequently on cost overruns.

The results from the GLM model are presented in Table 57. Despite not being formally reported, we also run the GLM using year effects. Table 58 presents the results for the Tobit model. Once again, despite not being formally reported, year effects were also used in the Tobit model, with similar results. This study confirms that exogenous determinants (particularly the political, institutional, and governance environment ones) have a strong impact on time deviations. This conclusion is in line with the analysis of cost deviations developed in Section 5.

[Insert ***Table 57*** and ***Table 58*** here]

For our first hypothesis (political determinants), we can observe that there is evidence that right-wing governments lead to less time deviations. This conclusion is similar that reached when studying cost deviations. Nevertheless, and contrary to what was registered in cost deviations, we can see that majority governments seem to lead to higher time deviations. Furthermore, Tobit regressions confirm both this evidence. Political decisions have an influence on the occurrence of time deviations. These results are in line with the previous literature (Akintoye & MacLeod, 1997; Asiedu & Alfen, 2015).

Concerning the second hypothesis (governance), we found that a better legal and institutional environment is a critical issue for reducing time deviations. The introduction of a new law in 2008, based on the European Union procurement rules, has a substantial impact on controlling time deviations. We conclude that introducing stronger legal frameworks are effective in also reducing time deviations. Once again, Tobit regressions confirm this evidence. As documented by Gori et al. (2017), insufficient institutional/governance is associated with a higher probability of incurring delays and with substantially longer delay durations. Possible solutions pointed out by the authors include the strengthening of the competencies of procuring authorities by using resource pooling, for the specialisation of procurement in central government levels bodies.

With respect to our third hypothesis (economic), the results show that economic growth (*gdpg*) and inflation (*infl*) are relevant determinants for time deviations. Nevertheless, these independent variables add different contribute to time deviations. Inflation and growth are negatively associated (Barro, 1995; Fischer, 1993), while economic growth impacts negatively (reduce) on time deviations and inflation impacts positively (increases) on time deviations, which means that higher prices lead to an increase in the project completion time. This may be the consequence, for example, of longer negotiations for construction materials acquisitions, as well as strikes and work stoppages due to workers demanding higher salaries (due to inflation). Both results are in line with the results presented by Senouci et al. (2016) and Alaghbari et al.

(2007), which identify inflation rate among the external factors of poor economic conditions which are responsible for time deviations.

Lastly, we have, as expected, evidence that the financial crisis reduced time deviations in public projects. Due to the government budget constraints, the financial crisis created a situation where there was less money available to invest, and additionally there was also an urgency to increase controls on both spending and project delivery for the remaining public projects. In this case, this had as a consequence a reduction in time deviations.

Regarding our fourth hypothesis (project), it is shown that economic infrastructure projects tend to have more time deviations than other sectors projects. Therefore, economic infrastructures tend to increase time deviations. Furthermore, projects developed by local government tend to perform worse than central government projects. Local government projects have more time deviations than those developed by the central government. As mentioned above, less centralised forms of government are indicated to have less formal levels of governance and project controls, which normally leads to accusations of paying overtime to complete the projects. This is confirmed by Gori et al. (2017), who demonstrate that appropriate levels of expertise and experience, which are typically found in central government structures and lacking in local government institutions, increase project completion and reduce time deviations. This might also be the result of a higher proximity to future users and individuals affected by the projects, that can interfere with the project development and/or force adjustments and adaptations, jeopardizing the one-time delivery.

Lastly, just as in the cost deviation analysis, no evidence was found that larger projects are more prone to time deviations. On the contrary, the literature generally indicates size has a determinant of time deviations. For size and the complexity of larger projects, when compared with smaller projects, lead to inefficiencies and productivity issues and consequently to time deviations and overruns (Han et al., 2009).

Regarding the size of the effect, we have found that, for example, in the GLM political determinant the *govrw* and *govmaj* variables and the governance determinant *law2008* variable, as well as the economic determinant *fincrisis* variable all had a far greater impact than the other variables. The Economic determinant variable *gdpg* also has a relevant effect. These results show that all exogenous determinants (political, governance and economic) play an important role in explaining time overruns.

The results of the probit time overruns model are presented in Table 59. These results aim to help us answer our sixth research question - “What exogenous and endogenous determinants impact in the likelihood of a time overrun?” The results tend to show that variables that increase (or decrease) time deviations also have an impact on increasing (or reducing) the probability of a project having a time overrun. Following the previous results, we found some evidence for our first hypothesis (political determinants) that majority governments increases the probability of time overruns. These results confirm that government majority has an impact, not just on increasing time deviations, but also contributes to a increase in the likelihood of time overruns . Furthermore, for our second hypothesis (governance determinants), the results show that the introduction of the 2008 EU law also leads to a lower probability of time overruns. This confirms the idea that stronger governance enforcement instruments improve project delivery time and that it is also less likely that projects have time overruns when institutional and governance improves.

[Insert ***Table 59*** here]

For our third hypothesis (economic determinants), also confirming the results from previous tables, there is evidence that a better economic cycle, represented by GDP growth, reduces the likelihood of occurrence of time overruns. Furthermore, the financial crisis variable also confirms the previous results, as it contributes to a reduction of the probability of time overruns, which again confirms the idea that less money available to spend, may lead to an increase in controls and therefore to a reduction in time overruns. For our fourth hypothesis (project determinants), the previous results on time deviations are confirmed, as public projects managed by local governments tend to increase the probability of time overruns. The same evidence is observed with transport and economic facilities public projects. Finally, we also found that there is no evidence that large projects increase the occurrence of time overruns. This is in line with large projects having an impact on the time deviation studies, where no contribution to the impact of large projects could be assessed.

Table 60 and Table 61 provide the results for the IVOLS and the IVprobit. We aim to test the indirect effect of exogenous instrument variables, namely the effect of elections years, together with the remaining exogenous variables on a set of endogenous instrumented variables - governance determinants rule of law, control of corruption, and government efficiency. As instrument variables in IVOLS, we used electoral dates reference periods, namely if a project is initiated in an electoral year (*ely*), or in a year before an electoral year (*elylag*), or in a year after the election being held (*elylead*).

[Insert ***Table 60*** and ***Table 61*** here]

For the IVprobit, we used electoral dates reference periods again as instrument variables, namely if a project is initiated in an electoral year (*ely*) or in a year after an electoral year (*elylag*). Additionally, we use *troika*, which aims to capture the effects of the presence of the Troika in Portugal, by measuring whether the year that the project started occurred before, or after the beginning of the financial aid programme. Consequently, we aim to test the indirect effect of these exogenous instrument variables, together with the remaining exogenous variables, on a set of instrumented variables - governance determinants rule of law, control of corruption, and government efficiency.

Therefore, controlling for endogeneity at project level confirmed the previous results. With regards to our first hypothesis (political), right wing governments have an impact on reducing both time deviations and time overruns. On the contrary, majority governments tend to increase time deviations and time overruns. With respect to our second and third hypotheses (governance and economic), a better legal environment, together with a better economic situation is shown to have an impact both on reducing time deviations and also overruns.

With regards to our fourth hypothesis (project), the results again show that transport projects tend to have fewer deviations than, for example, economic facilities projects. The transport projects variable impacts negatively (decreases) on time deviations, while for contrary economic facilities projects, this variable is positive, which thus impacts on our model positively (increase) for time deviations. We conclude that election years has an impact, both on time deviations and also the probability of time overruns. This is in line with the literature. As presented by Asiedu & Alfen (2015), one of the causes for time deviations are the deliberate delays promoted by contractors in an election year, due to uncertainties in the election results outcomes. Once again, these results continue to show no impact of being large projects, either for increasing, or reducing time deviations and overruns.

7. Time and Cost deviations and overruns

In this section, we aim to answer our seventh research question - "does the occurrence of time deviations and overruns in public projects affect cost deviations and overruns?" For this, we replicate the model used in Section 5.1.2 for the general sample. In this way, not only can we assess whether time deviation has an impact on cost deviation and overrun, as we can see its effect on the other explanatory variables.

For this purpose, we return to the data already used and described in Subsection 5.1.1. This means that we are again focusing our work on data which comprises all sectors (*edu*/*transp*/*econf*/*socialf*) and all levels of government (*cgov*/*notcgov*), considering cost deviation (*cdevp* and *cdevprob*) to be our dependent variables. The difference from research developed in the previous sections, namely Section 5, is that now we are also considering time deviations (*tdevp)* as an independent variable.

For the test carried out in this section, we work with 208 observations, rather than 4,266 observations, as previously (as we only have 208 project data which simultaneously have both *cdevp* or *cdevprob* as dependent variables and *tdevp* and *tdevprob* as independent variable). Despite the smaller number of observations, the difficulty in obtaining data for both variables to enable combining such variables is itself a justification of the importance of this study.

7.1. Results and discussion

Our results are now considering *tdevp* to be an independent variable, and therefore we go on to analyse the results in this section, and also compare (for the other independent variables) them with the results obtained in Subsection 5.1.2. Nevertheless, the results from this section should be read with care, due to the small number of observations for this sample. Figure 27 shows some evidence that higher time deviations tend to increase cost deviations, which means that those projects that take a longer time to complete are also more prone to having cost deviations.

[Insert ***Figure 27*** here]

GLM model results are presented in Table 62. Despite not being formally reported, we also run the GLM, using year effects, with similar results. Table 63 presents the results for the Tobit model. Once again, despite not being formally reported, the Tobit model with year effects was also used, and the previous result were confirmed.

[Insert ***Table 62*** and ***Table 63*** here]

We can also observe that time deviations leads to more cost deviations, as *tdevp* is statistically significant with a positive sign. This result is in line with the previous literature, which states that time overruns often lead to cost overruns (Akintoye & MacLeod, 1997). Furthermore, for our first hypothesis (political), in GLM we can observe that there is evidence that majority governments lead to more cost deviations. Tobit regressions confirm this evidence. This result is contrary to the GLM result in Subsection 5.1.2, where majority governments lead to less cost deviations. Furthermore, in model without *tdevp,* there is evidence (albeit weak) that right-wing government leads to less cost deviations, while in this study this is not confirmed. Nevertheless, political decisions continue to have an influence on the occurrence of cost deviations, as demonstrated by Siemiatycki (2009) and Flyvbjerg et al. (2002).

Regarding our second hypothesis (governance), in the GLM model with *tdevp* as an independent variable we found no evidence, which is contrary to the result achieved in the GLM model without *tdevp* as an independent variable that a better legal and regulatory framework, through independent variables *deltarlaw* and *deltacorrop*, is related with less cost deviations. Furthermore, the *deltacorrop* variable points to more cost deviations. Nevertheless, the stronger evidence negatively impacts (reduce) cost deviations and it is therefore shown to be effective in reducing deviations, is the introduction, following a EU directive on public procurement in 2008, of a new public procurement law (*law2008*). Tobit regressions confirm this evidence. This result is in line with the GLM model without *tdevp* as an independent variable, which means that this result confirms the evidence from the literature that governance influences cost deviations.

With respect to our third hypothesis (economic), economic growth (*gdpg*) and public investment (*publicinv*) are not relevant determinants of cost deviations in the GLM model with *tdevp* as an independent variable. This is contrary to the results from the the GLM model without *tdevp* as an independent variable. Still regarding exogenous economic determinants, inflation (*infl*) is a relevant determinant of cost deviations in the GLM model with *tdevp* as an independent variable. In this model, inflation (*infl*) leads to higher cost deviations. This result is in line with the results from the GLM model without *tdevp* as an independent variable, where inflation, as expected, also impacts positively (increases) on cost deviations, meaning that general increases of prices in the economy lead to an increase of project costs, through increases in work costs and construction materials. Nevertheless, the exception identified in the previous model is that when majority governments are significant, inflation has a negative contribution to cost deviations, which is not confirmed here. Even with majority governments, the time deviations effect surpasses the result identified earlier that majority governments are more prone to enforce better price control mechanisms for project contracts, due to their stronger negotiating position with contractors.

Lastly, the financial crisis has reduced cost deviations in public projects. This result is similar in both GLM models (with and without *tdevp* as an independent variable). The situation of pre-bankruptcy of the government led to large public budget constraints, creating a situation where there was less money available. This has led to an increase of controls on spending and consequently to a reduction in cost deviations. Once again, Tobit regressions confirm this evidence for the economic determinants.

Regarding our fourth hypothesis (project), the results show that education projects tend to lead to higher cost deviations. This result is in line with those from the GLM model without *tdevp* as an independent variable. Lastly, such as seen before in the GLM model without *tdevp* as an independent variable, we found no evidence that larger projects are more prone to deviations. The same results were found, both when using the *largeproj* variable and the *loginitialcost* variable.

Nevertheless, with some divergent result between the two analysed models, we can now answer our seventh research question, confirming that the occurrence of time deviations and overruns in public projects affects cost deviations and overruns. We believe that some of these results are due to two major factors: i) the smaller number of observations used in the current study, and; ii) the fact that in the analysed sample the number of projects with cost overruns (our dependent variable) is 84.6% of the sample projects (176 of 208 projects have cost overruns). Furthermore, 61% of the projects have time overruns (170 of 208 projects have time overruns), which means that the projects for which completion time information was published are mainly projects that also have cost overruns. This conclusion is in line with the previous literature which affirms that the main causes that influence cost and time overruns frequently interconnect (Adam et al., 2017; Bhargava et al., 2010). Furthermore, our study also confirms the previous literature which mentions that delays impact considerably both on the final cost of the investment (increasing further the final cost of the investment) and also on the longer time that the public investment keeps complying with the reason that was underlying the decision to build

(Adam et al., 2015; Ramanathan, Narayanan, et al., 2012; Ramanathan, Potty, et al., 2012; Shehu, Endut, & Akintoye, 2014).

The results of the probit cost overruns model with *tdevp* as an independent variable are presented in Table 64. Following the previous results, in our first hypothesis (political), we found evidence that majority governments increase the likelihood of cost overruns, as the *govmaj* variable presents statistical significance, and is positive.

[Insert ***Table 64*** here]

Furthermore, in our second hypothesis (governance), the results show that a better governance and regulatory framework also leads to less probability of cost overruns. The *deltacorrp* variable presents statistical significance (albeit weak) and is negative. An improvement in the control of corruption leads to a decrease in the likelihood of cost overruns. For our third hypothesis (economic) we add to the results from the previous tables that a better economic cycle, represented by GDP growth, reduces the probability of public projects having cost overruns. The *gdpg* variable presents statistical significance (albeit weak) and is negative. Furthermore, financial crisis also confirms the previous results, as it contributes to a reduction in the likelihood of cost overruns, which once again confirms the idea that less money available to spend leads to an increase in controls on spending, and therefore to a reduction in cost overruns.

In our fourth hypothesis (project), public projects managed by local governments tend to increase the probability of cost overruns when there is also a time overrun. Finally, we found that there is no evidence that large projects increase the likelihood of overruns (for both the *largeproj* and *loginitialcost* variables).

Despite some conflicting outcomes, the results allow us to conclude that the main causes that influence cost and time overruns interconnect. Nevertheless, when time deviation is added to our general model, several variables lose statistical significance or assume different impacts on cost deviation. This allows us to conclude that the longer the delay in completing a public project, the higher its final cost will be, independently of what happens exogenously regarding the evolution of the political, governance, and economic conditions, or endogenously regarding the project's own characteristics.

In order to further confirm the above results, Table 65 and Table 66 provide the results for the IVOLS and the IVprobit. For instrument variables in the IVOLS, we again used electoral dates reference periods, namely the fact if a project was initiated in an electoral year (*ely*), a year before an electoral year (*elylag*), or a year after the election being held (*elylead*). Additionally, in the IVprobit we also used as an instrument variable, the *troika* variable. This variable, as presented above, aims to capture the effects of the presence of the Troika in Portugal by measuring whether the year that the project started occurred before, or after the beginning of the financial aid programme. Consequently, we aim to test the indirect effect of these exogenous instrument variables, together with *tdevp* variable and the remaining exogenous variables on a set of instrumented variables - governance determinants rule of law, control of corruption, and government efficiency.

[Insert ***Table 65*** and ***Table 66*** here]

In addition, a Structural equation modelling regression was performed as a robustness check regarding endogeneity. The results are presented in Table 67, namely the direct, indirect and total effects on *cdevp* of the tested exogenous variables. These results allow us to conclude that the model exogenous variables (*ely, troika, deltacorrp, deltarlaw* and *deltaregulq*) have an impact on *cdevp* by its total effect (both through direct and indirect effects). Being indirect effect, the effect on *cdevp,* trough the effect on *tdevp*. Figure 28 presents the performed SEM path diagram in which *tdevp* appears as an intervening variable affected by exogenous variables *ely*, *troika*, *deltacorrp*, *deltarlaw* and *deltaregulq*, but also as a predictor of *cdevp* (Hamilton, 2012). Such a diagram allows visualising better causal ordering and tested connections. Although, SEM cannot confirm causality it allows us to assume and test a causal structure built on theory specifications (Hox & Bechger, 1998).

[Insert ***Table 67*** here]

[Insert ***Figure 28*** here]

After controlling for endogeneity at project level, we confirmed the previous results regarding our hypotheses. Overall, we can now state that both *tdevp* and exogenous determinants (particularly the political, institutional and governance environment) have a strong impact on cost deviations and overruns. This allows us to conclude that *tdevp* is not only a predictor of *cdevp* but might also be predicted by the same studied exogenous determinants.

8. Results Comparison

This section aims to compare the results from *cdevp* and *cdevprob* for the general sample (Subsection 5.1.2) with the transport subsample (Subsection 5.2.2) and the local government subsample (Subsection 5.3.2) and also these three with the general sample, using *tdevp* as an independent variable (Section 7), and with the *tdevp* and *tdevprob* general sample (Section 6). Accordingly, in Subsection 8.1 we compare the results from our cost deviation final sample study with the results from the cost deviation transport sector projects subsample study. In Subsection 8.2 we compare again the results from our cost deviation final sample study, but now with the results from the cost deviation local government projects subsample study. Finally, in Subsection 8.3 we compare the results from our cost deviation final sample study with the results from the time deviation final sample study.

8.1. Cost deviation – General vs transport projects

We have compared the results from GLM and Tobit tests from Subsection 5.1.2, where we analysed our general sample, and Subsection 5.2.2, where we analysed our transport projects subsample. Such a comparison is presented in Table 68 and Table 69. Regarding our first hypothesis (political determinants), we found that in both studies, majority governments and right-wing government are statistically significant determinants which negatively impact cost deviations (less cost deviations).

[Insert ***Table 68*** and ***Table 69*** here]

Regarding our second hypothesis (governance), we can conclude that there is evidence that cost deviations are negatively impacted (reduce) by a better legal and regulatory framework. Improvements in the rule of law and control of corruption indicators reduce cost deviations in both analyses. Furthermore, there is strong evidence that the introduction of the new 2008 public procurement law was effective in reducing cost deviation in both our general observations (that considers all sectors projects) and also in the transport projects sample.

With respect to our third hypothesis (economic), both studies consider that all the economic variables computed (economic growth, public investment, inflation, and the financial crisis) are relevant determinants of cost deviations. Furthermore, the impact on cost deviations on each of these economic variables is similar in both the complete final sample and the transport sample. Economic growth contributes contrary to what was expected, impacting negatively (reducing) on cost deviations. As expected, higher inflation and greater public investment impacts positively on cost deviations (increases cost deviations), leading to an increase in project costs, and therefore on cost deviations. Lastly, the financial crisis reduces cost deviations in both general public projects and transport projects, when it is considered isolated from other investment sectors. Additionally, in neither of the two studies being compared did we find evidence that larger projects are more prone to deviations.

In Table 70, a comparison of the results of the probit test is presented. The results for the transport projects also coincide with those attained in the general sample

[Insert ***Table 70*** here]

Following these results, we again found evidence regarding our first hypothesis (political determinants) that in both studies, majority government is a statistically-significant determinant which leads to a lower probability of occurring cost overruns, both in the general sample, and also in the transport projects subsample. Less strong evidence also indicates that a right-wing government (elected) in-charge reduces the likelihood of cost, both in the general sample, and in the transport projects subsample.

For our second hypothesis (governance), the results show that a better governance and regulatory framework also leads to less probability in both the general sample and the transport projects subsample. Better rule of law and control of corruption indicators and also the new 2008 public procurement law are responsible for much of this effect, reducing the likelihood in both the general sample and in the transport projects subsample.

Regarding our third hypothesis (economic) and confirming the results from previous tables, a better economic cycle and the financial crisis reduces the probability of the occurrence of cost overruns in both the general sample and in the transports projects subsample. Higher public investment and inflation are also significant determinants of both models and they contribute to an increase in the likelihood of a cost and a time overrun. Furthermore, for our fourth hypothesis (project), we found that there is no evidence that large projects increase the occurrence of cost overruns.

In Table 71 and Table 72, we compared results from the IVOLS and IVprobit tests, but we do not find any results different from those described above. These results for the transport projects observations follow the results of our general sample.

[Insert ***Table 71*** and ***Table 72*** here]

8.2. Cost deviation – General vs Local government projects

We have compared the results from GLM and Tobit tests from Subsection 5.1.2 where we analysed our general sample, and from Subsection 5.3.2, where we analysed our local government projects subsample. Such a comparison is again presented in Table 68 and Table 69.

Regarding our first hypothesis (political), we found that in both studies, majority governments are statistically significant determinants which impact cost deviations negatively (less cost deviations). Regarding the right-wing government variable, although it is statistically significant in both studies, in the general sample there is a strong evidence that this variable contributes clearly to a reduction in cost deviations, while at a local government level, the evidence is weaker.

Regarding our second hypothesis (governance) and considering both the general sample and the local government sample, we conclude that there is evidence that cost deviations are negatively impacted by a better legal and regulatory framework (less cost deviations). Improvements in the rule of law and control of corruption indicators also reduce cost deviations in both analyses. Furthermore, there is a strong evidence that the introduction of the new 2008 public procurement law was effective in reducing cost deviation in both our general sample observations (which considers all sectors projects) and at a local government level.

With respect to our third hypothesis (economic), both studies are again consistent in their achievements. All the economic variables considered (economic growth, public investment, inflation, and the financial crisis) are relevant determinants of cost deviations. Furthermore, the impact on cost deviations of each of these economic variables is similar in both the general sample and in the local government projects sample. In both studies, economic growth contributes contrary to what was expected, impacting negatively on cost deviations (reduction of cost deviations). As expected, higher inflation and greater public investment impacts positively on cost deviations (increases cost deviations), leading to increases in project costs, and therefore on cost deviations. Lastly, also as expected, the financial crisis has reduced cost deviations in both general public projects and local government projects when considered isolated from other investment sectors. Additionally, regarding our fourth hypothesis (project), in neither of the two studies being compared did we find evidence that larger projects are more prone to deviations.

In Table 70, a comparison of the results of the probit test is presented. Following these results, we again found evidence regarding our first hypothesis (political determinants), that in both studies majority government is a statistically-significant determinant, which leads to a lower probability of cost overruns occurring both in the general sample and in the local government projects subsample. Although less strong, evidence also points that an in-charge (elected) right-wing government leads to the likelihood of a reduction in costs, both in the general sample and in the local government projects subsample.

For our second hypothesis (governance), the results show that a better governance and regulatory framework also leads to a lower probability of both the general sample and the local government projects subsample. Better rule of law and control of corruption indicators and the new 2008 public procurement law is responsible for much of this effect, thus reducing the likelihood in both the general sample and in the local government projects subsample.

Regarding our third hypothesis (economic) and confirming the results from previous tables, a better economic cycle and the financial crisis reduce the probability of the occurrence of cost overruns in both the general sample and in the local government projects subsample. Higher public investment and inflation are also significant determinants of both models which contribute to an increase in the likelihood of a cost and a time overrun. Furthermore, for our fourth hypothesis (project), we found that there is no evidence that large projects increase the occurrence of cost overruns.

In Table 71 and Table 72, we compared the results from the IVOLS and IVprobit tests, but we do not find any results that were different from the ones just described above. For the local government projects, the results of these observations generally coincide with those attained for the general projects sample.

8.3. Cost deviation - General sample vs Time deviations general sample

We compared the results from GLM and Tobit tests from Subsection 5.1.2 where we analysed our general sample, considering cost deviation to be our dependent variable, and Subsection 6.2, where we analysed our general sample, considering time deviation to be our independent variable. Such a comparison is also presented in Table 68 and Table 69. The Tobit results confirm the GLM test results and therefore regarding our first hypothesis (political determinants), we found that that in both studies, right-wing government is a statistically-significant determinant which negatively impacts cost deviations (less cost deviations). Furthermore, the majority governments variable, despite being a statistically-significant determinant in both models, assumes opposing results, contributing to less cost deviations, but more time deviations.

Regarding our second hypothesis (governance), we conclude that there is evidence that both cost deviations and time deviations are negatively impacted (reduce) by a better legal and regulatory framework, namely there is strong evidence of the effect of the new 2008 public procurement law. Such a variable is a statistically-significant determinant which negatively impacts cost and time deviations (less cost deviations and less time deviations), thus confirming that the enforcement of such legislation was effective in reducing cost and time deviation.

With respect to our third hypothesis (economic), both studies consider that the economic variables of economic growth, inflation, and the financial crisis are all relevant determinants of cost and time deviations. Furthermore, the impact on cost deviations of each of these economic variables is similar in both studies. Economic growth and inflation negatively impact cost and time deviations (less cost deviations and less time deviations), while inflation contributes to more cost and time deviations.

Regarding our fourth hypothesis (project), both studies consider that local government projects is a statistically significant determinant which increases cost deviations. Furthermore, the economic facilities infrastructures variable, despite being a statistically-significant determinant for both models, assumes opposing results, thus contributing to less cost deviations, but to more time deviations. Additionally, in neither of the two studies being compared did we find evidence that larger projects are more prone to deviations.

In Table 70, a comparison of the results of the probit test is presented. Following these results, we again found evidence regarding our first hypothesis (political determinants), that in both studies, majority government is a statistically significant determinant which assumes opposing results, leading to a lower probability of cost overruns occurring, but to a higher probability of time overruns occurring.

For our second hypothesis (governance), the results show that a better governance and regulatory framework also leads to a lower probability of both cost and time overruns. The new

2008 public procurement law is responsible for much of this effect, reducing the likelihood of both cost and time overruns.

Regarding our third hypothesis (economic) and confirming the results from previous tables, a better economic cycle and the financial crisis reduces the probability of the occurrence of cost and time overruns. Higher public investment and inflation, despite being significant determinants of the cost overruns model, do not contribute to explaining the likelihood of time overruns. Furthermore, for our fourth hypothesis (project), we found that there is no evidence that large projects increase the occurrence of overruns. We also found that transport and economic facilities projects assume opposing results, leading to a lower probability of cost overruns occurring, but to a higher probability of time overruns occurring. The same conclusion applies to local government projects (lower probability of cost overruns occurring, but to a higher probability of time overruns occurring).

In Table 71 and Table 72, we have compared the results from IVOLS and IVprobit tests, and we do not find any results different from those described above.

In the next section we discuss the policy implications that result from the above results. Public projects being developed need to increase their efficiency, and consequently new public policies are needed to improve projects final outcomes (cost and time). This will only be achievable if better management structures are in place.

9. Policy Implications

In this section, we aim to answer our eighth research question - "What policy implications can be drawn?" Our study demonstrates that project overruns are also influenced by exogenous determinants, in addition to the already-existing scrutiny by the literature project determinants. This gives rise to new management problems which need to be confronted, especially at a local government level, due to its lower governance levels when compared with central governments (Andrew & Goldsmith, 1998; Bardhan & Mookherjee, 2000). This is in part due to the absence of investment standards, processes, and low accountability. Consequently, public organisations to be successful in their role as sponsors of public projects must allow themselves to be structured correctly (Wise, 1990).

From a public policy perspective, these findings on exogenous factors can help governments, both at a central and local level, to take better management decisions, enhancing governance and institutional frameworks to improve the decision-making process to launch a public infrastructure. Therefore, we aim to contribute to improving management processes that minimise the impacts on costs and delivery times in public projects and impacts on populations. It is necessary for a project to be completed on budget and on time to be able to understand not only the financial side of the problem, but also the reasons and consequences of the appearance of delays in these public projects. Only then will it be possible to create effective public policies, which is something that has only happened in few and limited numbers of cases (Gori et al., 2017; Guccio et al., 2014; Love, Sing, et al., 2013).

The Portuguese experience and the results presented above provide some insights into the causes of cost deviations and overruns. Election calendars seem to present a degree of impact in increasing cost deviations. This could be the result of two different motives. One is the effect of governments looking to launch and complete infrastructure before elections, in order to capture votes. This could lead to less control and scrutiny of the design, cost forecast, and execution of such projects. Elections can also provide the incentive for "strategic misrepresentation". Political decision-makers may deliberately underestimate costs, in order to approve and launch a large number of projects before elections. On the other hand, this could also be the effect of private sector opportunistic behaviour, in the knowledge that the public puts on pressure before elections regarding such projects, and therefore expect higher rents.

However, the improvement in the legal and regulatory framework in Portugal has already had some impact in reducing cost deviations. The 2008 law on public procurement was particularly effective. The implementation of EU procurement rules has shown to have improved the capacity of the Portuguese public sector during the various project stages. However, on the contrary, an increase in public investment highlights the limits of public-sector control in these projects. Our results demonstrate how strongly investment in governance and management capabilities is relevant for the public sector. A proper framework decision for public investment can increase the quality and effectiveness of the conceptualisation and planning, and thus reduce cost and time deviations.

Good project management in public-sector departments and agencies involved in public projects is also becoming a very relevant issue. Construction knowledge and establishing the correct organisational structures for developing critical skills is essential. This includes, but is not limited to being able to establish strong relationships with the main contractors, while employing robust legal framework agreements to clarify each party's responsibilities. Additionally, knowing when to quickly intervene when the first signs of overruns emerge is of utmost importance. To achieve this capability, strong management control mechanisms need to be implemented for the design and forecast steps of each project.

Consequently, our recommendations are as follows. Each future investment must have a proper decision framework which should sustain every new decision. Furthermore, every project should have a manager with management and financial skills who should make all project decisions as if it was a for-profit business. Every investment should build knowledgeable data to allow knowledge dissemination between project stakeholders. This would allow an improvement in project deliverability through past error learnings. Every project should also establish the correct organisational structures for developing critical skills. This includes, but not limited to being able to establish strong relationships with main contractors. The use of stronger legal framework agreements to clarify each party responsibilities is also desirable, In addition, and of utmost importance is knowing when to quickly intervene when the first signs of overruns emerge. For this, strong management control mechanisms should be implemented for the design and forecast steps of each project.

This approach gains even further relevance when we are addressing local government projects, as new management issues and challenges arise. Local government has low levels of governance when compared with the central government (Andrew & Goldsmith, 1998; Bardhan & Mookherjee, 2000). Nevertheless, the potential negative consequences of a lower level of sophistication of local governments (smaller budgets, less staff, and lower expertise) are surpassed by the benefits of having overall project management on a smaller scale. As mentioned above, the potential reasons for such a difference between local and central governments might be due to a more detailed knowledge of the specificities of the project and the geographical area where it is developed, as well as higher proximity with the communities and the potential beneficiaries of the project. This proximity can benefit public discussions and consultations, which can anticipate local stakeholders' and lobby groups' expectations and challenges and can also identify potential negative impacts and anticipate mitigation strategies.

This makes decentralisation a key factor for improving the efficiency of the use of public resources. In summary, this study shows that there is potential for improving the efficiency of public resource in infrastructure projects, by delivering these projects at the local level. These findings confirm the principle of government decentralisation being a key driver to increase the performance of cost management in infrastructure projects. Improving local government's capacities could have a strong impact in improving the allocation of public money (Andrew & Goldsmith, 1998; Bardhan & Mookherjee, 2000; Fisman & Gatti, 2002).

Past findings have highlighted the need to ensure more efficient project management, however this research sheds some light on what the optimal political level for project development should be. In fact, these findings confirm the principle of government decentralisation as being a key driver for increasing the performance of cost management in infrastructure projects. On the other hand, however, it is unquestionable that local governments have less resources and expertise in the management of infrastructure projects. This means that if a general principle of decentralisation of infrastructure projects is engaged, associated with a development of local governments managerial capabilities, then it might be possible to provide a relevant contribution to the mitigation of cost overrun levels and the probability of occurrence.

The improvement of the managerial capabilities of local governments to deal with the requirements of infrastructure project management should cover several aspects, targeting the establishing of investment evaluation standards and development processes, as well as increasing accountability. Normally, infrastructure investment decisions are believed to be taken at a political level, with low levels of financial valuation (estimation and budgeting forecasts), and without the adequate technical planning and design. Therefore, local governments need to create a financial manager role, which is independent of the political power, and which implements an investment framework based on basic assumptions, standard rules, KPIs, and evaluation metrics. This would allow not having to replace political decisions, but rather to validate such decisions *a priori*, before contracts are awarded that mis-use taxpayers' money. On one hand, this purposed framework would bring about greater and earlier transparency to the decision-making process, whilst on the other hand, it would give support to the political vision regarding the investments required.

Furthermore, the absence of fruitful engagement regarding the purpose of the project is a management issue that needs to be tackled from day one. When discussing public infrastructures, of which many are essential for citizens, public decision-makers must start to give growing attention and developing strategies to engage projects stakeholders. Everyone has strong opinions regarding any infrastructure being planned and this becomes stronger again when we are dealing with local investments that impact citizens' daily lives. In an era of social media and distorted/fake news, the risk of not doing this is allowing a few groups of people to create biased public discussion. This will create a strong public opposition, which will lead to the project being cancelled after a considerable amount of public money has already been invested, or to a reopening of the project planning and conceptualisation phases, which will lead to additional non-programmed cost (overruns) and additional delivery time (Lecourt & Baudelle, 2004).

This engagement may be achieved by more extended public discussions of the planned projects and creating strategies to give voice to local stakeholders and lobby groups anticipatedly. The implementation of digital campaigns to achieve online engagement is also highly recommended, as people react very well to this kind of stimulus. Nevertheless, public decision-makers, in general, but with growing importance at a local level, are far from being successful in engaging the public, primarily through digital campaigns (Mboumoua, 2017).

The correct institutional framework must also be considered when trying to achieve the development of public infrastructures on time and within budget. We have analysed above the agency problems that arise from the public-private relationship (owner vs contractor). Nevertheless, there are governance processes based on management partnership and contractors/employee's opinions that can be developed to achieve better final project results. This was the output of the construction of the Heathrow Airport Terminal 5, which was built as a support infrastructure for the London 2012 Olympic Games. Despite being a multi-million complex project, it was completed on budget and on the expected completion date, through a collaborative institutional arrangement, where contractors were brought on board the project as team members, instead of the classic procurement approach of client-contractor (Caldwell, Roehrich, & Davies, 2009; Deakin & Koukiadaki, 2009). We believe that this kind of arrangement should be more encouraged, as the proximity between client-contractors-workers is higher, and the project benefits will be more easily perceived by all parties involved.

As the results show, time deviations and overruns have a strong impact on cost deviations and overruns. Stringent processes and controls from inadequate regulations and public-sector procurement rules and material divergences between project risks and contractors rewards are examples of problems that need to be tackled by public decision-makers that may lead to project delays. Improving projects' productivity is essential to conclude projects on time, and therefore such improvements must come from simpler regulations that help remove complexity, and improve processes and control. Simpler approval processes would increase transparency and improve anti-corruption measures. Alignment between risk and reward among public project owners and private contractors would allow a convergence of objectives that would improve projects' budget targets and schedule goals. Furthermore, public infrastructures procurement rules should incorporate past rewarding points when awarding a new contract based on past performance (completion of public projects on or close to budget targets and schedules goals), rather than just the lowest cost proposal. This would reduce opportunistic behaviours from private contractors and promote the estimation of project budgets and schedules to be more accurate.

10. Conclusions, limitations and future research

Cost and time overruns have been, and will undoubtedly continue to be, a very relevant topic. The potential benefits of marginal decreases in average overruns can represent multi-million Euros (or Dollars) savings for governments. If one considers the need to increase infrastructure spending in Europe and the US to overcome decaying infrastructure, and the massive planned investments in African, Asian, and South American economies to overcome a significant infrastructure gap, then the subject of the control and mitigation of cost and time overruns becomes even more relevant and urgent. The fact that cost and time overruns have not decreased over time justifies the need for new perspectives of analysis. This thesis provides some new evidence on the effect of exogenous determinants on the occurrence and impact of cost and time deviations, particularly the governance and economic factors.

We have first developed a theoretical framework to support the research question and hypothesis. This theoretical framework was constructed on foundational theories, such as political-economics and management. This allowed us to build a network map of variables which have statistical probability to impact on the final cost and time result of public investment projects. We started with agency theory and information asymmetry, leading to opportunistic behaviour theory to sustain how political and electoral cycles contribute to the increase in cost and time deviations and overruns. This was followed by using institutional theory as the supportive theory to study governance in public projects, namely the impact of the institutional and regulatory framework and how such factors can impact cost and time deviations and overruns. Next, we made use of the economic cycles theory to assess the way economic cycles impact cost and time deviations and overruns and also whether there is a relationship between the health of the country's public finances and the propensity for the occurrence of overruns, due to weaker expenditure control mechanisms. Lastly, we used incomplete contracts theory to support the impact of higher uncertainty, measured by project size. Larger projects have more complex contractual frameworks, which ultimately lead to higher uncertainty regarding a contract's completion, which in turn also leads to an increase in cost and time deviations and overruns.

From here, we developed our research, aiming to answer eight research questions regarding cost deviations and overruns:

(i) What are the main exogenous and endogenous determinants of cost deviations?

(ii) What exogenous and endogenous determinants impact on the likelihood of a cost overrun?

Furthermore, still regarding cost deviations and overruns, we specifically analysed public transport projects and local government projects, aiming to answer two additional questions to fill a literature gap:

(iii) Do transport projects have lower cost deviations than other sectors' projects?

(iv) Do local government projects have lower cost deviations and overruns than central government projects?

Moving to the time deviations and overruns problem, we aimed to answer the following research questions:

(v) What are the main exogenous and endogenous determinants of time deviations?

(vi) What exogenous and endogenous determinants impact on the likelihood of a time overrun?

(vii) Does the occurrence of time deviations and overruns in public projects affect cost deviations and overruns?

Lastly, we aim to answer an eighth research question,

(viii) What policy implications can be drawn?

To answer these research questions and to test the determinants of cost and time deviations and overruns, we have defined four hypotheses:

Hypothesis 1 – Political determinants: how political and electoral cycles contribute to the increase in cost and time deviations and overruns;

Hypothesis 2 – Governance determinants: the impact of a worst institutional and regulatory framework in the increase of cost and time deviations and overruns, i.e., whether with worse corruption and rule of law indicators, governments will be less capable of enforcing contracts, which will lead to increased cost and time deviations and overruns;

Hypothesis 3 – Economic determinants: whether better economic cycles increase cost and time deviations and overruns, i.e., more money for governments to spend tends to lead to a reduction of expenditure control mechanisms, which also leads to an increase in cost and time overruns;

Hypothesis 4 – Project determinants: as a control factor, using an endogenous approach, the impact of higher uncertainty, measured by determinants such as project size (larger projects are more complex, which will lead to higher uncertainty in project completion, which in turn also leads to an increase in cost and time deviations and overruns), project ownership, or whether a sector can affect cost and time deviations and overruns.

Therefore, not only have we tested specific determinants, but we have also given each determinant and hypothesis a specific theoretical framework in order to give credibility and general acceptability to our conclusions. By presenting a model, theoretical framework, hypothesis, research questions, and the variables to be tested, we aimed to contribute to two significant achievements: management theory and management practice. Management theory, as this research extends management theory by using a new approach to a well-known problem, namely cost and time deviations and overruns in public projects. We believe that we filled a literature gap by contributing to the explanation of the occurrence of cost and time deviations and overruns, having a direct impact on several areas of management theory, namely, public management decision process, project management of public investments, contracts management, and stakeholder relationship management. Management practice relevance arises from the unique and not usual size sample of public projects observations, which allow testing for theories that otherwise would not have been tested. Our results and conclusions are worthy of study, as they can serve as an orientation for future policy implementation.

This thesis enhances past research by analysing a new database of 4,323 public projects, and, more importantly, by testing the effects of political, regulatory and legal, and economic determinants. It is important to note that past studies have been biased towards endogenous determinants. However, this research concludes that exogenous determinants are also important for enhancing, or mitigating, cost overruns, both regarding their statistical significance as well as the size of impact. This thesis provides some new evidence of the effect of exogenous determinants on the occurrence and impact of cost deviations, particularly, the political, governance and economic factors. The results confirm our initial hypothesis that many exogenous factors have been underrepresented in previous studies, and that they should be taken into careful consideration when analysing cost and time deviations and overruns.

Throughout this study two dependent variables were used, cost deviation and time deviation, depending on whether we were studying cost or time determinants. When aiming to study the main exogenous and endogenous determinants of cost and time deviations, we used as dependent variables cost deviation percentage (*cdevp*) and time deviation percentage (*tdevp*). These variables are the difference, in percentage, between the project's final and initial cost and execution time. To test for these variables, we started by performing both an OLS, a GLM, and a Tobit (censoring the negative values), using either *cdevp* or *tdevp* as dependent variable.

Furthermore, for *cdevp,* we additionally performed a negative binomial (with *cdevp* above zero) regression. A GLM test aims to check the robustness of the OLS test, as the dependent variable is a percentage. As we have a dependent variable in percentage, and we also have outliers (either negative deviation or positive deviation, above 100%), we run a Tobit with left censoring (negative values) to assess how the model reacts to outliers. In the Tobit model, we also run a censored OLS to test the robustness of the Tobit model. Since in our cost deviation sample the distribution of cost deviation is skewed to the right, and the frequency of observations with cost deviations is very large (the literature presents similar results), and although we have used the Tobit regression censoring for the negative values as mention above, for control purposes, we have additionally run a negative binomial.

When planning to study which exogenous and endogenous determinants impact on the likelihood of a cost and time overrun, we used as the dependent variable a dummy variable that assumes one when *cdevp* or *tdevp* is positive, and zero when *cdevp* or *tdevp* is zero or negative (*cdevprob/tdevprob).* The *cdevprob/tdevprob* variables aim to represent whether the project had a cost/time overrun (i.e., if *cdevp* or *tdevp* is positive), or not. Therefore, to test the impact of the determinants of the likelihood of a cost and time overrun, we started by using a probit model for measuring the probability of a project having cost/time overruns. Therefore, the probit model was used to assess whether each independent variable affects the likelihood of a cost/time overrun (along with marginal effects to assess the magnitude of that probability). Consequently, to determine what drives the probability of a cost overrun and the probability that a cost overrun is initiated by an exogenous variable (as opposed to a project variable), we estimate probit (and logit) models with cross-sectional data.

In addition, to assess endogeneity, and as a robustness test for the formulated hypotheses, we ran an instrumental variable OLS (IVOLS) for the *cdevp* or *tdevp*, and a probit (IVprobit) for the *cdevprob* or *tdevprob* variables. With these tests, we aim to surpass the possibility of inconsistent parameter estimation, due to endogenous regressors. Thus regression estimates measure only the magnitude of association, rather than the magnitude and direction of causation, which is needed for policy analysis (Cameron & Trivedi, 2010).

Furthermore, and also addressing the endogeneity issue, we performed two additional robustness tests to confirm our conclusions. A fractional response GLM model using *cdevp*, and a fractional response probit, using *cdevprob* as dependent variable. This allows us to relax regarding the issue that our dependent variable may have a skewness to the right (as discussed before, the literature presents evidence that cost deviations are frequently skewed to the right). We chose these fractional response models, which are generalised least square models, because we can thus establish the most appropriate type of distribution. Therefore, we were able to statistically reject the possibility of non-normal distribution of errors. This is crucial, because the models used, for instance, the Tobit regression, are based on this normality assumption.

When controlling for endogeneity at project level, we aim to confirm the previous results. We aim to assure that the evolution of the Portuguese public institutions over the last 30 years (the range of our observations) through the use of the governance indicators is also being considered in the explanatory variables. We ensure that the results of each project are affected by the exogenous and endogenous variables under analysis, as we are controlling the "quality" of the public agent that takes the decision to build the projects.

When specifically studying the effect of time deviation in cost deviation we used as endogeneity robustness check a structural equation modelling (SEM) to study which exogenous determinants have a direct effect in time deviation and simultaneously exert an indirect effect on cost deviation whether it has a distinct effect directly. With SEM, we aim to determine which exogenous determinants affect time deviations and if time deviations affect cost deviations. Structural equation modelling allows analysing the structural relationship between measured variables and latent constructs being useful to estimates the multiple and interrelated dependence in a single analysis since endogenous variables are equivalent to dependent variables and are equal to the independent variable.

Answering our first research question - "What are the main exogenous and endogenous determinants of cost deviations?" we conclude that, overall, exogenous political, governance and economic determinants all impact cost deviations.

Political decisions influence the occurrence of cost deviations with majority governments and right-wing governments, leading to less cost deviations. We also found evidence that a better legal and regulatory framework, mainly better rule of law and less corruption, is related to less cost deviations. Nevertheless, the stronger evidence that reduces cost deviations and therefore that shown to be effective in reducing deviations is the introduction of the 2008 procurement law (*law2008*), which was the adoption of the EU procurement directive. Economic determinants are also relevant determinants of cost deviations.

Furthermore, the emergence of the financial crisis has reduced cost deviations in public projects. Results also show that transport and economic infrastructure projects tend to have less deviations than, for example, education projects. Transport and economic infrastructure projects variables also decrease cost deviations, as education projects increase cost deviations. No evidence was found that larger projects are more prone to deviations.

When answering our second research question - "What exogenous and endogenous determinants impact in the likelihood of a cost overrun?" Following the previous results, we found evidence that exogenous political, governance and economic determinants impact on the probability of a public project having cost overruns. Majority governments and right-wing governments reduce the likelihood of cost overruns, while better governance and regulatory framework and the introduction of the 2008 procurement law also lead to a lower probability of cost overruns.

Furthermore, a better economic cycle (measured by GDP growth and inflation) reduces the occurrence of overruns. Likewise, the financial crisis also confirms the previous results, as it contributes to a reduction in the likelihood of cost overruns. Public projects managed by the Parque Escolar (a modernisation investment specific programme which aimed to plan, manage, develop, and execute the public network of secondary and other schools under the responsibility of the Portuguese Ministry of Education) present a robust evidence of increasing the probability of cost overruns. Finally, we found that there is no evidence that large projects increase the likelihood of overruns. Transport sector and local government projects sample studies confirm both previous results.

Regarding our third research question - "Do transport projects have lower cost deviations and overruns than other sectors projects?" the results show that transport projects indeed perform better than other sector projects (education, social and economic facilities projects) having less cost deviations and a lower likelihood of cost overruns.

Results also show evidence that, in the transport sector, political determinants influence cost deviations and overruns. Furthermore, a better legal and institutional environment influences cost deviations and overruns, reducing cost deviations and overruns. A positive economic cycle also tends to reduce cost deviations and overruns. The results continue to confirm that the size of the transport projects has no impact on cost deviations and overruns.

The results also show that transport projects developed at a local government level (usually with a smaller scale) tend to be less efficient in reducing cost deviations and overruns than transport projects developed at a central government level. Overall, we can state that exogenous determinants (particularly the institutional and governance environment and the economic cycle) have a strong impact on cost deviations and overruns. Political environment also has an impact on cost deviations and overruns, but is less significant than the previous ones.

Answering the fourth research question - “Do local government projects have lower cost deviations and overruns than central government projects?” the results show that local government projects tend to perform worse than central government projects in reducing cost deviations. Interestingly, local government projects tend to have higher cost deviations, but present a lower likelihood of cost overruns. It seems that projects conducted by local authorities are less prone to cost overruns, although in the event of occurring, they tend to be higher than the projects developed at the central government level. These results may be due to the higher number and lower scale of the projects developed by local governments when compared to those developed by central governments. Nevertheless, the argument that the apparent higher efficiency of local governments might be due to a lower complexity of projects (as generally, smaller projects in terms of contract value equates to simpler projects) is not supported by the findings, as project size has little or no influence on the level of deviation, neither on the probability of cost and time overruns. Future research work on these causes would allow how to better understand such reasons.

Regarding time deviations, we first aim to answer our fifth research question - “What are the main exogenous and endogenous determinants of time deviations?” We conclude that overall, exogenous political, governance and economic determinants impact time deviations.

For political determinants, we can observe that there is evidence that right-wing government lead to less time deviations. However, majority governments seem to lead to higher time deviations. Concerning governance determinants, we found that a better legal and institutional environment is a critical issue for reducing time deviations, an example being the introduction of law2008, which led to a substantial impact on controlling time deviations. We conclude that introducing stronger legal frameworks are effective in also reducing time deviations.

Concerning economic determinants, the results show that economic growth and the 2008 financial crisis (reducing time deviations) and inflation (increasing time deviations) are all relevant determinants of time deviations. Regarding project determinants, we conclude that economic infrastructure projects tend to have more time deviations than other sectors' projects. Therefore, economic infrastructures tend to increase time deviations. Furthermore, projects developed by local governments tend to have more time deviations than those developed by the central government. Similar to the cost deviation analysis, no evidence was found that larger projects are more prone to time deviations.

Moving to our sixth research question - "What exogenous and endogenous determinants impact on the likelihood of a time overrun?" we concluded that variables that increase (or decrease) time deviations also have an impact on increasing (or reducing) the probability of a project having a time overrun. We found that political determinant majority governments increases the probability of time overruns. This confirms that government majority has an impact, not just on increasing time deviations, but also on contributing to a increase in the likelihood of time overruns. Furthermore, for governance determinants results show that the introduction of the 2008 EU law also leads to less probability of time overruns. Stronger governance enforcement instruments also improve project delivery time. It is also less likely that projects have time overruns when institutional and governance improves.

Likewise, economic determinants also confirm the previous results. Better economic cycle reduces the likelihood of the occurrence of time overruns. Furthermore, the financial crisis variable also confirms the previous results, as it contributes to a reduction in the probability of time overruns. Less money available to spend may lead to an increase in controls, and therefore to a reduction in time overruns. Regarding project determinants, the results confirm that public projects managed by local governments tend to increase the probability of time overruns. The same evidence is observed with transport and economic facilities public projects. Once again, there was no evidence that large projects increase the occurrence of time overruns. The endogeneity test confirmed the above results when performed which aimed to surpass the possibility of inconsistent parameter estimation due to endogenous regressors.

Concerning our seventh research question - “Does the occurrence of time deviations and overruns in public projects affect cost deviations and overruns?” we conclude that time deviation leads to more cost deviations. The presence of time overruns in public projects increases the likelihood of occurrence of cost overruns.

We further conclude that some contradictions regarding the general model (not considering time deviation has a dependent variable) may be due to the smaller number of observations used in our study, and in the fact that a majority of the observations analysed has cost and time overruns (84.6% of the sample projects have cost overruns, and 61% of the projects have time overruns). Regarding exogenous determinants, we conclude that majority governments (political determinant) lead to more cost deviations, which is contrary to the general model (without time deviation as independent variable). Right-wing governments no longer impacts a decrease in cost deviations. Nevertheless, political decisions continue to influence (albeit weak) the occurrence of cost deviations. Regarding governance determinants, we again found a contrary result to the general model. No evidence was found that an improved legal and regulatory framework is related to less cost deviations. Concerning economic determinants, no evidence was found, contrary to the general model, that GDP growth and public investment had an impact on cost deviation when in the presence of a time deviation. Lastly, regarding endogenous determinants, the results show that neither transport projects, nor economic facilities projects, nor local government projects have any impact on cost deviation, when time deviation is added to the general model

Regarding the likelihood of the occurrence of cost overruns, the presence of time overruns increases this probability. Furthermore, the results regarding political determinants show that majority governments increase the probability of occurring a cost overrun, which is contrary to the general model. Right-wing governments stop having an impact on the likelihood of cost overruns. Furthermore, better governance and regulatory framework continue to lead to a lower probability of cost overruns. This result confirms the evidence that governance influences cost deviations, even with larger time overruns. We further conclude that a better economic cycle continues to reduce the probability of public projects having cost overruns. Nevertheless, public investment and inflation no longer impact such probability. Lastly, regarding endogenous determinants, the results demonstrate that public projects managed by local governments tend to increase the probability of cost overruns when there is also a time overrun.

Despite some conflicting outcomes, the results allow us to conclude that the main causes influencing cost and time overruns interconnect. Nevertheless, when time deviation is added to our general model, several variables lose statistical significance or assume different impacts on cost deviation. This allows us to conclude that the longer the delay in completing a public project, the higher its final cost, independently of what happens exogenously regarding the evolution of the political, governance and economic conditions or endogenously regarding project own characteristics.

When answering our eighth research question - “What policy implications can be drawn?” we conclude that public organisations need to be appropriately structured to succeed as sponsors of public projects. With the right information and policy leadership, public investments cost and time overruns can be successfully surpassed. This would allow for future infrastructure investment plans to successfully support stronger economic growth and better well-being for the populations. Likewise, policymakers need to be concerned with creating a framework that has to interact with different types of organisations, namely public and private structures. Such a framework should cover three analytic dimensions (public interest, economic, and managerial) in order to allow for a better evaluation of structural arrangements for public organisations. This purposely-built framework would bring about greater and earlier transparency to the decision-making process, and on the other hand, it would also give support to the political vision regarding the investments required.

Although mentioned in the literature, psychological theories were not approached in this current research, despite their relevance. We have fully understood the importance of addressing such theories, and it is our intention to do so in future research, in the sense of further enhancing our model with such an approach. The decision of not to include a psychological explanation was not an easy one to take, but the absence of finding available data for establishing at least one independent variable that could fit our model has forced us to pursue such a path for now.

Furthermore, due the absence of further observations, there was no specific information on further project characteristics and no information on the technical causes of cost and time deviations and overruns. Furthermore, information is not available regarding the renegotiations that occurred between public entities and private contractors in the cases of overruns and contract changes.

Cost and time deviations and, particularly, cost and time overruns, have been attracting more attention from both academics and practitioners alike. It is crucial to understand what the main determinants of these phenomena are, in the light of the expected need to upgrade existing infrastructures in developed economies and to construct new infrastructures in developing countries. Exogenous determinants are therefore important for enhancing, or mitigating, cost overruns, both in terms of their statistical significance as well as the size of the impact. This has profound implications for public policy, especially when undertaking public infrastructure development plans and estimating their potential cost (and overruns). To achieve this, we built a theoretical framework that supports and gives credit to our hypothesis and tested determinants, and consequently our conclusions, as mentioned above.

Therefore, political hypothesis supported by opportunistic behaviour theory originated by information asymmetry, is related to the occurrences where private contractors pursue their own interest, rather than the interests of the public organisms. Furthermore, public decision-makers are exposed to opportunistic behaviour when entering in a transaction with a private agent, particularly when at a government level there are low contract management skills (Light, 2011; Perry & Wise, 1990; Vining & Boardman, 2008). Furthermore, the agency theory supports strategic behaviour and why it is a consequence of asymmetric information, meaning the lack or incompleteness of information that the person in charge of taking decisions has when facing a project selection or project approval issue (Arvan & Leite, 1990; Flyvbjerg, Bruzelius, et al., 2003; Wachs, 1982). The decision-making process is expected to be influenced by the political decision regarding elections and votes. We expect opportunistic behaviour from the public sector, driven by the aim to win elections and also by private contractors using elections or election outcomes to increase revenues.

Therefore, we aimed to study how electoral years and outcomes (majority/minority governments or right/left wing governments) affect cost and time overruns in public projects, i.e., whether political cycles increase cost and time overruns. Cost and time overruns are more prone to occur with electoral cycles where political agents try to get a better electoral result. Decision-making process at a public level is often made taking into consideration the electoral calendar as a way of increasing the incumbent changes of re-election. The results present evidence that political decisions influence the occurrence of cost deviations and the probability of the occurrence of cost overruns.

Governance hypothesis is supported by institutional theory. This allowed us to confirm that governance determinants (e.g., rule of law indicator, control of corruption indicator, or the introduction of the 2008 procurement law) all play a relevant role in the occurrence of cost and time deviations and overruns. The institutional/governance framework of the public organisms responsible for the decision processes to build and to contract the private contractors is essential to sustain project outcomes concerning completion on budget and on schedule. Overruns tend to occur due to unfavourable behaviour consequences of the inadequate institutional ambience, which leads to costs underestimation, with the aim to easily approve such investments. Thus a decision-making problem emerges regarding management theory and practice which is highly relevant. The multiple decisions needed to be taken by individuals acting alone or grouped in a public organism to build and to contract in a decision-making process of a public project. Such decisions are expected to be rational, sustained, and to be taken according to the environment where such individuals are embedded (Cantarelli et al., 2010; Coviello & Gagliarducci, 2016; Dunleavy, 1992; Guccio et al., 2014)

Economic hypothesis supported by economic cycles theory allow us to confirm that economic determinants are relevant determinants that help to explain the occurrence of cost and time deviations and overruns in public projects. We aim to measure from a project exogenous perspective whether better economic cycles have an impact on increasing cost and time overruns. Economic cycles are repeated and alternating sequences of expansion and contraction of the economic activity. Factors such our determinants measure such activity, and consequently, an economic cycle is the fluctuation of the aggregated economic activity of a country, organised mainly in business (Burns & Mitchell, 1938; Greenwood & Hercowitz, 1991; Mascarenhas & Aaker, 1989; Nordhaus, 1975; OECD, 2017; Lucas, 1980).

In order to test whether more money being available for governments to spend tends to reduce expenditure control mechanisms, we used the GDP growth and public investment variables as proxies to help identify the point in the business cycle where the overrun occurs. Annual inflation is used to capture the increase of prices that may lead to the overrun, and financial crisis is used to determine whether, with the beginning of the crisis and the related public budget constraints, cost and time overruns have diminished. The results demonstrated that an increase in annual inflation and public investment leads to an increase and more frequent overruns, while GDP and the financial crisis lead to a decrease and a lower probability of the occurrence of overruns.

Lastly, project endogenous hypothesis is supported by incomplete contracts theory. Incomplete contract is the shortage of accuracy which does not allow public organisations responsible for the decision to build to foresee all contractual contingencies during their execution and up until completion. Consequently, incomplete contracts make it necessary to update and correct contractual arrangements, incorporating all unexpected events that may occur and which have occurred (Brown & Potoski, 2003; Brown et al., 2006; Hart, 2003). The literature on incomplete contracts has focused mainly on the question of which party in a collective organisation should have the right to undertake certain activities in the management of that organisation's assets. In a reality where all contracts are complete, this would be indifferent for the final decision of which party has that right, as the contract or agreement should stipulate what the necessary arrangements are as a function of the significant conditions.

Consequently, government organisations and contractors are not able to correctly forecast all the problems that occur during the execution of a contract which lead to cost and time deviations and overruns (Kavanagh & Parker, 2000). Many of these problems emerge from the project's own characteristics, such as size, sector, and level of government of the public organisation promoting the investment. Our results confirm that the endogenous risk of the project (risk related to the intrinsic characteristics of the project) is also an important determinant of cost and time deviations.

Therefore, it is fundamental to understand the current and future economic dynamics, as well as taking action to improve the overall legal (particularly regarding public procurement laws) and governance environment, particularly regarding the government's efficiency, corruption, and the overall rule of law. Specifically, in Portugal, there are several public investments of vital importance for the country's sustainability that are waiting for better fiscal conditions to turn in to reality (e.g., the high-speed train and the new Lisbon airport). Therefore, for these future projects, the country cannot be deterministic regarding the existence of overruns. Failure is not acceptable. The risk of endangering future economic growth and the country's sustainable development is too high to allow for this.

Regarding future research, this should include the analysis of similar external determinants in different countries in order to confirm whether similar results and conclusions are achieved. This would enable the confirmation of whether the model now developed is valid not only for Portugal, but also internationally. We would also suggest that the policy implication and recommendations be applied widely. In order to support the wider government trend of decentralisation, we expect that additional research will be carried out in the future focusing on how the impact of government decentralisation can sustain local government efficiency in controlling cost. Answers through the analysis of the organisational management of local governments should also be included in future studies.

Furthermore, we believe that future research on cost and time deviations and overruns should also address issues such as climate change and gamification. Climate change is important, as the increasing occurrence of extreme weather events might have an impact on projects that are carried out in “abnormal” years. Gamification is also important, as we believe that the implementation of gamification technics for the development of public projects would improve public projects outcomes regarding cost and time execution targets. This would be achieved by the implementation of a rewards programme that would benefit project delivery on budget and on time. Private contractors who won more points would be more eligible to be awarded new projects than contractors who are worse classified. This technic should be implemented as a procedure of each project public tender and validated by an independent body, e.g. the Court of Auditors. The aim of the development of these gamification principles is to have private contractors more engaged with public decision-makers.

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Appendix A. Worldwide Governance Indicators

The Worldwide Governance Indicators (WGI) project constructs the aggregate indicators of six broad dimensions of governance. These six aggregate indicators are based on 31 underlying data sources which report the perceptions of governance of a large number of survey respondents and expert assessments worldwide. The WGI compiles and summarises information from existing data sources that report the views and experiences of citizens, entrepreneurs, and experts in the public, private and NGO sectors from around the world, on the quality of various aspects of governance. The WGI draw on four different types of source data: (i) surveys of households and firms; (ii) commercial business information providers; (iii) non-governmental organisations, and; (iv) public sector organisations ("Worldwide Governance Indicators Documentation," 2016)

Details of the underlying data sources, the aggregation method, and the interpretation of the indicators can be found in the WGI methodology paper (Kaufmann et al., 2011). The indicators are:

1. Voice and Accountability - Reflects perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association and a free media.

2. Political Stability and Absence of Violence/Terrorism - Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism.

3. Government Effectiveness - Reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

4. Regulatory Quality - Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

5. Rule of Law - Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

6. Control of Corruption - Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

Each of the six aggregate WGI measures is constructed by averaging together data from the underlying sources that corresponds to the concept of governance being measured. According to the methodology followed, all the individual variables have been rescaled to run from 0 to 1, with higher values indicating better outcomes. Although nominally in the same 0-1 units, this rescaled data is not necessarily comparable across sources (Kaufmann et al., 2011). For example, one data source might use a 0-10 scale, but in practice, most scores are clustered between 6 and 10, while another data source might also use a 0-10 scale but have responses spread out over the entire range. While the max-min rescaling above does not correct for this source of non-comparability, the procedure used to construct the aggregate indicators does. These individual indicators can be used to make comparisons of countries over time, as all of our underlying sources use reasonably comparable methodologies from one year to the next. They can also be used to compare the scores of different countries for each of the individual indicators, recognising however that these types of comparisons are subject to margins of error ("Worldwide Governance Indicators Documentation," 2016).

Table 1 - Literature review on cost overruns (road sector)

This table presents the literature review on cost deviations and overruns regarding the road construction sector. The table identifies the data from these studies (geographical location, sector, time period of the sample, and number of projects covered), average cost deviation found for such data, and a summary of the main conclusions reached by the authors. The authors are presented in chronological order (newest to oldest). When multiple entries occur, the more recent publication defines its place in the table. This table presents only the studies that solely addresses roads. Source: Own table.

Author(s)	Region/ Country	Sector	Period	Nº projects	Average cost deviation	Main determinants	Classification of determinants	Main conclusions
(Odeck et al., 2015)	Norway	Roads	1993-2000	40	0%	▪ Planning	▪ Exogenous (Political and Governance)	▪ Implementation of strategies of quality assurance has led to a reduction in cost overruns ▪ Implementation of quality assurance strategies did not lead to a better accuracy of the estimates provided by the authorities ▪ The quality assurance regime achieved the purposes of reducing cost overruns ▪ Mean overrun of 13% and a mean underrun of -10,8% in the pre and post quality assurance time periods respectively. ▪ 47,5% of projects experienced overruns
(Odeck, 2014)	Norway	Roads	1993-2007	1,045	10% - 20%	▪ Size ▪ Regional effects	▪ Endogenous (Project)	▪ Public sector reform: no reduction in cost overruns ▪ More competition reduces overruns

Author(s)	Region/ Country	Sector	Period	Nº projects	Average cost deviation	Main determinants	Classification of determinants	Main conclusions
								▪ Separating planning and construction into two government departments eliminates cost overruns; privatisation of construction reduces cost overruns
(Makovšek et al., 2011)	Slovenia	Roads	1995-2007	56	19%	▪ Experience	▪ Exogenous (Governance)	▪ Time effect in reducing cost overruns ▪ No scale effect in cost overruns
(Creedy et al., 2010)	Australia	Roads	1995-2003	231	16%	▪ Planning	▪ Exogenous (Political and Governance)	▪ No correlations between project size and cost overruns ▪ Cost overruns are induced by changes in project ▪ Risk is not properly assessed
(Kaliba et al., 2009)	Zambia	Roads	1994-2005	13 (8 completed)	52%	▪ Inflation, local government pressures ▪ Weather ▪ Planning	▪ Exogenous (Economical, political and governance) ▪ Endogenous (Project)	▪ Inflation and government interference, weather, schedule delays, strikes, technical challenges, and environmental protection cause cost escalations
(Blanc-Brude et al., 2006, 2009)	Europe	Roads	1990-2005	227	24%	▪ Type of procurement	▪ Endogenous (Project)	▪ Public-Private-Partnership road projects have more cost deviations than traditional procurement projects ▪ The largest part of ex-ante construction cost difference

Author(s)	Region/ Country	Sector	Period	Nº projects	Average cost deviation	Main determinants	Classification of determinants	Main conclusions
								originates from transfer of construction risk
(Ellis et al., 2007)	US	Roads	1998-2006	3,130	8% to 9%	▪ Type of procurement	▪ Endogenous (Project)	▪ Projects by traditional procurement perform worse than those by alternative contract forms
(NAO, 2007a, 2007b)	UK	Roads	2004-2007	36 and 20	6% and 18%	▪ Planning, optimism bias, ▪ Size, sector	▪ Exogenous (Political and governance) ▪ Endogenous (Project)	▪ Project changes and cost underestimations are main sources of overruns ▪ Complex projects have higher cost overruns ▪ Local governments are more efficient
(Odeck, 2004)	Norway	Roads	1992-1995	620	9%	▪ Size	▪ Endogenous (Project)	▪ Cost deviations between -59% to +183% ▪ Cost overruns predominant in smaller projects
(Bordat et al., 2004)	US	Roads	1996-2001	2.668	4.5%	▪ Value, project type, location and procurement competition	▪ Endogenous (Project)	▪ 55% of projects have cost overruns ▪ Factors that influence cost overruns are contract bid amount, difference between the winning bid and second bid, project type (construction, maintenance or rehabilitation projects), and location by district (six highway administration districts in Indiana)

Table 2 - Literature review on cost overruns (transport sector, excluding roads)

This table presents the literature review on cost deviations and overruns regarding the transport sector (excluding roads). The table identifies the data from those studies (geographical location, sector, time period of the sample, and number of projects covered). Average cost deviation found for such data a summary of the main conclusions reached by the authors. The authors are presented in chronological order (newest to oldest). When multiple entries occur, the more recent publication defines its place in the table. Studies of other transport sectors even if they included roads are presentend in this table. N.A. = Non-applicable. Source: Own table.

Author(s)	Region/ Country	Sector	Period	Nº projects	Average cost deviation	Main determinants	Classification of determinants	Main conclusions
(Love et al., 2014)	Australia	Bridges, Roads and Tunnels and Subways		58	Bridge: 11.89%; Road construction (elevated highways) Road: 22.91%; Road construction (incl. upgrades): 12.49%; Tunnel and subways: 11.36%; Total (mean); 13.28%	▪ Planning	▪ Exogenous (Political and Governance)	▪ Data selected by Questionnaire ▪ Project type and contract value did not influence the amount of rework and cost and schedule overruns that were experienced ▪ cost and schedule underruns were also observed in some cases, even though rework occurred in all the projects sampled.
(Lundberg et al., 2011)	Sweden	Roads and Rail	1997-2009	102	11%	▪ N.A.	▪ N/A	No time or scale effects on cost deviations

Author(s)	Region/ Country	S e c t o r	Period	Nº projects	Average cost deviation	Main determinants	Classification of determinants	Main conclusions
(Cantarelli, 2009; Cantarelli et al., 2010)	Netherlands	Roads and Rail	1980-2008	87	10%	▪ Type of project	▪ Endogenous (Project)	▪ Cost deviations ranged between -46.8 and +90.3% ▪ Average cost deviation for the road sector was 20% ▪ For rail projects, Dutch projects perform well
(Lee, 2008)	South Korea	Road and Rail	1985-2005	138 road projects and 16 rail projects	Roads: 11%; Rail: 48%	▪ N.A.	▪ N/A	86% of projects have cost overruns
(Flyvbjerg, 2007a)	Europe, North America and other countries	Rail, Bridges, Tunnels and Roads		58 rail projects, 33 bridges and tunnels projects and 167 road projects	Rail 44.7%; Bridges and tunnels 33.8%; Roads 20.4%	▪ Type of project	▪ Endogenous (Project)	▪ Average cost overruns for urban rail is 45% ▪ 25% of urban rail projects cost overruns are at least 60%. ▪ urban rail projects are risky infrastructures: ▪ although other transportation projects (tunnels and bridges) are also infrastructures with high construction risk
(Dantata et al., 2006)	USA	Urban Rail	1991-2001	16	50%	▪ Experience	▪ Exogenous (Governance)	▪ 90% of the projects experienced cost overruns of 13% to 106% ▪ This paper compares the results of the for projects completed after 1990 (Pickrell, 1990)

Author(s)	Region/ Country	S e c t o r	Period	Nº projects	Average cost deviation	Main determinants	Classification of determinants	Main conclusions
								▪ Although not statistically significant concludes that evidence exists to support that cost overruns have become smaller for projects completed after 1994 (comparing to ones before 1990)
(Flyvbjerg, 2004, 2005; Flyvbjerg et al., 2002; Flyvbjerg, Skamris Holm, et al., 2003)	USA, Europe and Japan	Rail, Bridges, Tunnels and Roads	1910-1998	254	28%	▪ Type of project, size, type of procuremnet ▪ Planning	▪ Endogenous (Project) ▪ Exogenous (Political and Governance)	▪ 90% of projects with cost deviations ▪ Average cost deviations for rail was 45%, 34% for bridges and 20% for roads ▪ Cost deviations do not reduce over time ▪ Larger projects have larger percentage cost escalations ▪ The main problem in megaproject development is pervasive misinformation about the costs, benefits, and risks involved ▪ Public ownership increases cost deviations
(Skamris & Flyvbjerg, 1997)	Denmark	Bridges and Tunnels	1990-1997	7	14%	▪ Optimism bias, planning	▪ Exogenous (Political and Governance)	▪ Cost overruns between 50% and 100%

Author(s)	Region/ Country	Sector	Period	Nº projects	Average cost deviation	Main determinants	Classification of determinants	Main conclusions
								▪ Optimism leads to underestimating cost forecasts ▪ Construction costs have been underestimated in the design phase of the project
(Leavitt et al., 1993)	France and USA	High Speed Rail	1975-1990	2	-	▪ Inflation ▪ Planning	▪ Exogenous (economic) ▪ Exogenous (Political and Governance)	▪ Indicates inflation as one of the main drivers for cost escalations ▪ To improve planning estimations the authors, suggest the use of a contingency factor, the project capital costs must be reviewed and compared to other comparable projects in terms of reasonability
(Pickrell, 1990, 1992)	USA	Urban Rail	1980-1990	10	50%	▪ Planning	▪ Exogenous (Political and Governance)	▪ 86% of projects have cost overruns ▪ Cost estimations are imprecise ▪ Cost deviations are similar across different projects and locations

Table 3 - Literature review on cost overruns (other sectors)

This table presents the literature review on cost deviations and overruns regarding other sectors rather than the transport sector. However, in some studies, transport sector infrastructures can be mixed with other infrastructure sectors. The table identifies the data from those studies (geographical location, sector, time period of the sample, and number of projects covered), the average cost deviation found for such data, and a summary of the main conclusions reached by the authors. The authors are presented in chronological order (newest to oldest). When multiple entries occur, the more recent publication defines its place in the table. N.A. = Non-applicable. Source: Own table.

Author(s)	**Region/ Country**	**Period**	**Nº projects/ sector**	**Average cost deviation**	**Main determinants**	**Main conclusions**
(Sarmento & Renneboog, 2016b)	Portugal	1999-2012	243 projects from 3 sectors (Education, transports and social facilities)	24%	▪ Size ▪ Governance (central vs. local governments)	▪ Large projects have higher overruns ▪ Transport projects record lower levels and probability of cost deviations and cost overruns, respectively ▪ Local and regional governments perform better than central governments in controlling projects costs ▪ Lower corruption improves overruns and their probability of occurrence
(Ansar et al., 2014)	5 continents (65 countries)	1934-2007	245 dams	96%	▪ Size	▪ Costs are systematically underestimated ▪ Larger projects take longer to build ▪ Time effect do not have a positive impact in improving cost estimations. ▪ Longer projects have greater cost overruns
(Shehu, Endut, Akintoye, et al., 2014)	Malaysia	n.a.	359 projects (308 public + 51 private): - 139 Infrastructure - 111 Educational - 52 residential - 29 Office - 12 Commercial - 11 Health - 3 Recreational	12%	▪ Procurement process ▪ Sector ▪ Public vs. private	▪ 45% of projects are completed at, or below contract sum ▪ Large projects were completed at a cost overrun of less than 10%

Author(s)	Region/ Country	Period	Nº projects/ sector	Average cost deviation	Main determinants	Main conclusions
			- 1 Industrial			
(Sovacool et al., 2014)	57 countries		401 Electricity Infrastructures (power plants and transmission projects)	66%	▪ Not identified	▪ Only a small 9% of projects had no excess cost ▪ Cost overruns are multi-causal ▪ Electrical infrastructures have a predisposition to cost deviations which are fully independent of both technology and location.
(Bucciol et al., 2013)	Italy	2004-2009	1,093 small projects (including road works and building maintenance)	8%	▪ Procurement model	▪ Cost overruns are smaller under the Italian average bid format, but only when this format is combined with restricted entry
(Singh, 2010)	India	1992-2009	894 projects from 17 infrastructure sectors	15%	▪ Planning and governance ▪ Institutional environment	▪ Contractual and institutional failures lead to cost and time overruns ▪ Incomplete contracts are source of cost overruns
(Aibinu & Pasco, 2008)	Australia	1999-2007	56 construction projects	10%	▪ Project size	▪ Cost estimates of smaller projects are more inaccurate than those of larger projects ▪ Cost deviations do not improve over time
(Magnussen & Olsson, 2006)	Norway	1999-2005	31 projects: transport, building, defence, IT	9%	▪ N.A.	▪ Cost deviations decreased after introduction of quality assurance measures ▪ 74% of projects have cost deviations ▪ Project scale has no impact on cost deviations

Author(s)	Region/ Country	Period	Nº projects/ sector	Average cost deviation	Main determinants	Main conclusions
(Macdonald, 2002)	UK	1982-2002	50 projects: standard and non-standard buildings, roads, rail, and utility projects	79%	▪ Poor planning	▪ Strong optimism bias
(Morris, 1990; Morris & Hough, 1987)	India	1980-1990	290 public projects (133 completed projects): - 23 railways - 13 Steel (steel & mines) - 31 Coal (energy) - 16 Power (energy) - 7 Fertilizer (agriculture) - 3 Mines (steel & mines) - 9 Industry - 19 Petroleum - 10 Transport - 2 Telecommunications	82%	▪ Poor planning and project management	▪ Cost deviations between 40% and 200% ▪ Reasons: delays, poor project concept, poor planning and implementation, bureaucracy, lack of coordination
(Arditi et al., 1985)	Turkey	1970-1980	384 building construction projects	44%	▪ Economic environment (inflation)	▪ Inflation increases in prices and wages, construction delays, and inaccurate estimates were the most important sources for cost overruns.

Table 4 – Studies focused on larger sized projects

This table presents the literature review separated by studies that focus on large projects and in mega projects. We kept the original definition from each author to divide the studies into large and mega projects. This table aims to demonstrate the relevance and the large number of studies that have focused on project size as being an essential variable for cost deviations and overruns. No precise definition of large projects arises from the literature. When it is stated that no definition is provided, this means that although the authors do not specify the minimum investment amount, they clearly state that they are focusing either on large projects or mega projects. Source: Own table.

	Large Projects focus	Mega Projects focus
Author(s)	• (Abdul Rahman et al., 2013) projects with contract amounts larger than RM 5 Milliom, i.e. circa 1M EUR in 2013 prices) • (Assaf & Al-Hejji, 2006) no definition is provided • (Cantarelli et al., 2008) no definition is provided • (Flyvbjerg et al., 2009) no definition is provided, although some examples are given, such as Eurotunnel and Sydney Opera Houce • (Macdonald, 2002) 50 major projects (with costs exceeding £40m in 2001 prices) • (Skamris Holm & Flyvbjerg, 1996, 1997) no definition is provided. The authors state that analysed projets are among the most	• (Altshuler & Luberoff, 2003) no definition is provided • (Ansar et al., 2014) no definition is provided. Study is focused on large dams infrastrucure projects. Mean estimated cost of the projects analysed is 700M USD in 2010 constant) • (Bhaumik, 2010) no definition is provided • (Bruzelius et al., 2002) Megaprojects are projects with investment expenditure that equals or surpasses US$1 billion (around 890 million Euros), with more than five years construction schedule, an expected lifetime of at least 50 years and considerable uncertainty regarding demand and cost forecasts • (Capka, 2004) uses USA Federal Highway Administration definition that

	Large Projects focus	Mega Projects focus
	expensive projects constructed in Denmark since 1960. • (The Swedish National Audit Office, 2010) no definition is provided	megaprojects are major infrastructure projects wih budget cost over US$ 1 billion. Nevertheless, states that also projects under US$ 1 billion that have higher public attention, political interest due to project direct and indirect impacts on community, enviroment or state budget can be considered as megaprojects Complements that regarding roads projects can be considered megaprojects due to size , complexity, controvery, uncertainty, complex procuremet and time. • (De Bruijn & Leijten, 2007) no definition is provided. Uses for illustrative purposes the construction of a high-speed rail link (Zuiderzee line) in the Netherlands with a budget cost of 3.75 billion EUR. • (Flyvbjerg, 2007b, 2007c) Megaprojects are defined as the most expensive infrastructure and investment projects performed in the world, typically at prices per project from hundreds of millions to billions of dollars. • (Flyvbjerg, Bruzelius, et al., 2003) no definition is provided. Nevertheless, several over US$ 1 billion (multi-billion) infrastrucutre projects are given as example of a megaproject. • (Flyvbjerg & Stewart, 2012) no definition is provided. Compares cost overruns over time in relation to summer and winter olympic games infrastructure investments. All

	Large Projects focus	Mega Projects focus
		investments are multi-billion USD investments. • (Han et al., 2009) projects with investment expenditure over US$1 billion, with more than five years construction schedule • (Szyliowicz & Goetz, 1995) no definition is provided • (van Marrewijk, Clegg, Pitsis, & Veenswijk, 2008) no definition is provided. Authors state that "*Megaprojects have been described as multibillion-dollar mega-infrastructure projects, usually commissioned by governments and delivered by private enterprise; and characterised as uncertain, complex, politically-sensitive and involving a large number of partner. Increasingly, complex and extensive civil engineering and construction projects resemble megaprojects, as they too set up an integrated project organisation, combining different organisations' skills, designs and constructs; and in some instances, not only build, but also operate the facility.*"

Table 5 – price changes main drivers for cost overruns

This table presents the literature review that focuses on price changes, i.e., changes in the price of the project inputs, including supplies, materials and inflation. In each study, we specify the source of price rises considered to explain cost deviations and overruns. This table aims to present the main studies that present price changes as one of the explanatory variables for cost deviations and overruns. Authors are presented in chronological order (newest to oldest). Source: Own table.

Author(s)	Price changes and inflation	Labor costs increases
(Lind & Brunes, 2015)	✔	
(Sundar, 2015)	✔	
(Shehu, Endut, & Akintoye, 2014)	✔	
(Sweis, Sweis, Rumman, Hussein, & Dahiyat, 2013)	✔	
(Kaliba et al., 2009)	✔	
(Schexnayder, Weber, & Fiori, 2003)		✔
(Kaming et al., 1997)	✔	✔
(Arditi et al., 1985)	✔	✔
(Morris, 1990)	✔ (only price change)	

Table 6 – Rework causes and contribution of rework causes to overall cost

This table details the causes classifications and contribution of rework cause to the overall project costs reached by Josephson et al. (2002). Rework is the unnecessary effort of correcting construction errors, while rework costs are the total costs resulting from problems that occur before and after the project delivery (Love et al., 1998, 1999). Others included in the six categories were omitted to ensure that the results are informative and are responsible for the missing percentages adding to 100%. Source: Own table, adapted from Josephson et al. (2002).

Categories / Causes of rework	Causes of rework and their contribution to overall rework cost [%]	Contribution to rework costs [%]
Workmanship	**20.00**	
Erroneous workmanship		13.00
Faulty materials handling		3.20
Insufficient cleaning		1.00
Design	**26.00**	
Lack of coordination		7.28
Unsuitable or faulty design		8.10
Incomplete drawings		2.60
Production management	**25.00**	
Mistakes in planning		6.00
Faulty work preparation		4.50
Faults in materials administration		4.00
Wrong setting out		4.00
Client	**6.00**	
Wrong information		0.90
Changes		2.04
Extra orders		1.20
Bad choice of material or method		0.90
Machines	**3.00**	
Machine breakdown		1.47
Faulty machine handling		1.40
Machines delivered with defects		0.21
Manufacturing defects of the machines		0.48
Machines not working satisfactorily		0.69
Material	**17.00**	
Material hard to work with		1.36
Late deliveries		6.29
Deliveries with wrong type		1.19
Faulty manufacturing		5,10

Table 7 – Underlying causes of cost and time overruns

This table presents the conclusions of the literature review work performed by (Adam et al., 2015). The table resumes: (i) the factors; (ii) the appearance frequency, and; (iii) the type of study carried out for both cost and time overruns. With this table, we aim to start to demonstrate that cost and time overruns have similar underlying causes. Source: Own table, adapted from (Adam et al., 2015).

Factors	Delays			Costs		
	# of times factors are mentioned	Quantitative study	Qualitative study	# of times factors are mentioned	Quantitative study	Qualitative study
Communication	2	1	1	0	0	0
Management	4	0	4	2	2	0
Personnel	2	1	1	0	0	0
Organizational	1	1	0	1	1	0
Planning	4	1	3	3	2	1
Site Conditions	2	1	1	0	0	0
Weather	3	0	3	1	0	1
Project related	4	4	0	4	0	4
Material related	2	1	1	0	0	0
Process related	1	0	1	1	1	0
Psychological	0	0	0	4	4	0
Financial	1	0	1	0	0	0
Price Related	0	0	0	3	2	1

Table 8 – Time and cost overruns - Identification of Factors and Category

This table resumes the 18 categories of factors identified in the extensive literature review of Ramanathan, Narayanan, et al. (2012). The authors aim to present a critical review to determine the factors causing time and cost overrun in projects. We divided the categories of causes by type of effect (Panel A – time delay/overrun and Panel B – time and cost overrun) and these types are studied. The table also indicates the number of causes, factors, or problems that occur within each category. Source: Own table, adapted from Ramanathan, Narayanan, et al. (2012).

Category No.	Category	No. of causes / factors / problems
	Panel A – Time delay/overrun	
1	Financier-related	4
1	Financier-related	3
2	Project-related	6
4	Owner / Client	5
4	Owner / Client	4
5	Contractor	12
6	Consultant	6
10	Plant / Equipment	1
14	Contractual relationships	14
15	External	4
15	External	8
16	Changes	7
17	Scheduling & Controlling	11
18	Government relations	4
2	Project-related	5
4	Owner / Client	4
5	Contractor	4
7	Design	3
9	Materials	4
10	Plant / Equipment	4
11	Labour / Manpower	4
15	External	2
	Panel B – Time and cost overrun	
3	Project Attributes	8
4	Owner / Client	10
4	Owner / Client	10
5	Contractor	13
5	Contractor	17
5	Contractor	6
6	Consultant	7
6	Consultant	7
6	Consultant	4
7	Design	8
8	Coordination	7
9	Materials	7
9	Materials	2
9	Materials	5
10	Plant / Equipment	5
10	Plant / Equipment	5
11	Labour / Manpower	5

Category No.	Category	No. of causes / factors / problems
11	Labour / Manpower	2
11	Labour / Manpower	3
12	Environment	9
12	Environment	4
15	External	12
14	Contractual relationships	3
13	Contract	2

Table 9 – Literature review on the main determinants of time overruns

This table presents the relevant literature on the determinants of time deviations and overruns. We aim to identify the main determinants from the widespread number of causes and factors that are presented in literature. We identified the following determinants of time deviations and overruns: (i) management; (ii) planning; (iii) site conditions; (iv) weather; (v) project-related; (vi) financial; (vii) communication, and; (viii) personnel. The authors are presented in chronological order (newest to oldest). Source: Own table.

Causes	Study
Management - Organisational / Coordination - Stakeholders - Contractual relationship	• (Anastasopoulos et al., 2012) • (Ramanathan, Narayanan, et al., 2012) • (Sambasivan & Soon, 2007) • (Majid & McCaffer, 1998) • (Chan & Kumaraswamy, 1997) • (Morris, 1990)
Planning - Design - Scheduling and Controlling	• (Adam et al., 2015) • (Ramanathan, Narayanan, et al., 2012) • (Han et al., 2009) • (Sambasivan & Soon, 2007) • (Majid & McCaffer, 1998) • (Chan & Kumaraswamy, 1997) • (Morris, 1990)
Site conditions	• (Han et al., 2009) • (Sambasivan & Soon, 2007) • (Chan & Kumaraswamy, 1997)

Causes	Study
Weather	• (Anastasopoulos et al., 2012) • (Bhargava et al., 2010) • (Chan & Kumaraswamy, 1997)
Project related - Project complexity - Project duration - Materials	• (Adam et al., 2015) • (Anastasopoulos et al., 2012) • (Ramanathan, Narayanan, et al., 2012) • (Bhargava et al., 2010) • (Sambasivan & Soon, 2007) • (Bordat et al., 2004) • (Chan & Kumaraswamy, 1997)
Financial - Delayed payment	• (Ramanathan, Narayanan, et al., 2012) • (Sambasivan & Soon, 2007) • (Majid & McCaffer, 1998)
Communication	• (Sambasivan & Soon, 2007) • (Majid & McCaffer, 1998) • (Chan & Kumaraswamy, 1997)
Personnel	• (Anastasopoulos et al., 2012) • (Ramanathan, Narayanan, et al., 2012) • (Sambasivan & Soon, 2007) • (Majid & McCaffer, 1998) • (Chan & Kumaraswamy, 1997)

Table 10 – Merging time and cost overruns causes

This table merges the theoretical explanations and causes of cost overruns defined in the research of Cantarelli et al. (2010) with the group of causes and causes of time and cost overruns defined by Ramanathan, Narayanan, et al. (2012). The aim of this table is to conclude that both cost and time causes share the same theoretical explanation. Source: Own table.

Theoretical Explanation	**Causes in** Cantarelli et al. (2010)	**Causes number in** Ramanathan, Narayanan, et al. (2012)	**Group of causes in** Ramanathan, Narayanan, et al. (2012)	**Causes in** Ramanathan, Narayanan, et al. (2012)
Economical Explanation	Deliberate underestimation due to: - lack of incentives, - lack of resources, - inefficient use of resources - dedicated funding process - poor financing / contract management - strategic behaviour	1	Financing	Slow payment for completed works
		2		Contractor financial difficulties
		3		Cash problems during construction
		4		Inflation
		5		Financial difficulties to owner
		96	Scheduling & Control	Inaccurate time estimates
		97		Planning and scheduling deficiencies
		98		Preparation and approval of shop drawing
		99		Waiting for sample materials approval
		100		Preparation of schedule networks and revisions by consultant during construction
		101		Lack of training personnel and management support to model construction operation
		102		Lack of database in estimating activity duration and resources
		103		Poor judgment and experience of involved people in estimating time and resources
		104		Inadequate early planning of project
		105		Inspection and testing procedures used in project
		106		Application of quality control based on foreign specification
		107		Traffic control regulation practiced at site
		108		Accident during construction
		109		Inadequate control procedures

Theoretical Explanation	**Causes in** Cantarelli et al. (2010)	**Causes number in** Ramanathan, Narayanan, et al. (2012)	**Group of causes in** Ramanathan, Narayanan, et al. (2012)	**Causes in** Ramanathan, Narayanan, et al. (2012)
Political Explanation	Deliberate cost underestimation Manipulation of forecasts Private information	87	External	Fraudulent practices and kickbacks
		12	Owner / Client	Owner interference
		13		Long waiting time for approval of drawings
		14		Client initiated variations
		15		Unrealistic contract durations imposed by client
		16		Unrealistic client initial requirement
		17		Low speed of decision-making
		18		Slow site clearance difficulties
		110	Govt. relations	Obtaining permits from Government
		111		Obtaining permits from labourers
		112		Excessive bureaucracy in project-owner operation
		113		Building codes used in design of projects
Technical Explanation	Forecasting errors including price rises, poor project design, and incompleteness of estimations Scope changes Uncertainty Inappropriate organisational structure Inadequate decision-making process Inadequate planning process	48	Materials	Shortage
		49		Change in type & Spec.
		50		Procurement
		51		Slow / late delivery
		52		Damage in storage while needed at site
		53		Delay in special manufacturer from foreign country (imported)
		54		Quality
		55		Escalation in prices
		56		Difficulty in obtaining at official current prices
		6	Project	Necessary variations of works
		19	Contractor	Delays in subcontractors’ work
		20		Poor site management and supervision
		21		Unstable management structure and style of contractor
		22		Shortage of Technical, managerial and supervisory personnel
		23		Construction method
		24		Improper planning

Theoretical Explanation	**Causes in** Cantarelli et al. (2010)	**Causes number in** Ramanathan, Narayanan, et al. (2012)	**Group of causes in** Ramanathan, Narayanan, et al. (2012)	**Causes in** Ramanathan, Narayanan, et al. (2012)
		25		Mistakes during construction
		26		Inadequate contractor experience
		27		Severe overtime
		28		Excessive contracts and subcontracts
		29		Lack of responsibilities
		30	Consultant	Contract Management
		31		Delay in work approval
		32		Preparations and approval of drawings
		33		Quality assurance/Control
		34		Waiting for information
		35		Long waiting time for approval of test samples of material
		36		Poor contract management
		37		Supervision too late & slowness in making decision
		38		Slow to give instructions
		39		Lack of consultant's experience
		69	Contract	Project delivery systems used. (#)
		70		Mistakes and discrepancies in contract documents
		71		Deficiencies/inaccurate in cost estimates
		72		Low warded bid price
		73	Contractual Relationship	Conflicts between contractor & consultant
		74		Uncooperative owner
		75		Slowness of owner's decision-making process
		76		Joint owner ship of project
		77		Poor organization of contractor or consultant
		78		Difficulty of coordination with various parties in the project
		79		Insufficient communication between the owner & design in the design phase.
		80		Unavailability of professional construction management

Theoretical Explanation	**Causes in** Cantarelli et al. (2010)	**Causes number in** Ramanathan, Narayanan, et al. (2012)	**Group of causes in** Ramanathan, Narayanan, et al. (2012)	**Causes in** Ramanathan, Narayanan, et al. (2012)
		81		Controlling subcontractors by general contractors in execution of works
		82		Unavailability of financial incentive for contractor to finish ahead of schedule
		83		Negotiations and obtaining of contracts
		84		Legal disputes between various parties in the const. project
		40	Design - related	Poor project management assistance
		41		Delay in design information
		42		Inadequate design team experience
		43		Mistakes and discrepancies in design
		44		Impractical design
		45	Coordination	Slow information flow between project team
		46		Lack of communication between consultant and contractor
		47		Lack of communication between client and consultant
		89	Changes	Design changes by owner
		90		Design changes made by designers
		91		Foundation conditions encountered in the field
		92		Mistakes in soil investigation
		93		Water table conditions on site
		94		Geological problems on site
		95		Errors committed during field construction on site
		7	Project attributes	Obsolete technology
		8		Unsatisfactory site compensation
		9		Lack of involvement through project life
		10		Incompetence project team
		11		Slow site handover
		57	Plant/Equipment	Failure
		58		Shortage/Availability

Theoretical Explanation	**Causes in** Cantarelli et al. (2010)	**Causes number in** Ramanathan, Narayanan, et al. (2012)	**Group of causes in** Ramanathan, Narayanan, et al. (2012)	**Causes in** Ramanathan, Narayanan, et al. (2012)
		59	Manpower	Unskilled operators
		60		Slow / late delivery
		61		Poor productivity
		62		Shortage / Supply
		63		Labour skills/Productivity
		64		Nationality of labour
		65	Environment	Hot weather effect on construction activity
		66		Rain / inclement weather effect on construction activity
		67		Insufficient available utilities on site
		68		Social and cultural factor
		88	External	Price fluctuation
		85		Problems with neighbours
		86		Unforeseen ground conditions
Psychological Explanation	Optimism bias among local officials Cognitive bias of people Cautious attitudes towards risk	-	-	-

Table 11 – Theoretical framework resume

This table details the theoretical framework designed in our research, starting from the supporting theories and explanations through to research hypotheses and then to the definition of the independent variables. Source: Own table, partially adapted from Cantarelli et al. (2010).

Literature			Our Research				
Explanations Supporting Theories	**Explanations**	**Causes**	**Explanations Supporting Theories**	**Explanations**	**Research Hypothesis**	**Causes / Independent Variables**	**Control Variables**
Machiavellianism Agency Ethical	Political	- Deliberate cost underestimation - Manipulation of forecasts - Private information	Political Economy - Opportunistic Behaviour	Political	**Hypothesis 1:** Political cycles increase cost and time overruns	• Election year • Election year lead • Election Year lag	• Right/Left wing Government • Majority/Minority Government • Political Stability and Absence of Violence
			Institutional	Governance (Legal/Institutional)	**Hypothesis 2:** a worse institutional and regulatory framework increases cost and time overruns	• Rule of Law • Control of Corruption • Government Effectiveness • Regulatory Quality	• 2008 Procurement Law • Voice and Accountability

Literature			Our Research				
Explanations Supporting Theories	**Explanations**	**Causes**	**Explanations Supporting Theories**	**Explanations**	**Research Hypothesis**	**Causes / Independent Variables**	**Control Variables**
Neoclassical economics Rational choice	Economical	Deliberate underestimation due to: - lack of incentives - lack of resources - inefficient use of resources - dedicated funding process - poor financing / contract management - strategic behaviour	Economic Cycles	Economical	**Hypothesis 3**: a better economic cycle increases cost and time overruns	• % GDP Growth • Public Investment as % GDP • Annual Inflation	• The Financial Crisis • Troika
Forecasting Planning Decision-making	Technical	- Forecasting errors - Scope changes - Uncertainty - Inappropriate organisational structure - Inadequate decision-making process - Inadequate planning process	Incomplete Contracts	Project (control)	**Hypothesis 4:** a higher uncertainty in contracts increase cost and time overruns (control hypothesis)	• Large project • Sector	• Subsector (level of government) • Parque Escolar

Literature			Our Research				
Explanations Supporting Theories	**Explanations**	**Causes**	**Explanations Supporting Theories**	**Explanations**	**Research Hypothesis**	**Causes / Independent Variables**	**Control Variables**
Planning fallacy & optimism bias Prospect Rational choice	Psychological	- Optimism bias among local officials - Cognitive bias of people - Cautious attitudes towards risk	*Out of scope for our research*				

Table 12 – Literature that focuses on the impact of political decisions and elections

This table presents the relevant literature that focuses on the impact of political decisions and elections and its expected signal for cost overruns. Source: Own table.

Author(s)	Key ideas	Signal	Main conclusions
(Aidt, Veiga, & Veiga, 2011)	Political business cycles Opportunistic behaviour	+	▪ The existence of manipulation of political business cycles, suggests that the elected owners systematically manipulate economic and fiscal conditions before elections to increase their chances of re-election. ▪ Study for a large panel of Portuguese municipalities ▪ Opportunism leads to a larger win-margin for the incumbent, since those behave more opportunistically when their win-margin is small
(Flyvbjerg, 2007a; Mackie & Preston, 1998; Wachs, 1982, 1987, 1989)	Dishonesty Weak forecast Manipulation Political criteria Competition for public funds	+	▪ Supportive of the claims of dishonesty, mainly in the transport sector ▪ Largely due to data manipulation and weak forecasting techniques ▪ Assumptions chosen to intend to produce manipulated forecasts to defend projects favoured on the basis of political criteria. ▪ Competition for public funding creates an environment where the process of supporting a determined proposal is influenced by other factors other than objectivity in the use of forecasting methods. ▪ Decisive proofs of these claims have, however, been difficult to find.
(Buchanan & Tullock, 1962; Downs, 1957; Mueller, 2003)	Political agents; Electoral results;	+	▪ Political agents need to be modelled as prosecuting in a rational form their personal interests, meaning that politicians and political parties depend on electoral results to gain or retain power and for that reason they design strategies to achieve that particular goal. ▪ Public officers intend to maximise their budgets, as these amounts are positively related with an increase status quo and power independently of the best interests of the public.

Author(s)	Key ideas	Signal	Main conclusions
(Szyliowicz & Goetz, 1995)	Lack of political elements	undefined	▪ Through the lens of the Rational model of decision-making and the capability of this approach to explain the major events. ▪ The objectives are only half meted, as the model does not incorporate political elements which are critical when dealing with super-size projects. ▪ Being a democratic political system, the USA does not provide the possibility of the political system allowing a powerful agency to design and implement the project
(Wachs, 1990)	Ethical issues Political consequences Intentional lying	+	▪ Proven for a small sample of urban rail projects that forecasting has embedded serious ethical issues which raises serious political consequences for our established democratic framework ▪ At a different level, individual consequences for those preparing these forecasts. ▪ Intentional lying is, in fact, an important cause of cost deviations through the undervaluing of forecasted costs.

Table 13 – Explanations versus Hypotheses

This table details the theoretical framework designed in our research and the way it interacts with the independent variables used in this study. Starting from supporting theories and explanations through to research hypotheses and then to the definition of the independent variables. Source: Own table.

Theory	Explanations	Hypothesis	Causes / Independent Variables	Control Variables
Political Economy - Opportunistic Behaviour	Political	# 1	·Election year ·Election year lead ·Election year lag	·Right/Left wing Government ·Majority/Minority Government ·Political Stability and Absence of Violence/Terrorism
Institutional	Governance (Legal/Institutional)	# 2	·Rule of Law ·Control of Corruption ·Government Effectiveness ·Regulatory Quality	·Voice and Accountability ·2008 Procurement law
Economic Cycles	Economical	# 3	·% GDP Growth ·Public Investment as % GDP ·Annual Inflation	·Financial Crisis ·Troika
Incomplete Contracts	Project (control)	# 4	·Large projects ·Sector	·Subsector (level of government) ·Parque Escolar

Table 14 – Hypotheses and independent variables' expected signals

This table details the independent and control variables used in this study. The table presents each variable definition, expected signal, and justification for the contribution of each variable to cost and time overruns. IV means Instrumented Variables for the endogeneity tests. ND means that the literature does not provide sufficient evidence to determine an expected signal for the specific variable. Source: Own table.

Variables	**Type of variable**	**Definition**	**Expected Signal**	**Justification**
		Hypothesis I - Political determinants		
Causes / Independent Variables				
·Election year (IV) (general, regional or municipal election)	Dummy (0 - No; 1- Yes)	Project initiated on a central, regional or municipal electoral year (t)	+	Cost and time overruns are more prone to occur with electoral cycles where political agents try to get a better approval rates, precipitating the beginning of the projects
·Election year lag (IV) (general, regional or municipal election)	Dummy (0 - No; 1- Yes)	Project initiated a year before a central, regional or municipal electoral year (t-1)	+	
·Election year lead (IV) (general, regional or municipal election)	Dummy (0 - No; 1- Yes)	Project initiated a year after a central, regional or municipal electoral year (t+1)	+	
Control Variables				
·Right/Left wing Government	Dummy (0 - Right wing; 1- Left Wing)	Political party ideological spectrum in government at project initiation	ND	Right wing governments are normally more conservative which could tend to be more realistic in forecasting completion costs and time
·Majority/Minority Government	Dummy (0 - Majority; 1- Minority)	Political representation in government at project initiation is a political majority or a political minority	ND	Governments with political majorities could tend to be less realistic in forecasting completion costs and time
·Political Stability and Absence of Violence/Terrorism	Discrete (0.100)	This index measures perceptions of the likelihood of political instability. A higher index reflects an improvement in the variable. We use the Portugal percentile rank in the Index	-	The better ranked Portugal is the more likely lower cost and time overruns exist

Variables	Type of variable	Definition	Expected Signal	Justification
Hypothesis II - Governance determinants				
Causes / Independent Variables				
·Control of Corruption Index	Discrete (0.100)	This index reflects the level of corruption. A higher index reflects an improvement in the variable. We use the Portugal percentile rank in the Index	-	The lower the corruption index is, the more likely lower cost and time overruns exist
·Rule of Law Index	Discrete (0.100)	This index reflects the existing legal environment. A higher index reflects an improvement in the variable. We use the Portugal percentile rank in the Index	-	The better ranked Portugal is, the more likely lower cost and time overruns exist
·Government Effectiveness	Discrete (0.100)	This index reflects perceptions of the quality of public and civil service and their degree of independence from political pressures. A higher index reflects an improvement in the variable. We use the Portugal percentile rank in the Index	-	
·Regulatory Quality	Discrete (0.100)	This index reflects the ability of the government to formulate and implement sound policies and regulations. A higher index reflects an improvement in the variable. We use the Portugal percentile rank in the Index	-	

Variables	Type of variable	Definition	Expected Signal	Justification
Control Variables				
·Voice and Accountability	Discrete (0.100)	This index reflects perceptions of the extent to which a country's citizens are able to participate in selecting their government. A higher index reflects an improvement in the variable. We use the Portugal percentile rank in the Index	-	The better ranked Portugal is the more likely lower cost and time overruns exist
·2008 Procurement law	Dummy (0 - before 2008; 1- after 2008)	Projects that were initiated before or after the 2008 Procurement Law has been introduced	-	The new legislation introduced a tighter procurement framework which should result in lower cost and time overruns
Hypothesis III – Economic determinants				
Causes / Independent Variables				
·% GDP Growth	Discrete	The GDP Growth (at initial and final year of construction)	+	Better economic cycles mean more money for governments to spend which may lead to reduction of controls on spending
·Public Investment as % GDP	Discrete	Public Investment as % GDP	+	The higher the % of money invested in public infrastructures, the more money and projects are circulating, which may leave to reduction of controls on spending
·Annual Inflation	Discrete	Annual Inflation	+	Higher inflation means general increase of prices in the economy which may leave both to an increase of project costs through increases in work cost and construction materials and project time due to constraints on personnel hirings to keep project margins unchanged.

Variables	Type of variable	Definition	Expected Signal	Justification
Control Variables				
·Financial Crisis 1	Dummy (0 - after 2007; 1- before 2007)	Projects that were started before 2007, in order to capture the effects of the financial crisis	-	Less money for governments (public budget constraints) to spend, which may lead to an increase of controls on spending
·Financial Crisis 2	Dummy (0 - after 2008; 1- before 2008)	Projects that were started before 2008, in order to capture the effects of the financial crisis	-	
·Financial Crisis 3	Dummy (0 - after 2009; 1- before 2009)	Projects that were started before 2009, in order to capture the effects of the financial crisis	-	
·Troika	Dummy (0 - before 2011; 1- after 2011)	In order to capture the effects of the presence of the Troika in Portugal	-	
Hypothesis IV - Project determinants (control)				
Causes / Independent Variables				
·Large project	Dummy (0 - small; 1- large)	The size of a project measured by its initial cost. A large project is one with an initial cost higher than EUR. 5,225,000. This was defined using the EU Regulations that fixes in EUR 5,225,000 the upper limits for public projects contract amount that are not subject to an international tender	+	Larger projects have a higher construction completion uncertainty, which may be prone to the occurrence of cost and time overruns
·Sector (Education, transports, social or economic facilities)	Dummy (0 - No; 1- Yes)	The project activity sector	ND	No sector is more likely to present cost and time overruns

Variables	Type of variable	Definition	Expected Signal	Justification
Control Variables				
·Subsector (level of government)	Dummy (0 – central government; 1 – regional/local government)	The project's promoter Level of government	+	Less centralised levels of government are more likely to present cost and time overruns
·Parque Escolar	Dummy (0 – No 1- Yes)	Projects belong to the Parque Escolar Program. Parque Escolar is a central government investment program whose purpose was the planning, management, development, and execution of the modernisation program for the public network of secondary and other schools under the responsibility of the Portuguese Ministry of Education. All projects of Parque Escolar belong to the education sector.	-	A specific investment programme can be more efficient in forecast and control for project costs and delivery times

Table 15 – Summary of the studies carried out

This table summarises the studies carried out during our research. Five studies were carried out, each one standing for a different dependent variable and/or analysed data. The table also reflects the relationship established between dependent variables, data, formulated hypotheses, and the quantitative tested carried out. Source: Own table.

Study	Dependent Variable	Data	Hypothesis	Quantitative tests
#1	*cdevp* - % cost deviation *cdevprob* - cost deviation probability	All observations	#1 #2 #3 #4	descriptive statistics econometric tests (OLS, GLM, Tobit, Probit, IVReg, IVProbit; Negative Binomial and fractional response model for the GLM and Probit regression – *cdevp* and *cdevprob* only)
#2	*tdevp* - % time deviation *tdevprob* - time deviation probability			
#3	*cdevp* - % cost deviation (with *tdevp* as independent variable) *cdevprob* - cost deviation probability (with *tdevp* as independent variable)			descriptive statistics econometric tests (OLS, GLM, Tobit, Probit, IVReg, IVProbit, and SEM)
#4	*cdevp* - % cost deviation *cdevprob* - cost deviation probability	Transport sector observations		descriptive statistics econometric tests (OLS, GLM, Tobit, Probit, IVReg, IVProbit, Negative Binomial and fractional response model for the GLM and Probit regression)
#5	*cdevp* - % cost deviation *cdevprob* - cost deviation probability	Local Government observations		descriptive statistics econometric tests (OLS, GLM, Tobit, Probit, IVReg, IVProbit, Negative Binomial and fractional response model for the GLM and Probit regression)

Table 16 –Summary of the Statistical/Econometric tests

This table describe the econometric test carried out and the justification for its application. The table also reflects the relationship established between hypotheses, independent variables, and the quantitative test carried out. Each test is replicated for each dependent variable. Source: Own table.

<table>
<tr><th></th><th></th><th colspan="7">Dependent Variable</th><th colspan="3">Dependent Variable</th></tr>
<tr><td></td><td></td><td colspan="7">% cost deviation</td><td colspan="3">Dummy variable:
0 if cost deviation ≤ 0%
1 if cost deviation > 0%</td></tr>
<tr><td></td><td></td><td colspan="7">% time deviation</td><td colspan="3">Dummy variable:
0 if time deviation ≤ 0%
1 if time deviation > 0%</td></tr>
<tr><th>Hypothesis</th><th>Independent Variable</th><th>OLS</th><th>GLM</th><th>Tobit</th><th>Negative Binomial</th><th>IVReg</th><th>Fractional GLM</th><th>SEM</th><th>Probit</th><th>IVProbit</th><th>Fractional Probit</th></tr>
<tr><td>#1</td><td>*·ely*
·elylead
·elylag</td><td rowspan="4">Our standard test - see the impact of each independent variable in the % of deviation</td><td rowspan="4">As the dependent variable is a % we can use GLM as a robustness check for the OLS</td><td rowspan="4">As the dependent variable is a %, and we also have outliers (either negative deviation and positive deviation), we can run a Tobit with left- and right censoring</td><td rowspan="4">Control and robustness check</td><td rowspan="4">To assess endogeneity, and as a robustness test to the formulated hypothesis</td><td rowspan="4">Robustness test (addressing the endogeneity issue)</td><td rowspan="4">To test if our hypothesis exogenous determinants have a direct effect in *tdevp* and simultaneously exert an indirect effect on *cdevp* whether it has a distinct effect directly</td><td rowspan="4">Will be used to assess whether each independent variable affects the likelihood of a cost and time overrun (along with marginal effects to assess the magnitude of that probability)</td><td rowspan="4">To assess endogeneity, and as a robustness test to the formulated hypothesis</td><td rowspan="4">Robustness test (addressing the endogeneity issue)</td></tr>
<tr><td>#2</td><td>*·rlaw*
·corrp
·goveff
·regulq</td></tr>
<tr><td>#3</td><td>*·gdpg*
·publicinv
·infl</td></tr>
<tr><td>#4</td><td>*·largeproj / loginitialcost*
·sectors</td></tr>
</table>

Table 17 – Descriptive statistics for dependent variable cost deviation

This table present the descriptive statistics for the dependent variable cost deviation percentage and cost deviation probability. Source: Own table.

	Variable	Obs	Mean	Std. Dev.	Min	Max
Cost deviation final sample	*budgetcost*	3,487	2,482	9,823	7.00 (‘000 EUR)	308,178 (‘000 EUR)
	fincost	3,487	2,639	11,085	7.00 (‘000 EUR)	406,938 (‘000 EUR)
	cdev	4,266	129	1,755	-14,843 (‘000 EUR)	98,760 (‘000 EUR)
	cdevp	4,266	3.7%	0.0911	-47.0%	49.0%
	cdevprob	4,266	42.1%	0.4937	0	1
Cost deviation transport sector final subsample	*budgetcost*	923	2,624	12,528	31.39 (‘000 EUR)	308,178 (‘000 EUR)
	fincost	923	2,906	15,784	31.39 (‘000 EUR)	406,938 (‘000 EUR)
	cdev	1,091	239	3,227	-2,313 (‘000 EUR)	98,760 (‘000 EUR)
	cdevp	1,091	0.0223	0.1039	-47.0%	49.0%
	cdevprob	1,091	0.3309	0.4707	0	1
Cost deviation local government projects final subsample	*budgetcost*	2,714	1,377	3,138	16.55 (‘000 EUR)	81,128 (‘000 EUR)
	fincost	2,714	1,456	3,467	16.55 (‘000 EUR)	89,370 (‘000 EUR)
	cdev	3,338	64	364	-901 (‘000 EUR)	9,265 (‘000 EUR)
	cdevp	3,338	0.0371	0.0874	-45.0%	48.0%
	cdevprob	3,338	0.4089	0.4917	0	1

Table 18 – Descriptive statistics for dependent variable time deviation

This table presents the descriptive statistics for dependent variable time deviation percentage and time deviation probability. Source: Own table.

Variable	Obs	Mean	Std. Dev.	Min	Max
budgettime	145	448 days	284	15 days	1,440 days
finaltime	145	635 days	446	15 days	2,160 days
tdev	161	172 days	195	-40 days	990 days
tdevp	161	36.7%	0.3299	-44%	100%
tdevprob	161	73.29%	0.4438	0	1

Table 19 – Correlation Matrix – Cost deviations final sample

This table presents the correlation between all the variables used in Section 5 which comprises the study of the determinants of cost deviations using the total sample of collected observations. This sample includes all sectors and subsectors analysed in our research. Due to table size problems, we split the table in two. Nevertheless, all data was computed at the same time. The continuation table should be read as if it was presented on the right side of the initial table. Higher and lower than 0.6 correlation are highlighted in the table. Source: Own table.

	largeproj	*edu*	*transp*	*econf*	*socf*	*notcgov*	*pescolar*	*law2008*	*fincrisis1*	*fincrisis2*	*fincrisis3*	*troika*	*elylag*	*ely*	*elylead*	*regelylag*	*regely*
largeproj	1.00																
edu	0.08	1.00															
transp	0.02	-0.29	1.00														
econf	-0.01	-0.22	-0.26	1.00													
socf	-0.08	-0.39	-0.47	-0.35	1.00												
notcgov	-0.34	-0.07	-0.04	0.08	0.04	1.00											
pescolar	0.37	0.28	-0.08	-0.06	-0.11	-0.26	1.00										
law2008	-0.09	0.18	0.07	-0.07	-0.16	0.03	0.12	1.00									
fincrisis1	-0.09	0.14	0.07	-0.05	-0.13	0.00	0.09	0.70	1.00								
fincrisis2	-0.07	0.18	0.07	-0.06	-0.16	0.02	0.12	0.91	0.76	1.00							
fincrisis3	-0.09	0.18	0.07	-0.07	-0.16	0.03	0.12	1.00	0.70	0.91	1.00						
troika	-0.07	-0.02	0.01	0.01	0.00	0.03	0.00	0.40	0.28	0.36	0.40	1.00					
elylag	0.04	0.01	0.02	-0.01	-0.02	-0.04	-0.02	0.08	0.10	0.24	0.08	-0.23	1.00				
ely	-0.01	0.11	0.01	-0.04	-0.07	0.03	0.09	0.45	0.15	0.37	0.45	0.30	-0.51	1.00			
elylead	-0.07	-0.02	-0.01	0.02	0.01	0.04	-0.05	0.02	-0.23	-0.04	0.02	-0.12	0.32	-0.62	1.00		
regelylag	-0.05	-0.01	-0.01	0.01	0.01	0.02	-0.04	-0.03	-0.28	-0.09	-0.03	-0.26	0.35	-0.55	0.91	1.00	
regely	-0.02	-0.10	0.00	0.02	0.07	-0.01	-0.04	-0.15	0.20	-0.21	-0.15	0.46	-0.14	-0.07	-0.41	-0.41	1.00
regelylead	-0.04	-0.06	-0.04	0.04	0.05	0.03	-0.05	-0.23	-0.39	-0.27	-0.23	0.07	-0.16	0.21	-0.10	-0.25	-0.24
munelylag	0.04	0.13	0.03	-0.05	-0.09	0.01	0.11	0.43	0.22	0.37	0.43	-0.10	-0.15	0.40	-0.31	-0.43	-0.18
munely	0.00	0.13	0.01	-0.04	-0.09	0.03	0.09	0.25	0.01	0.19	0.25	-0.28	-0.36	0.73	-0.48	-0.45	-0.44
munelylead	-0.03	0.00	-0.01	0.02	-0.01	0.02	-0.04	-0.01	-0.24	-0.07	-0.01	-0.25	0.39	-0.52	0.85	0.90	-0.40
deltagoveff	-0.05	0.12	0.00	-0.03	-0.07	0.03	0.05	0.30	-0.04	0.20	0.30	-0.48	0.20	0.10	0.29	0.27	-0.72

	largeproj	*edu*	*transp*	*econf*	*socf*	*notcgov*	*pescolar*	*law2008*	*fincrisis1*	*fincrisis2*	*fincrisis3*	*troika*	*elylag*	*ely*	*elylead*	*regelylag*	*regely*
deltarlaw	-0.08	-0.02	-0.01	0.03	0.01	0.04	-0.04	-0.09	-0.08	-0.11	-0.09	0.06	-0.27	-0.01	0.35	0.34	-0.27
deltacorrp	0.00	-0.02	-0.04	0.02	0.04	0.05	0.02	-0.28	-0.24	-0.27	-0.28	0.10	-0.77	0.47	-0.52	-0.53	0.09
deltaaccount	0.05	-0.08	0.00	0.02	0.05	-0.02	-0.02	-0.27	-0.18	-0.31	-0.27	0.26	-0.38	0.24	-0.41	-0.27	0.54
deltapolstab	-0.04	-0.05	0.02	0.00	0.02	-0.02	-0.03	0.27	0.20	0.17	0.27	0.54	0.40	-0.15	0.09	0.11	0.60
deltaregulq	-0.08	0.05	0.02	0.00	-0.06	0.02	0.00	0.37	-0.03	0.20	0.37	0.10	0.07	0.16	0.43	0.42	-0.40
infl	0.07	-0.19	-0.04	0.07	0.14	-0.04	-0.13	-0.52	-0.40	-0.49	-0.52	0.40	0.04	-0.31	0.09	0.05	0.45
publicinv	0.06	0.09	0.04	-0.04	-0.08	-0.06	0.04	0.34	0.04	0.31	0.34	-0.38	0.67	-0.01	0.23	0.36	-0.40
gdpg	0.04	-0.13	-0.03	0.05	0.10	-0.05	-0.11	-0.58	-0.33	-0.58	-0.58	-0.36	0.42	-0.71	0.36	0.48	0.21
govrw	0.04	-0.07	0.01	0.01	0.04	-0.02	-0.03	0.14	-0.05	0.09	0.14	0.76	-0.03	0.13	-0.13	-0.24	0.51
govmaj	0.00	0.02	-0.03	0.00	0.01	0.04	0.03	-0.37	-0.11	-0.30	-0.37	-0.51	-0.50	0.17	-0.31	-0.25	-0.24

(continuation)

	regelylead	*munelylag*	*munely*	*munelylead*	*deltagoveff*	*deltarlaw*	*deltacorrp*	*deltaaccount*	*deltapolstab*	*deltaregulq*	*infl*	*publicinv*	*gdpg*	*govrw*	*govmaj*
regelylead	1.00														
munelylag	-0.08	1.00													
munely	0.39	0.59	1.00												
munelylead	-0.24	-0.41	-0.44	1.00											
deltagoveff	0.33	0.37	0.51	0.31	1.00										
deltarlaw	0.34	-0.65	-0.02	0.33	0.04	1.00									
deltacorrp	0.18	0.28	0.45	-0.52	-0.25	0.00	1.00								
deltaaccount	-0.11	-0.31	-0.04	-0.38	-0.74	0.12	0.38	1.00							
deltapolstab	-0.20	-0.29	-0.57	0.08	-0.34	-0.21	-0.58	0.21	1.00						
deltaregulq	0.35	-0.31	0.16	0.38	0.38	0.65	-0.40	0.01	0.17	1.00					
infl	0.28	-0.72	-0.60	0.06	-0.54	0.30	-0.03	0.38	0.41	0.04	1.00				
publicinv	-0.07	0.05	0.16	0.35	0.52	-0.11	-0.72	-0.26	0.27	0.47	-0.30	1.00			
gdpg	-0.05	-0.70	-0.59	0.51	-0.08	0.23	-0.46	0.02	0.26	0.03	0.51	0.20	1.00		
govrw	-0.01	0.03	-0.36	-0.26	-0.54	-0.36	-0.02	0.33	0.65	-0.11	0.46	-0.20	-0.26	1.00	
govmaj	0.08	0.17	0.50	-0.21	0.13	0.18	0.69	0.02	-0.86	-0.32	-0.31	-0.43	-0.13	-0.65	1.00

Table 20 – Correlation Matrix – Time deviations final sample

This table presents the correlation between all variables used in Section 6, which comprises the study of the determinants of cost deviations using the total sample of collected observations. This sample includes all sectors and subsectors analysed in our research. Due to table size problems, we split the table in two. Nevertheless, all data was computed at the same time. The continuation table should be read as if it was presented on the right side of the initial table. Higher and lower than 0.6 correlation are highlighted in the table. Source: Own table.

	largeproj	*edu*	*transp*	*econf*	*socf*	*notcgov*	*law2008*	*fincrisis1*	*fincrisis2*	*fincrisis3*	*troika*	*elylag*	*ely*	*elylead*	*regelylag*	*regely*
largeproj	1.00															
edu	-0.03	1.00														
transp	0.28	-0.21	1.00													
econf	0.05	-0.15	-0.31	1.00												
socf	-0.28	-0.28	-0.56	-0.41	1.00											
notcgov	-0.32	0.17	-0.34	0.02	0.19	1.00										
law2008	-0.10	0.05	-0.19	0.05	0.10	0.32	1.00									
fincrisis1	-0.16	0.16	-0.17	-0.04	0.09	0.39	0.67	1.00								
fincrisis2	-0.10	0.24	-0.24	-0.03	0.10	0.43	0.83	0.82	1.00							
fincrisis3	-0.10	0.05	-0.19	0.05	0.10	0.32	1.00	0.67	0.83	1.00						
troika	-0.05	-0.08	-0.04	-0.11	0.17	0.12	0.49	0.33	0.40	0.49	1.00					
elylag	0.19	0.12	0.03	0.16	-0.22	0.08	0.02	0.08	0.23	0.02	-0.18	1.00				
ely	-0.09	0.03	-0.20	-0.08	0.23	-0.11	0.15	-0.11	0.02	0.15	0.10	-0.55	1.00			
elylead	-0.06	-0.10	0.08	0.00	-0.01	0.15	0.24	0.00	0.12	0.24	0.09	-0.06	-0.43	1.00		
regelylag	-0.18	-0.14	-0.09	-0.02	0.18	-0.04	0.04	-0.20	-0.07	0.04	-0.17	-0.20	-0.03	0.61	1.00	
regely	0.00	-0.13	0.14	0.00	-0.05	0.07	-0.10	0.16	-0.18	-0.10	0.18	0.10	-0.24	-0.22	-0.40	1.00
regelylead	0.02	-0.01	-0.01	-0.11	0.10	-0.02	-0.03	-0.16	-0.10	-0.03	0.20	-0.20	0.20	-0.11	-0.30	-0.24
munelylag	0.09	0.04	0.00	0.07	-0.08	0.15	0.31	0.09	0.20	0.31	0.14	0.16	-0.03	-0.08	-0.37	0.38
munely	0.02	0.11	-0.08	-0.02	0.02	0.11	0.19	0.00	0.10	0.19	-0.12	-0.26	0.46	-0.30	-0.35	-0.28
munelylead	0.03	-0.02	-0.01	0.22	-0.15	-0.04	0.08	-0.14	-0.03	0.08	-0.16	0.20	-0.23	0.47	0.31	-0.34
deltagoveff	-0.12	-0.05	-0.22	-0.02	0.25	-0.06	0.33	-0.04	0.12	0.33	-0.09	-0.11	0.42	0.04	0.28	-0.34
deltarlaw	-0.04	0.00	0.06	-0.13	0.04	0.06	0.12	0.18	0.13	0.12	0.07	-0.40	0.08	0.37	0.19	-0.47

	largeproj	*edu*	*transp*	*econf*	*socf*	*notcgov*	*law2008*	*fincrisis1*	*fincrisis2*	*fincrisis3*	*troika*	*elylag*	*ely*	*elylead*	*regelylag*	*regely*
deltacorrp	0.01	0.08	0.12	-0.28	0.05	0.18	-0.19	-0.02	-0.11	-0.19	0.10	-0.43	0.20	-0.22	-0.31	0.11
deltaaccount	0.17	-0.09	0.31	-0.02	-0.22	-0.08	-0.35	-0.28	-0.39	-0.35	-0.14	-0.05	-0.16	-0.02	-0.06	0.18
deltapolstab	0.00	-0.20	0.03	0.09	0.02	0.00	0.17	-0.03	-0.04	0.17	0.24	0.34	-0.18	0.03	0.06	0.59
deltaregulq	0.09	-0.06	0.11	0.03	-0.09	0.04	0.32	0.00	0.09	0.32	0.09	-0.11	0.03	0.46	0.19	-0.40
infl	0.19	-0.11	0.34	-0.14	-0.14	-0.29	-0.30	-0.29	-0.29	-0.30	0.03	0.15	-0.08	0.09	-0.12	0.14
publicinv	0.14	-0.03	-0.02	0.16	-0.09	-0.31	0.02	-0.35	-0.10	0.02	-0.41	0.36	0.15	-0.09	0.23	-0.27
gdpg	0.02	-0.19	0.06	0.12	-0.04	-0.44	-0.49	-0.38	-0.52	-0.49	-0.43	0.22	-0.16	-0.14	0.23	0.08
govrw	0.20	-0.09	0.27	-0.05	-0.15	-0.08	-0.05	-0.27	-0.15	-0.05	0.35	0.14	-0.08	0.01	-0.19	0.28
govmaj	-0.06	0.13	0.04	-0.11	-0.03	0.23	-0.12	0.25	0.06	-0.12	-0.23	-0.20	0.01	-0.14	-0.22	-0.12

(continuation)

	regelylead	*munelylag*	*munely*	*munelylead*	*deltagoveff*	*deltarlaw*	*deltacorrp*	*deltaaccount*	*deltapolstab*	*deltaregulq*	*infl*	*publicinv*	*gdpg*	*govrw*	*govmaj*
regelylead	1.00														
munelylag	-0.05	1.00													
munely	0.68	0.17	1.00												
munelylead	-0.27	-0.34	-0.32	1.00											
deltagoveff	0.33	0.16	0.36	0.03	1.00										
deltarlaw	0.35	-0.63	0.28	0.24	0.01	1.00									
deltacorrp	0.31	0.14	0.44	-0.38	-0.01	0.20	1.00								
deltaaccount	-0.05	-0.25	0.09	-0.16	-0.65	0.20	0.14	1.00							
deltapolstab	-0.25	0.27	-0.40	-0.09	-0.09	-0.59	-0.50	0.06	1.00						
deltaregulq	0.36	-0.34	0.33	0.31	0.04	0.72	-0.13	0.38	-0.15	1.00					
infl	0.02	-0.13	-0.20	0.04	-0.13	0.10	0.08	0.21	0.00	0.08	1.00				
publicinv	-0.06	-0.08	0.07	0.18	0.26	-0.23	-0.66	0.04	0.32	0.12	0.02	1.00			
gdpg	-0.15	-0.42	-0.32	0.25	0.11	-0.09	-0.37	0.02	0.13	-0.20	0.23	0.49	1.00		
govrw	-0.14	0.29	-0.34	-0.02	-0.39	-0.45	-0.10	0.20	0.55	-0.08	0.22	-0.02	-0.32	1.00	
govmaj	0.10	-0.15	0.33	-0.04	0.00	0.45	0.70	0.05	-0.68	0.04	-0.04	-0.60	-0.21	-0.39	1.00

Table 21 – Descriptive statistics for independent variables – Cost deviations - final sample study

This table presents the descriptive statistics of the independent variables used in Subsection 5.1. Independent variables are presented according to the research hypotheses (I to IV). Source: Own table.

Variable	Obs	Mean	Std. Dev.	Min	Max
Hyphotesis I – Political determinants					
ely	4,266	0.4454	0.4971	0	1
elylag	4,266	0.2466	0.4311	0	1
elylead	4,266	0.3218	0.4672	0	1
regely	4,266	0.2886	0.4531	0	1
regelylag	4,266	0.2975	0.4572	0	1
regelylead	4,266	0.1280	0.3341	0	1
munely	4,266	0.3277	0.4694	0	1
munelylag	4,266	0.3005	0.4585	0	1
munelylead	4,266	0.2857	0.4518	0	1
govrw	4,266	0.2166	0.4120	0	1
govmaj	4,266	0.6228	0.4847	0	1
deltapolstab	4,266	0.8700	5.3579	-4.9	10.1
Hyphotesis II – Governance determinants					
deltarlaw	4,266	-0.0611	1.9966	-7.7	3.3
deltacorrp	4,266	-0.2224	1.8535	-4.4	1.2
deltagoveff	4,266	0.9428	3.0506	-4.9	4.8
deltaregulq	4,266	-0.6952	2.2252	-5.8	5.3
deltaaccount	4,266	-1.3183	1.3910	-5.7	2.5
law2008	4,266	0.5056	0.5000	0	1
Hyphotesis III – Economic determinants					
gdpg	4,266	-0.1635	2.0666	-4	4.7
publicinv	4,266	3.9771	0.7058	2.47	5.56
infl	4,266	1.8594	1.6560	-0.8	16.1
fincrisis1	4,266	0.6777	0.4674	0	1
fincrisis2	4,266	0.5511	0.4974	0	1
fincrisis3	4,266	0.5056	0.5000	0	1
Troika	4,266	0.1376	0.3445	0	1
Hyphotesis IV – Project determinants (control)					
largeproj	3.486	0.0637	0.2442	0	1
edu	4,266	0.1971	0.3979	0	1
transp	4,266	0.2557	0.4363	0	1
econf	4,266	0.1594	0.3661	0	1
socialf	4,266	0.3877	0.4873	0	1
notcgov	4,266	0.7825	0.4126	0	1
mun	4,266	0.7564	0.4293	0	1
region	4,266	0.0263	0.1599	0	1
pescolar	4,266	0.0183	0.1340	0	1

Table 22 – Descriptive statistics for independent variables – Cost deviations - transport sector final subsample study

This table presents the descriptive statistics of the independent variables to be used in Subsection 5.2. Independent variables are presented according to the research hypotheses (I to IV). Source: Own table.

Variable	Obs	Mean	Std. Dev.	Min	Max
Hypothesis I – Political determinants					
ely	1,091	0.4546	0.4982	0	1
elylag	1,091	0.2631	0.4405	0	1
elylead	1,091	0.3153	0.4649	0	1
regely	1,091	0.2887	0.4534	0	1
regelylag	1,091	0.2878	0.4529	0	1
regelylead	1,091	0.1054	0.3072	0	1
munely	1,091	0.3355	0.4724	0	1
munelylag	1,091	0.3217	0.4674	0	1
munelylead	1,091	0.2805	0.4494	0	1
govrw	1,091	0.2236	0.4169	0	1
govmaj	1,091	0.5976	0.4906	0	1
deltapolstab	1,091	1.0842	5.3722	-4.9	10.1
Hypothesis II – Governance determinants					
deltarlaw	1,091	-0.1067	1.8106	-7.7	3.3
deltacorrp	1,091	-0.3486	1.9432	-4.4	1.2
deltagoveff	1,091	0.9334	3.1217	-4.9	4.8
deltaregulq	1,091	-0.6015	2.1876	-5.8	5.3
deltaaccount	1,091	-1.3129	1.4530	-5.7	2.5
law2008	1,091	0.5646	0.4960	0	1
Hypothesis III – Economic determinants					
gdpg	1,091	-0.2648	2.1500	-4	4.7
publicinv	1,091	4.0257	0.7268	2.47	5.56
infl	1,091	1.7537	1.7797	-0.8	16.1
fincrisis1	1,091	0.7351	0.4415	0	1
fincrisis2	1,091	0.6068	0.4887	0	1
fincrisis3	1,091	0.5646	0.4960	0	1
Troika	1,091	0.1448	0.3521	0	1
Hypothesis IV – Project determinants (control)					
largeproj	923	0.0715	0.2578	0	1
notcgov	1,091	0.7534	0.4312	0	1

Table 23 – Descriptive statistics for independent variables – Cost deviations - local government projects final subsample study

This table presents the descriptive statistics of the independent variables to be used in Subsection 5.3. Independent variables are presented according to the research hypotheses (I to IV). Source: Own table.

Variable	Obs	Mean	Std. Dev.	Min	Max
Hypothesis I – Political determinants					
ely	3,338	0.4524	0.4978	0	1
elylag	3,338	0.2382	0.4260	0	1
elylead	3,338	0.3310	0.4707	0	1
regely	3,338	0.2858	0.4519	0	1
regelylag	3,338	0.3017	0.4591	0	1
regelylead	3,338	0.1333	0.3400	0	1
munely	3,338	0.3346	0.4719	0	1
munelylag	3,338	0.3038	0.4600	0	1
munelylead	3,338	0.2900	0.4538	0	1
govrw	3,338	0.2112	0.4082	0	1
govmaj	3,338	0.6339	0.4818	0	1
deltapolstab	3,338	0.8213	5.4305	-4.9	10.1
Hypothesis II – Governance determinants					
deltarlaw	3,338	-0.0153	2.0191	-7.7	3.3
deltacorrp	3,338	-0.1705	1.8490	-4.4	1.2
deltagoveff	3,338	0.9855	3.0445	-4.9	4.8
deltaregulq	3,338	-0.6677	2.1854	-5.8	5.3
deltaaccount	3,338	-1.3342	1.3685	-5.7	2.5
law2008	3,338	0.5126	0.4999	0	1
Hypothesis III – Economic determinants					
gdpg	3,338	-0.2208	2.0343	-4	4.7
publicinv	3,338	3.9551	0.6964	2.47	5.56
infl	3,338	1.8219	1.5582	-0.8	4.4
fincrisis1	3,338	0.6768	0.4678	0	1
fincrisis2	3,338	0.5575	0.4968	0	1
fincrisis3	3,338	0.5126	0.4999	0	1
Troika	3,338	0.1432	0.3503	0	1
Hypothesis IV – Project determinants (control)					
largeproj	2,714	0.0195	0.1384	0	1
edu	3,338	0.1815	0.3855	0	1
transp	3,338	0.2463	0.4309	0	1
econf	3,338	0.1753	0.3802	0	1
socialf	3,338	0.3969	0.4893	0	1

Table 24 – Descriptive statistics for independent variables – Time deviations - final sample study

This tables presents the descriptive statistics of the independent variables to be used in Section 6. Independent variables are presented according to the research hypotheses (I to IV). Source: Own table.

Variable	Obs	Mean	Std. Dev.	Min	Max
Hypothesis I – Political determinants					
ely	161	0.3540	0.4797	0	1
elylag	161	0.3540	0.4797	0	1
elylead	161	0.2795	0.4502	0	1
regely	161	0.2422	0.4298	0	1
regelylag	161	0.3354	0.4736	0	1
regelylead	161	0.1491	0.3573	0	1
munely	161	0.1925	0.3955	0	1
munelylag	161	0.2112	0.4094	0	1
munelylead	161	0.2981	0.4589	0	1
govrw	161	0.3292	0.4714	0	1
govmaj	161	0.4658	0.5004	0	1
deltapolstab	161	1.0398	4.6270	-4.9	10.1
Hypothesis II – Governance determinants					
deltarlaw	161	-0.7559	2.6584	-7.7	3.3
deltacorrp	161	-0.6478	1.6600	-4.4	1.2
deltagoveff	161	0.5863	3.0008	-4.9	4.8
deltaregulq	161	-1.3714	2.7778	-5.8	5.3
deltaaccount	161	-1.1876	1.5421	-5.7	2.5
law2008	161	0.1988	0.4003	0	1
Hypothesis III – Economic determinants					
gdpg	161	0.9317	2.0406	-4	4.7
publicinv	161	4.2212	0.7083	2.47	5.56
infl	161	2.9354	2.9462	-0.8	28.5
fincrisis1	161	0.3540	0.4797	0	1
fincrisis2	161	0.2671	0.4438	0	1
fincrisis3	161	0.1988	0.4003	0	1
Troika	161	0.0559	0.2304	0	1
Hyphotesis IV – Project determinants (control)					
largeproj	153	0.3072	0.4628	0	1
edu	161	0.0932	0.2916	0	1
transp	161	0.2981	0.4589	0	1
econf	161	0.1801	0.3855	0	1
socialf	161	0.4286	0.4964	0	1
notcgov	161	0.5280	0.5008	0	1
mun	161	0.3416	0.4757	0	1
region	161	0.1925	0.3955	0	1

Table 25 – Descriptive Results – Cost deviations - final sample study

This table presents the results of cost deviations for the variables described in Subsection 5.1, which comprises the study of the determinants for cost deviations using the final sample of collected observations. This sample includes all sectors and subsectors analysed in our research. A positive number in cost deviations represents a cost overrun, while a negative number represents a cost below the initial forecasted budget cost. Source: Own table.

Subsample	Nº Obs (N=4,266)	Nº Obs with overruns (N=1,794) (=42%)	Cost deviation (%) – Mean (= 3.7%)	St. Dev (=0.09)	Min (=-47%)	Max (=49%)	Cost deviation (%) – Mean (overruns subsample) (=11.04%)
Hypothesis **I – Political determinants**							
ely	1,900 (44%)	825 (46% of overruns project sample) (43% of *ely* sample)	3.1%	0.09	-47%	49%	10%
elylag	1,052 (24%)	441 (25% of overruns project sample) (42% of *elylag* sample)	3.4%	0.09	-42%	49%	11%
elylead	1,373 (32%)	532 (30% of overruns project sample) (39% of *elylead* sample)	3.0%	0.08	-39%	48%	10%
regely	1,231 (29%)	426 (24% of overruns project sample) (35% of *regely* sample)	3.4%	0.08	-47%	49%	12%
regelylag	1,269 (30%)	504 (28% of overruns project sample) (40% of *regelylag* sample)	3.1%	0.09	-39%	48%	10%
regelylead	546 (13%)	439 (25% of overruns project sample) (80% of *regelylead* sample)	9.7%	0.10	-17%	49%	12%
munely	1,398 (33%)	726 (40% of overruns project sample) (52% of *munely* sample)	4.4%	0.10	-45%	49%	11%
munelylag	1,282 (30%)	539 (30% of overruns project sample) (42% of *munelylag* sample)	3.1%	0.09	-45%	48%	10%

Subsample	Nº Obs (N=4,266)	Nº Obs with overruns (N=1,794) (=42%)	Cost deviation (%) – Mean (= 3.7%)	St. Dev (=0.09)	Min (=-47%)	Max (=49%)	Cost deviation (%) – Mean (overruns subsample) (=11.04%)
munelylead	1,219 (29%)	465 (26% of overruns project sample) (38% of *munelylead* sample)	2.8%	0.08	-42%	48%	10%
govrw	924 (22%)	432 (24% of overruns project sample) (47% of *govrw* sample)	4.6%	0.10	-47%	49%	12%
govmaj	2,657 (62%)	1,158 (65% of overruns project sample) (44% of *govmaj* sample)	4.1%	0.08	-45%	49%	11%
Hypothesis II – Governance determinants							
law2008	2,157 (50%)	561 (31% of overruns project sample) (26% of *law2008* sample)	0.21%	0.07	-47%	45%	7%
Hypothesis III – Economic determinants							
fincrisis1	2,891 (68%)	751 (42% of overruns project sample) (26% of *fincrisis1* sample)	0.09%	0.07	-46%	46%	8%
troika	587	107 (6% of overruns project sample) (18% of *troika* sample)	-0.03%	0.06	-47%	36%	7%
Hypothesis IV – Project determinants (control)							
largeproj	222 (6%)	146 (8% of overruns project sample) (66% of *largeproj* sample)	5.8%	0.13	-33%	49%	11%
edu	841 (20%)	362 (20% of overrun project sample) (43% of *edu* sample)	3.5%	0.07	-20%	47%	9%
transp	1,091 (26%)	361 (20% of overruns project sample) (33% of *transp* sample)	2.3%	0.1	-47%	49%	12%
econf	680 (16%)	279 (16% of overruns project sample) (41% of *econf* sample)	3.7%	0.10	-39%	49%	11%

Subsample	Nº Obs (N=4,266)	Nº Obs with overruns (N=1,794) (=42%)	Cost deviation (%) – Mean (= 3.7%)	St. Dev (=0.09)	Min (=-47%)	Max (=49%)	Cost deviation (%) – Mean (overruns subsample) (=11.04%)
socialf	1,654 (38%)	792 (44% of of overruns project sample) (48% of *socialf* sample)	4.7%	0.09	-42%	48%	11%
notcgov	3.338 (78%)	1,365 (76% of overruns project sample) (41% of *notcgov* sample)	3.7%	0.09	-45%	48%	11%
pescolar	78 (2%)	38 (2% of overruns project sample) (49% of *pescolar* sample)	2.3%	0.07	-11%	23%	7%

Table 26 – Parametric and Nonparametric tests – Cost deviations - final sample study

This table presents the results of the two sample T-test (parametric test) and the Mann-Whitney test (nonparametric test). For both tests, we considered a p-value of 0.1 (* means variables is statistically significant). As our data is not totally normal, we also decided to use the Mann-Whitney test, which does assume any properties regarding the distribution of the dependent variable in the analysis. Nonparametric tests or distribution-free tests are tests that have the advantage of not requiring the assumption of normality or the assumption of homogeneity of variance. Nonparametric tests compare medians instead of means resulting that if the data has a small number of outliers, their influence is negated. Likewise, the Mann-Whitney test is more powerful than the T-test, while maintaining a preferred type I error rate (wrongly rejecting the null hypothesis). Source: Own table.

	T-test (reject Ho if p-value < 0.1)	**Mann-Whitney test (accept with statistical significance if p-value<0.1)**
ely	0.00*	0.00*
govrw	0.00*	0.05*
govmaj	0.00*	0.00*
law2008	0.00*	0.00*
largeproj	0.01*	0.23
edu	0.41	0.73
transp	0.00*	0.00*
econf	0.91	0.68
socialf	0.00*	0.00*
notcgov	0.94	0.77
pescolar	0.09*	0.06*

Table 27 – GLM Results – Cost deviations - final sample study

This table presents the results of a GLM regression. Results were similar to using an OLS regression. We were only able to collect data on large projects for 3,486 observations. Regarding regressions with year effects, and as a number of critical variables are not time dependent, the applicable procedure was of to remove from the GLM regression all independent variables where it is possible to record a different value in each registered observation year (e.g. *gdpg*). This way, we only use the above-mentioned dummy variables in these regressions as independent variables. For control purpose, Regression 1 was also run, by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project) with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
Hypothesis I – Political determinants						
govrw	0.0072	0.0169	-0.0103	-0.0459***		
	(0.0065)	(0.0111)	(0.0068)	(0.0105)		
govmaj					-0.0450***	-0.0452***
					(0.0058)	(0.0082)
Hypothesis II – Governance determinants						
deltarlaw		-0.0005		-0.0082***		0.0001
		(0.0015)		(0.0014)		(0.0012)
deltacorrp	-0.0018		-0.0117***			
	(0.0016)		(0.0015)			
law2008	-0.1267***	-0.1199***			-0.1194***	-0.1196***
	(0.0053)	(0.0051)			(0.0063)	(0.0090)
Hypothesis III – Economic determinants						
gdpg	-0.0032	-0.0145***	-0.0174***	-0.0212***	-0.0092***	-0.0092***
	(0.0022)	(0.0015)	(0.0022)	(0.0019)	(0.0008)	(0.0010)
publicinv		0.0442***		0.0450***		
		(0.0027)		(0.0031)		
infl	-0.0020	0.0059*	0.0065***	0.0236***	-0.0052***	-0.0053*
	(0.0021)	(0.0036)	(0.0021)	(0.0037)	(0.0020)	(0.0028)
fincrisis			-0.1155***	-0.1062***		
			(0.0053)	(0.0038)		
Hypothesis IV – Project determinants (control)						
largeproj	-0.0058					
	(0.0090)					
educ	0.0074**	0.0078**	0.0085***	0.0079***	0.0095***	0.0095***
	(0.0033)	(0.0031)	(0.0032)	(0.0031)	(0.0032)	(0.0032)
transp	-0.0163***	-0.0132***	-0.0132***	-0.0130***	-0.0123***	-0.0123***
	(0.0038)	(0.0033)	(0.0034)	(0.0033)	(0.0034)	(0.0034)
econf	-0.0068	-0.0074**	-0.0078**	-0.0073**	-0.0078**	-0.0079**
	(0.0045)	(0.0037)	(0.0039)	(0.0037)	(0.0039)	(0.0039)
notcgov	0.0079*	0.0085**	0.0049	0.0092***	0.0054	0.0053
	(0.0041)	(0.0035)	(0.0037)	(0.0035)	(0.0037)	(0.0037)
pescolar	0.0119	0.0117	0.0111	0.0113	0.0111	0.0112
	(0.0103)	(0.0083)	(0.0091)	(0.0087)	(0.0085)	(0.0085)
Constant	0.1203***	-0.0991***	0.0841***	-0.1259***	0.1316***	0.1320***
	(0.0056)	(0.0135)	(0.0048)	(0.0158)	(0.0102)	(0.0146)

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.3207	0.2388	0.1890	0.2264	0.1922	0.1922
Observations	3,486	4,266	4,266	4,266	4,266	4,266

Table 28 – Tobit Results – Cost deviations - final sample study

This table presents the results of a Tobit regression, with censoring at the left side, at 0% (for only projects with positive cost deviation, i.e., with cost overruns). We ran these regressions with time effects (using only the variables that do not change over time) and the results were similar. For control purpose, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project). We also run, for control purpose, a negative binomial regression with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
Hypothesis I – Political determinants						
govrw	0.0057	0.0184	-0.0200**	-0.0710***		
	(0.0072)	(0.0131)	(0.0089)	(0.0156)		
govmaj					-0.0757***	-0.0799***
					(0.0072)	(0.0113)
Hypothesis II – Governance determinants						
deltarlaw		-0.0002		-0.0112***		0.0012
		(0.0018)		(0.0020)		(0.0016)
deltacorrp	-0.0002		-0.0230***			
	(0.0021)		(0.0025)			
law2008	-0.1980***	-0.2170***			-0.2138***	-0.2179***
	(0.0074)	(0.0076)			(0.0088)	(0.0123)
Hypothesis III – Economic determinants						
gdpg	-0.0026	-0.0289***	-0.0344***	-0.0390***	-0.0183***	-0.0187***
	(0.0027)	(0.0023)	(0.0031)	(0.0028)	(0.0016)	(0.0017)
publicinv		0.0909***		0.0896***		
		(0.0045)		(0.0047)		
infl	-0.0065**	0.0089**	0.0080***	0.0329***	-0.0097***	-0.0109**
	(0.0026)	(0.0042)	(0.0028)	(0.0054)	(0.0032)	(0.0043)
fincrisis			-0.2224***	-0.2002***		
			(0.0089)	(0.0071)		
Hypothesis IV – Project determinants (control)						
largeproj	0.0041					
	(0.0104)					
educ	0.0039	0.0064	0.0114*	0.0082	0.0112*	0.0110*
	(0.0056)	(0.0063)	(0.0067)	(0.0063)	(0.0067)	(0.0067)
transp	-0.0230***	-0.0231***	-0.0224***	-0.0216***	-0.0219***	-0.0220***
	(0.0055)	(0.0061)	(0.0064)	(0.0060)	(0.0064)	(0.0064)
econf	-0.0097	-0.0146**	-0.0142**	-0.0136**	-0.0155**	-0.0156**
	(0.0062)	(0.0068)	(0.0071)	(0.0066)	(0.0071)	(0.0071)
notcgov	-0.0031	0.0013	-0.0083	0.0013	-0.0072	-0.0074
	(0.0060)	(0.0061)	(0.0064)	(0.0061)	(0.0064)	(0.0064)
pescolar	0.0205	0.0366**	0.0365**	0.0342**	0.0362**	0.0365**
	(0.0159)	(0.0154)	(0.0172)	(0.0161)	(0.0163)	(0.0163)
Constant	0.1424***	-0.2994***	0.0830***	-0.3215***	0.1516***	0.1587***
	(0.0081)	(0.0218)	(0.0085)	(0.0241)	(0.0137)	(0.0206)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	3,486	4,266	4,266	4,266	4,266	4,266

Table 29 – Negative Binomial Results – Cost deviations - final sample study

This table presents the results of a negative binomial regression. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
Hypothesis I – Political determinants						
govrw	0.0944	-0.0548	0.0456	-0.4693***		
	(0.0611)	(0.0877)	(0.0857)	(0.0993)		
govmaj					-0.4897***	-0.4441***
					(0.0581)	(0.0874)
Hypothesis II – Governance determinants						
deltarlaw		-0.0204*		-0.0700***		-0.0118
		(0.0114)		(0.0124)		(0.0123)
deltacorrp	0.0357*		-0.0920***			
	(0.0215)		(0.0238)			
law2008	-1.6301***	-1.6996***			-1.6358***	-1.6080***
	(0.0868)	(0.0773)			(0.0838)	(0.0941)
Hypothesis III – Economic determinants						
gdpg	0.0015	-0.2003***	-0.1985***	-0.2667***	-0.1509***	-0.1521***
	(0.0220)	(0.0221)	(0.0258)	(0.0229)	(0.0192)	(0.0199)
publicinv		0.7009***		0.6606***		
		(0.0462)		(0.0443)		
infl	-0.0524*	0.0745***	0.0549**	0.1467***	0.0014	0.0140
	(0.0296)	(0.0254)	(0.0253)	(0.0242)	(0.0360)	(0.0413)
fincrisis			-1.6036***	-1.7310***		
			(0.0819)	(0.0791)		
Hypothesis IV – Project determinants (control)						
largeproj	0.0943					
	(0.0900)					
educ	-0.0206	0.0101	0.0379	0.0114	0.0406	0.0431
	(0.0576)	(0.0644)	(0.0682)	(0.0643)	(0.0673)	(0.0675)
transp	0.0358	0.0084	0.0260	0.0162	0.0243	0.0254
	(0.0511)	(0.0590)	(0.0604)	(0.0581)	(0.0612)	(0.0613)
econf	-0.0257	-0.0708	-0.0689	-0.0641	-0.0727	-0.0702
	(0.0579)	(0.0657)	(0.0689)	(0.0650)	(0.0689)	(0.0689)
notcgov	-0.0327	0.0462	-0.0414	0.0437	-0.0317	-0.0311
	(0.0582)	(0.0615)	(0.0641)	(0.0623)	(0.0635)	(0.0633)
pescolar	0.3719*	0.5853***	0.6371***	0.5895***	0.6168***	0.6084***
	(0.1909)	(0.1731)	(0.1998)	(0.1917)	(0.1805)	(0.1799)
Constant	-1.9497***	-5.3078***	-2.4017***	-5.1228***	-2.0251***	-2.0951***
	(0.0965)	(0.2039)	(0.0876)	(0.1941)	(0.1263)	(0.1653)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	2,785	3,565	3,565	3,565	3,565	3,565

Table 30 –Probit Results – Cost deviations - final sample study

This table presents the results of a probit model regression, using the cost overruns as a dependent variable (i.e., 0 - if the project had a negative or zero cost deviation; 1 – if the project had a positive cost deviation). Panel A shows the coefficients, and Panel B the marginal effects. Logit models were calculated and yields similar results. For this reason, the results were omitted. For control purpose, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project) with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns	(4) Cost Overruns	(5) Cost Overruns	(6) Cost Overruns
			PANEL A – Coefficients			
			Hypothesis I – Political determinants			
govrw	-0.0044	1.3914***	-0.3339***	-1.3178***		
	(0.0971)	(0.2785)	(0.0785)	(0.1748)		
govmaj					-0.9471***	-1.0779***
					(0.0822)	(0.1347)
			Hypothesis II– Governance determinants			
deltarlaw		0.1437***		-0.1819***		0.0439**
		(0.0346)		(0.0224)		(0.0180)
deltacorrp	-0.0710**		-0.3350***			
	(0.0312)		(0.0294)			
law2008	-2.5994***	-2.6814***			-1.9925***	-2.1310***
	(0.1160)	(0.1799)			(0.1002)	(0.1539)
			Hypothesis III – Economic determinants			
gdpg	-0.1022***	-0.2859***	-0.4553***	-0.5933***	-0.1874***	-0.2074***
	(0.0394)	(0.0202)	(0.0358)	(0.0338)	(0.0151)	(0.0192)
publicinv		1.1459***		1.2989***		
		(0.0669)		(0.0631)		
infl	-0.0702***	-0.1676***	0.1038***	0.6453***	-0.1495***	-0.1847***
	(0.0257)	(0.0649)	(0.0226)	(0.0585)	(0.0275)	(0.0423)
fincrisis			-2.2668***	-2.1189***		
			(0.1128)	(0.0801)		
			Hypothesis IV – Project determinants (control)			
largeproj	0.0041					
	(0.1301)					
educ	0.0287	0.0792	0.1070*	0.0984	0.1152*	0.1129*
	(0.0712)	(0.0607)	(0.0608)	(0.0617)	(0.0600)	(0.0600)
transp	-0.5323***	-0.3264***	-0.3000***	-0.3132***	-0.2849***	-0.2832***
	(0.0687)	(0.0567)	(0.0537)	(0.0571)	(0.0535)	(0.0536)
econf	-0.2098***	-0.1814***	-0.1607***	-0.1879***	-0.1693***	-0.1732***
	(0.0792)	(0.0645)	(0.0614)	(0.0668)	(0.0606)	(0.0606)
notcgov	-0.0111	-0.0534	-0.1036*	-0.0268	-0.0952*	-0.1091**
	(0.0756)	(0.0588)	(0.0544)	(0.0596)	(0.0541)	(0.0539)
pescolar	0.2616	0.3210**	0.3308**	0.3234**	0.3247**	0.3258**
	(0.1861)	(0.1560)	(0.1588)	(0.1563)	(0.1567)	(0.1568)
Constant	1.9798***	-3.2521***	0.9275***	-5.0488***	1.7845***	2.0122***
	(0.1064)	(0.1940)	(0.0825)	(0.2843)	(0.1472)	(0.2376)

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns	(4) Cost Overruns	(5) Cost Overruns	(6) Cost Overruns
			PANEL B – Maginal Effects			
			Hypothesis I – Political determinants			
govrw	-0.00173	0.501***	-0.127***	-0.439***		
	(0.0383)	(0.0768)	(0.0287)	(0.0438)		
govmaj					-0.363***	-0.409***
					(0.0296)	(0.0469)
			Hypothesis II – Governance determinants			
deltarlaw		0.0567***		-0.0719***		0.0172**
		(0.0137)		(0.0089)		(0.0071)
deltacorrp	-0.0280**		-0.131***			
	(0.0123)		(0.0115)			
law2008	-0.758***	-0.816***			-0.672***	-0.704***
	(0.0185)	(0.0302)			(0.0244)	(0.0351)
			Hypothesis III – Economic determinants			
gdpg	-0.0402***	-0.113***	-0.178***	-0.235***	-0.0732***	-0.0810***
	(0.0155)	(0.0080)	(0.0141)	(0.0136)	(0.0059)	(0.0075)
publicinv		0.452***		0.514***		
		(0.0271)		(0.0256)		
infl	-0.0277***	-0.0661**	0.0405***	0.255***	-0.0584***	-0.0721***
	(0.0101)	(0.0257)	(0.0089)	(0.0234)	(0.0108)	(0.0166)
fincrisis			-0.741***	-0.710***		
			(0.0240)	(0.0183)		
			Hypothesis IV – Project determinants (control)			
largeproj	0.00162					
	(0.0512)					
educ	0.0113	0.0313	0.0420*	0.039	0.0453*	0.0443*
	(0.0279)	(0.0241)	(0.0240)	(0.0245)	(0.0237)	(0.0237)
transp	-0.210***	-0.126***	-0.115***	-0.122***	-0.109***	-0.108***
	(0.0266)	(0.0213)	(0.0200)	(0.0217)	(0.0200)	(0.0200)
econf	-0.0832***	-0.0706***	-0.0619***	-0.0734***	-0.0652***	-0.0666***
	(0.0315)	(0.0247)	(0.0233)	(0.0257)	(0.0229)	(0.0229)
notcgov	-0.00435	-0.0211	-0.0407*	-0.0106	-0.0374*	-0.0428**
	(0.0297)	(0.0233)	(0.0215)	(0.0236)	(0.0213)	(0.0213)
pescolar	0.0999	0.128**	0.131**	0.128**	0.129**	0.129**
	(0.0681)	(0.0614)	(0.0629)	(0.0613)	(0.0621)	(0.0621)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.3721	0.2209	0.1540	0.2488	0.1373	0.1389
Observations	3,486	4,266	4,266	4,266	4,266	4,266

Table 31 –IV Reg Results – Cost deviations - final sample study

This table presents the results of a IV OLS regression (Instrumented Variable OLS) to perform a single-equation instrumental-variables regression. The goal is to fit a linear model where three of the regressors are endogenously determined. The model instrumented variables are identified with the indication of (IV) after the variable name and these will be our endogenous variables. Instrument variables *elylag*, *ely* and *elylead* are the exogenous variables used with the remaining exogenous variables (*govrw*, *govmaj*, *law2008*, *gdpg*, *publicinv*, *infl*, *fincrisis*, *largeproj*, *edu*, *transp*, *econf*, *notcgov* and *pescolarar*). The goal is to test the indirect effect of election years (*elylag*, *ely* and *elylead*), together with the remaining exogenous variables on the endogenous variables. A two-stage least squares estimator is used.

Additional tests were made using the predicted residuals (not formally reported, but consistent with the findings) which consisted in running the previous OLS and probit regressions, and then taking the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %
Instrument variables:		*elylag / ely / elylead*	
Hypothesis I – Political determinants			
govrw	-0.0320	-0.1371***	
	(0.0256)	(0.0237)	
govmaj			-0.0289
			(0.0187)
Hypothesis II – Governance determinants			
deltarlaw (IV)	0.0001	-0.0059***	-0.0155***
	(0.0024)	(0.0021)	(0.0019)
deltacorrp (IV)	-0.0090**	-0.0103*	0.0236***
	(0.0045)	(0.0056)	(0.0076)
deltagoveff (IV)	-0.0062**	-0.0262***	0.0118***
	(0.0032)	(0.0043)	(0.0036)
law2008	-0.1465***		
	(0.0099)		
Hypothesis III – Economic determinants			
gdpg	-0.0144***	-0.0221***	0.0117***
	(0.0054)	(0.0053)	(0.0040)
publicinv	0.0140***	0.0436***	
	(0.0051)	(0.0076)	
infl	0.0018	0.0069*	0.0168***
	(0.0052)	(0.0042)	(0.0044)
fincrisis		-0.1357***	-0.0298**
		(0.0150)	(0.0144)

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %
Hypothesis IV – Project determinants (control)			
largeproj	-0.0096		
	(0.0091)		
educ	0.0050	0.0067*	0.0099***
	(0.0034)	(0.0035)	(0.0034)
transp	-0.0184***	-0.0148***	-0.0095***
	(0.0039)	(0.0038)	(0.0035)
econf	-0.0077*	-0.0085*	-0.0069*
	(0.0045)	(0.0044)	(0.0040)
notcgov	0.0097**	0.0064	0.0052
	(0.0041)	(0.0041)	(0.0039)
pescolar	0.0141	0.0047	0.0097
	(0.0103)	(0.0089)	(0.0090)
Constant	0.0793***	-0.0105	0.0363*
	(0.0199)	(0.0326)	(0.0187)
Wald Test	0.0000	0.0000	0.0000
Observations	3,486	4,266	4,266

Table 32 – IV Probit Results – Cost deviations - final sample study

This table presents the results of a IV Probit regression (Instrumented Variable Probit). The model instrumented variables that are identified with the indication of (IV) after the variable name and these will be our endogenous variables. The instrument *troika, ely* and *elylead* variables are the exogenous variables used with the remaining exogenous variables (*govrw, govmaj, law2008, gdpg, publicinv, infl, fincrisis, largeproj, edu, transp, econf, notcgov* and *pescolar*). The goal is to test the indirect effect of election years (*troika, ely* and *elylead*) together with the remaining exogenous variables on the endogenous variables. A Newey's two-step estimator is used.

Additional tests were made using the predicted residuals (not formally reported, but consistent with the findings) which consisted in running the previous OLS and probit regressions, and then taking the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost overruns	(2) Cost overruns	(3) Cost overruns
Instrument variables:	*troika / ely / elylead*		
Hypothesis I – Political determinants			
govrw	1.4372**	1.4020*	
	(0.7148)	(0.7229)	
govmaj			2.4876***
			(0.2526)
Hypothesis II – Governance determinants			
deltarlaw (IV)	1.8886**	0.8428***	-0.9054***
	(0.8328)	(0.2960)	(0.0647)
deltacorrp (IV)	-0.9343**	0.0160	-0.0839
	(0.3655)	(0.0626)	(0.0648)
deltaregulq (IV)	-2.0083**	-1.0066***	0.6938***
	(0.9022)	(0.2617)	(0.0635)
law2008	-4.1449***		
	(0.5576)		
Hypothesis III – Economic determinants			
gdpg	-1.2892***	-0.3276***	-0.0029
	(0.4975)	(0.0654)	(0.0438)
publicinv	3.3886**	2.4591***	
	(1.4646)	(0.4591)	
infl	0.1346	0.0484	0.5881***
	(0.1581)	(0.1308)	(0.0632)
fincrisis		-1.9309***	-0.8144***
		(0.1917)	(0.1139)

VARIABLES	(1) Cost overruns	(2) Cost overruns	(3) Cost overruns
	Hypothesis IV – Project determinants (control)		
largeproj	-0.6806**		
	(0.3419)		
educ	-0.1664	0.0986	0.0706
	(0.1357)	(0.0752)	(0.0667)
transp	-0.5971***	-0.2895***	-0.3439***
	(0.1041)	(0.0688)	(0.0615)
econf	-0.1968	-0.1567**	-0.1756**
	(0.1213)	(0.0789)	(0.0704)
notcgov	0.2354	-0.0123	-0.0713
	(0.1473)	(0.0672)	(0.0599)
pescolar	0.7442**	0.2692	0.2628
	(0.3504)	(0.1973)	(0.1728)
Constant	-13.0215**	-9.6192***	-1.6720***
	(6.5945)	(1.8539)	(0.2786)
Wald Test	0.0000	0.0000	0.0000
Observations	3,486	4,266	4,266

Table 33 – GLM Fractional response model Results – Cost deviations - final sample study

This table presents a GLM fractional response model using *cdevp* as dependent variable (only positive values – 3,565 observations, with 636 observations when using *largeproj* variable). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
Hypothesis I – Political determinants						
govrw	0.2899***	0.8269***	1.1222***	1.0774***		
	(0.1106)	(0.3133)	(0.0632)	(0.3142)		
govmaj					-0.7828***	-1.7053***
					(0.1774)	(0.3795)
Hypothesis II – Governance determinants						
deltarlaw		-0.1110***		-0.0370**		-0.1117***
		(0.0382)		(0.0155)		(0.0095)
deltacorrp	-0.0392		-0.0495			
	(0.0277)		(0.3740)			
law2008	-3.3866***	-9.1119***			-2.9987***	-1.2822***
	(3.1922)	(3.3317)			(0.9478)	(2.2096)
Hypothesis III – Economic determinants						
gdpg	0.0511**	0.3208***	0.2881	0.2220***	-0.0621***	0.0311
	(0.0242)	(0.1148)	(0.3448)	(0.0803)	(0.0176)	(0.0265)
publicinv		0.2544***		0.3996***		
		(0.0817)		(0.0621)		
infl	0.0128	0.0143	-0.0453	-0.0974*	0.1397***	0.0996**
	(0.0157)	(0.0384)	(0.1032)	(0.0559)	(0.0373)	(0.0446)
fincrisis			0.0818	-1.9224***		
			(1.4440)	(1.3216)		
Hypothesis IV – Project determinants (control)						
largeproj	0.0568					
	(0.0716)					
educ	0.0288	0.0035	-0.0640*	-0.0586	0.0650	-0.0145
	(0.0450)	(0.0444)	(0.0374)	(0.0614)	(0.0636)	(0.0264)
transp	0.0898**	0.0293	-0.0114	0.0552	0.0712	0.0018
	(0.0423)	(0.0361)	(0.0877)	(0.0580)	(0.0583)	(0.0193)
econf	0.0621	0.0359	0.0317	0.0386	0.0759	0.0170
	(0.0464)	(0.0375)	(0.0466)	(0.0513)	(0.0656)	(0.0211)
notcgov	0.2455***	0.2398***	0.0737	0.3454**	0.3916***	0.1323***
	(0.0474)	(0.0867)	(0.0873)	(0.1588)	(0.0673)	(0.0296)
pescolar	-0.0205	0.6776*	-0.4927	-0.2998	0.4650*	0.8502**
	(0.2311)	(0.3493)	(0.7722)	(0.4885)	(0.2622)	(0.3931)
Constant	-1.3966***	-3.8380***	-1.6952***	-4.0836***	-1.6910***	-1.5098***
	(0.0848)	(0.4501)	(0.3475)	(0.5333)	(0.1575)	(0.1448)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.09	0.07	0.06	0.07	0.05	0.06
Observations	2,785	3,565	3,565	3,565	3,565	3,565

Table 34 – Probit Fractional response model Results – Cost deviations - final sample study

This table presents a fractional response Probit model regression for the conditional mean, using the *cdevprob* dependent variable (values are 0 or 1). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns	(4) Cost Overruns
		Marginal effects		
		Hypothesis I – Political determinants		
govrw	-0.00173	0.501***	-0.127***	
	(0.0383)	(0.0768)	(0.0287)	
govmaj				-0.363***
				(0.0296)
		Hypothesis II – Governance determinants		
deltarlaw		0.0567***		
		(0.0137)		
deltacorrp	-0.0280**		-0.131***	
	(0.0123)		(0.0115)	
law2008	-0.758***	-0.816***		-0.672***
	(0.0185)	(0.0302)		(0.0244)
		Hypothesis III – Economic determinants		
gdpg	-0.0402***	-0.113***	-0.178***	-0.0732***
	(0.0155)	(0.00798)	(0.0141)	(0.00589)
publicinv		0.452***		
		(0.0271)		
infl	-0.0277***	-0.0661**	0.0405***	-0.0584***
	(0.0101)	(0.0257)	(0.00885)	(0.0108)
fincrisis			-0.741***	
			(0.0240)	
		Hypothesis IV – Project determinants (control)		
largeproj	0.00162			
	(0.0512)			
educ	0.0113	0.0313	0.0420*	0.0453*
	(0.0279)	(0.0241)	(0.0240)	(0.0237)
transp	-0.210***	-0.126***	-0.115***	-0.109***
	(0.0266)	(0.0213)	(0.0200)	(0.0200)
econf	-0.0832***	-0.0706***	-0.0619***	-0.0652***
	(0.0315)	(0.0247)	(0.0233)	(0.0229)
notcgov	-0.00435	-0.0211	-0.0407*	-0.0374*
	(0.0297)	(0.0233)	(0.0215)	(0.0213)
pescolar	0.0999	0.128**	0.131**	0.129**
	(0.0681)	(0.0614)	(0.0629)	(0.0621)
Wald Test	0.0000	0.0000	0.0000	0.0000
R^2	0.37	0.22	0.15	0.14
Observations	3,486	4,266	4,266	4,266

Table 35 – Descriptive Results – Cost deviations - transports sector final subsample study

This table presents the results of cost deviations for the variables described in Subsection 5.2, which comprises the study of the determinants for cost deviations using the transport sector final subsample of collected observations. This sample includes only the transport sector observations analysed in our research. The *pescolar* variable is not presented, as it is a variable linked to education projects and is consequently automatically dropped from a transport project subsample. The same happens to the *edu*, *econf* and *socialf* variables. A positive number in cost deviations represents a cost overrun, while a negative number represents a final cost below the initial forecasted budget cost. Source: Own table.

Subsample	Nº Obs (N=1,091)	Nº Obs with overruns (N=361) (=33%)	Cost deviation (%) – Mean (=2.2%)	St. Dev (=0.10)	Min (=-47%)	Max (=49%)	Cost deviation (%) – Mean (overruns subsample) (=12.41%)
Hypothesis I – Political determinants							
ely	496 (45%)	143 (40% of overruns project sample) (29% of *ely* sample)	0.7%	0.11	-47%	49%	12%
elylag	287 (26%)	99 (27% of overruns project sample) (34% of *elylag* sample)	2.0%	0.11	-37%	49%	12%
elylead	344 (32%)	116 (32% of overruns project sample) (34% of *elylead* sample)	2.0%	0.10	-37%	44%	12%
regely	312 (29%)	87 (24% of overruns project sample) (28% of *regely* sample)	2.6%	0.09	-47%	46%	14%
regelylag	314 (29%)	106 (29% of overruns project sample) (34% of *regelylag* sample)	2.0%	0.10	-37%	44%	11%
regelylead	115 (11%)	86 (24% of overruns project sample) (75% of *regelylead* sample)	8.8%	0.10	-13%	49%	12%
munely	366 (34%)	130 (36% of overruns project sample) (26% of *munely* sample)	1.4%	0.11	-45%	49%	12%

Subsample	Nº Obs (N=1,091)	Nº Obs with overruns (N=361) (=33%)	Cost deviation (%) – Mean (=2.2%)	St. Dev (=0.10)	Min (=-47%)	Max (=49%)	Cost deviation (%) – Mean (overruns subsample) (=12.41%)
munelylag	351 (32%)	101 (28% of overruns project sample) (29% of *munelylag* sample)	0.5%	0.11	-45%	45%	11%
munelylead	306 (28%)	100 (28% of overruns project sample) (33% of *munelylead* sample)	2.0%	0.10	-37%	46%	13%
govrw	244 (22%)	102 (28% of overruns project sample) (42% of *govrw* sample)	4.4%	0.12	-47%	49%	14%
govmaj	652 (60%)	218 (60% of overruns project sample) (33% of *govmaj* sample)	2.7%	0.11	-45%	49%	13%
Hypothesis II – Governance determinants							
law2008	616 (56%)	100 (28% of overruns project sample) (16% of *law2008* sample)	1.7%	0.09	-47%	45%	8%
Hypothesis III – Economic determinants							
fincrisis1	802 (74%)	141 (39% of overruns project sample) (18% of *fincrisis1* sample)	0.07%	0.09	-47%	46%	10%
troika	158 (14%)	20 (6% of overruns project sample) (13% of *troika* sample)	-1.2%	0.07	-47%	36%	7%
Hypothesis IV – Project determinants (control)							
largeproj	3 (0.3%)	3 (1% of overruns project sample) (100% of *largeproj* sample)	31.3%	0.18	13%	49%	31%
notcgov	822 (75%)	266 (74% of overruns project sample) (32% of *notcgov* sample)	23.2%	0.09	-45%	39%	12%

Table 36 – Parametric and Nonparametric tests - Cost deviations - transports sector final subsample study

This table presents the results of the two sample T-test (parametric test) and the Mann-Whitney test (nonparametric test). For both tests, we considered a p-value of 0.1 (* means variables is statistically significant). Since our data is not totally normal, we also decided to use the Mann-Whitney test that does assume any properties regarding the distribution of the dependent variable in the analysis. Nonparametric tests or distribution-free tests are tests that have the advantage of not requiring the assumption of normality or the assumption of homogeneity of variance. Nonparametric tests compare medians instead of means. This means that if the data has a small number of outliers, then their influence is negated. Likewise, the Mann-Whitney test is more powerful than the T-test while maintaining a preferred type I error rate (wrongly rejecting the null hypothesis). Source: Own table.

	T-test (reject Ho if p-value < 0.1)	**Mann-Whitney test (accept with statistical significance if p-value<0.1)**
ely	0.01*	0.00*
govrw	0.00*	0.00*
govmaj	0.11	0.02*
law2008	0.00*	0.00*
largeproj	0.00*	0.00*
notcgov	0.31	0.00*

Table 37 – GLM Results - Cost deviations - transports sector final subsample study

This table presents the results of a GLM regression. The results were similar to using an OLS regression. We were only able to collect data on large projects for 923 observations. Regarding regressions with year effects, and since a number of critical variables are not time dependent the applicable procedure was of removing from the GLM regression all independent variables where it is possible to record a different value in each registered observation year (e.g., *gdpg*). This way we will only use in these regressions, as independent variables, the already described dummy variables. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project) with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
Hypothesis I – Political determinants						
govrw	-0.0007	0.0005	-0.0185	-0.0474**		
	(0.0142)	(0.0201)	(0.0147)	(0.0187)		
govmaj					-0.0040	0.0196
					(0.0117)	(0.0140)
Hypothesis II – Governance determinants						
deltarlaw		-0.0029		-0.0086***		-0.0044**
		(0.0028)		(0.0025)		(0.0020)
deltacorrp	-0.0013		-0.0118***			
	(0.0032)		(0.0031)			
deltagoveff					0.0049***	
					(0.0011)	
law2008	-0.1265***	-0.1225***			-0.1297***	-0.1090***
	(0.0116)	(0.0104)			(0.0107)	(0.0131)
Hypothesis III – Economic determinants						
gdpg	-0.0042	-0.0161***	-0.0189***	-0.0221***	-0.0179***	-0.0154***
	(0.0044)	(0.0031)	(0.0046)	(0.0036)	(0.0022)	(0.0023)
publicinv		0.0446***		0.0468***	0.0375***	0.0495***
		(0.0056)		(0.0060)	(0.0069)	(0.0068)
infl	0.0069	0.0167***	0.0146***	0.0295***	0.0196***	0.0212***
	(0.0045)	(0.0063)	(0.0044)	(0.0063)	(0.0042)	(0.0046)
fincrisis			-0.1262***	-0.1207***		
			(0.0110)	(0.0081)		
Hypothesis IV – Project determinants (control)						
largeproj	0.0238					
	(0.0170)					
notcgov	0.0231**	0.0122	0.0099	0.0132*	0.0082	0.0127*
	(0.0091)	(0.0074)	(0.0076)	(0.0073)	(0.0072)	(0.0074)
Constant	0.0781***	-0.1312***	0.0609***	-0.1507***	-0.1029***	-0.1782***
	(0.0125)	(0.0267)	(0.0095)	(0.0293)	(0.0397)	(0.0437)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.3157	0.2636	0.2349	0.2882	0.2721	0.2661
Observations	923	1,091	1,091	1,091	1,091	1,091

Table 38 – Tobit Results - Cost deviations - transports sector final subsample study

This table presents the results of a Tobit regression, with censoring at the left side, at 0% (only projects with positive cost deviation, i.e., with cost overruns). We ran these regressions with time effects (using only the variables that do not change over time) and results were similar. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project). We also run, for control purpose a negative binomial regression with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
			Hypothesis I – Political determinants			
govrw	-0.0059	0.0086	-0.0306	-0.0668**		
	(0.0167)	(0.0245)	(0.0205)	(0.0285)		
govmaj					-0.0331**	0.0217
					(0.0162)	(0.0186)
			Hypothesis II – Governance determinants			
deltarlaw		-0.0017		-0.0106***		-0.0042*
		(0.0034)		(0.0037)		(0.0025)
deltacorrp	-0.0017		-0.0249***			
	(0.0047)		(0.0054)			
deltagoveff					0.0138***	
					(0.0024)	
law2008	-0.2318***	-0.2502***			-0.2790***	-0.2364***
	(0.0177)	(0.0173)			(0.0186)	(0.0187)
			Hypothesis III – Economic determinants			
gdpg	-0.0067	-0.0319***	-0.0384***	-0.0412***	-0.0356***	-0.0321***
	(0.0058)	(0.0050)	(0.0068)	(0.0056)	(0.0042)	(0.0042)
publicinv		0.0966***		0.0952***	0.0697***	0.1029***
		(0.0102)		(0.0100)	(0.0120)	(0.0122)
infl	0.0055	0.0201***	0.0191***	0.0377***	0.0241***	0.0259***
	(0.0055)	(0.0071)	(0.0058)	(0.0089)	(0.0053)	(0.0054)
fincrisis			-0.2640***	-0.2460***		
			(0.0200)	(0.0169)		
			Hypothesis IV – Project determinants (control)			
largeproj	0.0223					
	(0.0230)					
notcgov	0.0029	-0.0074	-0.0151	-0.0080	-0.0195	-0.0071
	(0.0166)	(0.0144)	(0.0148)	(0.0140)	(0.0141)	(0.0145)
Constant	0.0940***	-0.3615***	0.0496***	-0.3612***	-0.2274***	-0.4160***
	(0.0206)	(0.0465)	(0.0183)	(0.0479)	(0.0633)	(0.0673)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	923	1,091	1,091	1,091	1,091	1,091

Table 39 – Negative Binomial Results - Cost deviations - transports sector final subsample study

This table presents the results of a negative binomial regression. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
			Hypothesis I – Political determinants			
govrw	-0.0248	0.0333	-0.0538	-0.3380*		
	(0.1296)	(0.1761)	(0.1853)	(0.2021)		
govmaj					-0.1054	0.3011*
					(0.1430)	(0.1545)
			Hypothesis II – Governance determinants			
deltarlaw		0.0006		-0.0400		-0.0202
		(0.0236)		(0.0255)		(0.0189)
deltacorrp	-0.0288		-0.0863**			
	(0.0448)		(0.0532)			
deltagoveff					0.0912***	
					(0.0208)	
law2008	-1.6682***	-1.6575***			-1.9080***	-1.6506***
	(0.1658)	(0.1525)			(0.1743)	(0.1606)
			Hypothesis III – Economic determinants			
gdpg	-0.0130	-0.1667***	-0.2060***	-0.2442***	-0.2002***	-0.1739***
	(0.0410)	(0.0473)	(0.0507)	(0.0507)	(0.0399)	(0.0373)
publicinv		0.5980***		0.5855***	0.4844***	0.7357***
		(0.0899)		(0.0861)	(0.1134)	(0.1244)
infl	0.0408	0.0910***	0.1058***	0.1279***	0.0976***	0.1009***
	(0.0296)	(0.0296)	(0.0308)	(0.0323)	(0.0259)	(0.0204)
fincrisis			-1.7358***	-1.8658***		
			(0.1649)	(0.1634)		
			Hypothesis IV – Project determinants (control)			
largeproj	0.0981					
	(0.1797)					
notcgov	-0.3530**	-0.2599*	-0.3393**	-0.2795**	-0.3890***	-0.2633*
	(0.1675)	(0.1422)	(0.1413)	(0.1399)	(0.1379)	(0.1417)
Constant	-1.8424***	-4.7402***	-2.2246***	-4.5224***	-4.1041***	-5.5027***
	(0.1917)	(0.4172)	(0.1691)	(0.4031)	(0.5470)	(0.6112)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	636	804	804	804	804	804

Table 40 –Probit Results - Cost deviations - transports sector final subsample study

This table presents the results of a probit model regression, using the cost overruns as a dependent variable (i.e., 0 - if the project had a negative or zero cost deviation; 1 – if the project had a positive cost deviation). Panel A shows the coefficients, and Panel B the marginal effects. Logit models were calculated and yields similar results. For this reason, results were omitted. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project) with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns	(4) Cost Overruns	(5) Cost Overruns	(6) Cost Overruns
			PANEL A – Coefficients			
			Hypothesis I – Political determinants			
govrw	0.0760	0.8467**	-0.2231	-1.4996***		
	(0.1697)	(0.4053)	(0.1636)	(0.3417)		
govmaj					-0.5234***	-0.3343
					(0.1608)	(0.2464)
			Hypothesis II– Governance determinants			
deltarlaw		0.0638		-0.2228***		-0.0014
		(0.0551)		(0.0462)		(0.0326)
deltacorrp	-0.0825		-0.2868***			
	(0.0551)		(0.0549)			
deltagoveff					0.1265***	
					(0.0214)	
law2008	-2.3932***	-2.3839***			-2.5349***	-2.3375***
	(0.2108)	(0.2758)			(0.1852)	(0.2774)
			Hypothesis III – Economic determinants			
gdpg	-0.0997	-0.2591***	-0.3797***	-0.5871***	-0.3618***	-0.3409***
	(0.0679)	(0.0371)	(0.0668)	(0.0676)	(0.0364)	(0.0458)
publicinv		0.9795***		1.2751***	0.6784***	0.8969***
		(0.1083)		(0.1205)	(0.1030)	(0.0979)
infl	-0.0247	-0.0096	0.1184***	0.7384***	0.1989***	0.1302**
	(0.0437)	(0.0945)	(0.0443)	(0.1143)	(0.0565)	(0.0603)
fincrisis			-2.2161***	-2.1668***		
			(0.2179)	(0.1585)		
			Hypothesis IV – Project determinants (control)			
largeproj	0.1646					
	(0.2049)					
notcgov	0.2219	0.0033	-0.0205	-0.0324	-0.0869	-0.0078
	(0.1465)	(0.1119)	(0.1047)	(0.1106)	(0.1056)	(0.1101)
Constant	1.0386***	-3.2953***	0.5094***	-5.3504***	-1.9648***	-2.8724***
	(0.1868)	(0.3457)	(0.1536)	(0.5483)	(0.5589)	(0.6372)

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns	(4) Cost Overruns	(5) Cost Overruns	(6) Cost Overruns
			PANEL B – Marginal Effecta			
			Hypothesis I – Political determinants			
govrw	0.0291	0.320**	-0.0762	-0.410***		
	(0.0653)	(0.1530)	(0.0540)	(0.0643)		
govmaj					-0.189***	-0.121
					(0.0580)	(0.0902)
			Hypothesis II – Governance determinants			
deltarlaw		0.0229		-0.0815***		-0.0005
		(0.0199)		(0.0171)		(0.0116)
deltacorrp	-0.0314		-0.101***			
	(0.0210)		(0.0196)			
deltagoveff					0.0450***	
					(0.0075)	
law2008	-0.766***	-0.745***			-0.773***	-0.734***
	(0.0395)	(0.0597)			(0.0357)	(0.0615)
			Hypothesis III – Economic determinants			
gdpg	-0.038	-0.0929***	-0.134***	-0.215***	-0.129***	-0.122***
	(0.0259)	(0.0136)	(0.0239)	(0.0260)	(0.0135)	(0.0171)
publicinv		0.351***		0.466***	0.241***	0.321***
		(0.0410)		(0.0472)	(0.0375)	(0.0353)
infl	-0.00943	-0.00343	0.0418***	0.270***	0.0707***	0.0465**
	(0.0167)	(0.0339)	(0.0157)	(0.0433)	(0.0203)	(0.0214)
fincrisis			-0.717***	-0.713***		
			(0.0502)	(0.0374)		
			Hypothesis IV – Project determinants (control)			
largeproj	0.0639					
	(0.0805)					
notcgov	0.0829	0.00119	-0.00728	-0.0119	-0.0312	-0.00278
	(0.0532)	(0.0401)	(0.0372)	(0.0407)	(0.0383)	(0.0394)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.3551	0.2473	0.1906	0.2831	0.2697	0.2440
Observations	923	1,091	1,091	1,091	1,091	1,091

Table 41 – IV Reg Results - Cost deviations - transports sector final subsample study

This table presents the results of an IV OLS regression (Instrumented Variable OLS) to perform a single-equation instrumental-variables regression. The goal is to fit a linear model where three of the regressors that are endogenously determined. The model instrumented variables are identified with the indication of (IV) after the variable name and will be our endogenous variables. Instrument variables *elylag*, *ely* and *elylead* are the exogenous variables used with the remaining exogenous variables (*govrw*, *govmaj*, *law2008*, *gdpg*, *publicinv*, *infl*, *fincrisis, largeproj and notcgov*). The goal is to test the indirect effect of election years (*elylag*, *ely* and *elylead*), together with the remaining exogenous variables on the endogenous variables. A two-stage least squares estimator is used.

Additional tests were made using the predicted residuals (not formally reported, but consistent with the findings) which consisted in running the previous OLS and probit regressions, and then taking the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %
Instrument variables:		elylag / ely / elylead	
	Hypothesis I – Political determinants		
govrw	-0.0780	-0.1988***	
	(0.0554)	(0.0541)	
govmaj			0.1507***
			(0.0385)
	Hypothesis II – Governance determinants		
deltarlaw (IV)	0.0001	-0.0082*	-0.0007
	(0.0055)	(0.0046)	(0.0045)
deltacorrp (IV)	-0.0181*	-0.0251**	-0.0403**
	(0.0097)	(0.0127)	(0.0164)
deltagoveff (IV)	-0.0109*	-0.0307***	-0.0257***
	(0.0064)	(0.0086)	(0.0080)
law2008	-0.1633***		
	(0.0207)		
	Hypothesis III – Economic determinants		
gdpg	-0.0267**	-0.0336***	-0.0212**
	(0.0115)	(0.0122)	(0.0088)
publicinv	0.0183*	0.0244*	0.0389***
	(0.0094)	(0.0134)	(0.0130)
infl	0.0148	0.0192**	0.0073
	(0.0103)	(0.0085)	(0.0071)
fincrisis		-0.1641***	-0.1463***
		(0.0308)	(0.0293)

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %
Hypothesis IV – Project determinants (control)			
largeproj	0.0198		
	(0.0186)		
notcgov	0.0289***	0.0100	0.0161*
	(0.0101)	(0.0088)	(0.0089)
Constant	0.0236	0.0582	-0.1374**
	(0.0425)	(0.0687)	(0.0611)
Wald Test	0.0000	0.0000	0.0000
Observations	923	1,091	1,091

Table 42 – IV Probit Results - Cost deviations - transports sector final subsample study

This table presents the results of a IV Probit regression (Instrumented Variable Probit). The model instrumented variables are identified with the indication of (IV) after the variable name and will be our endogenous variables. Instrument variables *troika, ely* and *elylead* are the exogenous variables used with the remaining exogenous variables (*govrw, govmaj, law2008, gdpg, publicinv, infl, fincrisis, largeproj and notcgov*). The goal is to test the indirect effect of election years (*troika, ely and elylead*), together with the remaining exogenous variables on the endogenous variables. A Newey's two-step estimator is used. Additional tests were made using the predicted residuals (not formally reported, but consistent with the findings) which consisted in running the previous OLS and probit regressions, and then taking the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns
Instrument variables:	*troika / ely / elylead*		
Hypothesis I – Political determinants			
govrw	1.9806	1.4336	
	(2.8447)	(3.2162)	
govmaj			2.7613***
			(1.0653)
Hypothesis II – Governance determinants			
deltarlaw (IV)	4.2038	1.3424	-1.0613*
	(3.3591)	(1.5682)	(0.5501)
deltacorrp (IV)	-2.0208	-0.3206	-0.2537**
	(1.3621)	(0.2401)	(0.1288)
deltaregulq (IV)	-4.6833	-1.5591	0.7739
	(3.5985)	(1.3717)	(0.5749)
law2008	-4.9731***		
	(1.7627)		
Hypothesis III – Economic determinants			
gdpg	-2.8721	-0.6433**	0.0200
	(1.8470)	(0.2824)	(0.1989)
publicinv	7.8467	3.0113	-0.5097
	(5.8083)	(2.2976)	(0.7899)
infl	0.8795*	0.1826	0.6098***
	(0.4868)	(0.5220)	(0.1519)
fincrisis		-2.6590***	-1.1181**
		(0.8523)	(0.4704)
Hypothesis IV – Project determinants (control)			
largeproj	0.3896		
	(0.6653)		
notcgov	1.2553	-0.1238	-0.0498
	(0.8996)	(0.1511)	(0.1195)
Constant	-35.3155	-12.2188	0.0330
	(26.7323)	(9.3270)	(2.5781)
Wald Test	0.0000	0.0000	0.0000
Observations	923	1,091	1,091

Table 43 – GLM Fractional response model Results - Cost deviations - transports sector final subsample study

This table presents a GLM fractional response model regression using *cdevp* as the dependent variable (only positive values – 804 observations, with 636 observations when using *largeproj* variable). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
			Hypothesis I – Political determinants			
govrw	0.0610	-0.2605	-0.5840***	-0.5012***		
	(0.1511)	(0.1721)	(0.1681)	(0.1175)		
govmaj					0.3685	0.4975***
					(0.3555)	(0.1713)
			Hypothesis II – Governance determinants			
deltarlaw		0.1571***		0.0661		-0.1335***
		(0.0421)		(0.0487)		(0.0184)
deltacorrp	-0.0325		-0.0525**			
	(0.0361)		(0.0263)			
deltagoveff					0.0392**	
					(0.0190)	
law2008	-4.6682***	-5.6022***			-5.5072***	-5.0306***
	(0.1742)	(0.9184)			(0.9463)	(0.6069)
			Hypothesis III – Economic determinants			
gdpg	-0.0316	-0.1529**	-0.1266***	-0.1617***	-0.2009*	-0.2722***
	(0.0361)	(0.0624)	(0.0400)	(0.0423)	(0.1046)	(0.0356)
publicinv		0.2192		0.2344*	0.5833***	0.7098***
		(0.1961)		(0.1222)	(0.2212)	(0.1177)
infl	-0.0505	0.0405	0.1119***	0.1291**	0.2469***	0.0815
	(0.0323)	(0.0575)	(0.0369)	(0.0565)	(0.0671)	(0.0660)
fincrisis			-5.2955***	-5.0927***		
			(0.1256)	(0.5718)		
			Hypothesis IV – Project determinants (control)			
largeproj	0.6447**					
	(0.3124)					
notcgov	0.2893***	0.2530***	0.2959***	0.2845***	0.3288***	0.2484***
	(0.0998)	(0.0955)	(0.0846)	(0.0898)	(0.0898)	(0.0790)
Constant	-1.1374***	-3.1702***	-1.8484***	-3.7315***	53.8556	-13.3414**
	(0.1784)	(0.8161)	(0.1803)	(0.9303)	(53.9369)	(6.3639)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.12	0.10	0.09	0.09	0.09	0.08
Observations	636	804	804	804	804	804

Table 44 – Probit Fractional response model Results - Cost deviations - transports sector final subsample study

This table presents a fractional response model Probit regression. For the conditional mean using *cdevprob* as the dependent variable (values are 0 or 1). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns	(4) Cost Overruns
		Marginal effects		
		Hypothesis I – Political determinants		
govrw	0.0291	0.320**	-0.0762	
	(0.0653)	(0.153)	(0.0540)	
govmaj				-0.189***
				(0.0580)
		Hypothesis II – Governance determinants		
deltarlaw		0.0229		
		(0.0199)		
deltacorrp	-0.0314		-0.101***	
	(0.0210)		(0.0196)	
deltagoveff				0.0450***
				(0.00753)
law2008	-0.766***	-0.745***		-0.773***
	(0.0395)	(0.0597)		(0.0357)
		Hypothesis III – Economic determinants		
gdpg	-0.0380	-0.0929***	-0.134***	-0.129***
	(0.0259)	(0.0136)	(0.0239)	(0.0135)
publicinv		0.351***		0.241***
		(0.0410)		(0.0375)
infl	-0.00943	-0.00343	0.0418***	0.0707***
	(0.0167)	(0.0339)	(0.0157)	(0.0203)
fincrisis			-0.717***	
			(0.0502)	
		Hypothesis IV – Project determinants (control)		
largeproj	0.0639			
	(0.0805)			
notcgov	0.0829	0.00119	-0.00728	-0.0312
	(0.0532)	(0.0401)	(0.0372)	(0.0383)
Wald Test	0.0000	0.0000	0.0000	0.0000
R^2	0.35	0.24	0.19	0.27
Observations	923	1,091	1,091	1,091

Table 45 – Descriptive Results - Cost deviations – local government projects final subsample study

This table presents the results of cost deviations for the variables described in Subsection 5.3, which comprises the study of the determinants for cost deviations using the local government projects final subsample of collected observations. This sample includes only the local government projects observations analysed in our research. The *pescolar* variable is not presented, as this investment programme was managed at a central government level. A positive number in cost deviations represents a cost overrun, while a negative number represents a final cost below the initial forecasted budget cost. Source: Own table.

Subsample	Nº Obs (N=3,338)	Nº Obs with overruns (N=1,365) (=41%)	Cost deviation (%) – Mean (=3.7%)	St. Dev (=0.09)	Min (=-45%)	Max (=48%)	Cost deviation (%) – Mean (overruns subsample) (=11.2%)
Hypothesis I – Political determinants							
ely	1,510 (45%)	629 (46% of overruns project sample) (42% of *ely* sample)	3.1%	0.09	-45%	47%	10%
elylag	795 (24%)	307 (22% of overruns project sample) (39% of *elylag* sample)	3.5%	0.09	-39%	48%	12%
elylead	1,105 (33%)	422 (31% of overruns project sample) (38% of *elylead* sample)	3.2%	0.08	-39%	48%	10%
regely	954 (29%)	331 (24% of overruns project sample) (35% of *regely* sample)	3.5%	0.08	-25%	48%	12%
regelylag	1,107 (33%)	396 (29% of overruns project sample) (36% of *regelylag* sample)	3.4%	0.08	-39%	47%	11%
regelylead	445 (13%)	359 (26% of overruns project sample) (81% of *regelylead* sample)	10%	0.09	-17%	47%	12%
munely	1,117 (33%)	565 (41% of overruns project sample) (51% of *munely* sample)	4.4%	0.10	-45%	47%	11%
munelylag	1,014 (30%)	401 (29% of overruns project sample)	3.0%	0.09	-45%	48%	11%

Subsample	Nº Obs (N=3,338)	Nº Obs with overruns (N=1,365) (=41%)	Cost deviation (%) – Mean (=3.7%)	St. Dev (=0.09)	Min (=-45%)	Max (=48%)	Cost deviation (%) – Mean (overruns subsample) (=11.2%)
		(40% of *munelylag* sample)					
munelylead	968 (29%)	359 (26% of overruns project sample) (37% of *munelylead* sample)	3.0%	0.08	-39%	48%	10%
govrw	705 (21%)	301 (22% of overruns project sample) (43% of *govrw* sample)	4.3%	0.09	-25%	48%	12%
govmaj	2,116 (63%)	922 (68% of overruns project sample) (44% of *govmaj* sample)	4.2%	0.09	-45%	48%	11%
Hypothesis II – Governance determinants							
law2008	1,711 (51%)	398 (29% of overruns project sample) (23% of *law2008* sample)	0.09%	0.07	-45%	35%	7%
Hypothesis III – Economic determinants							
fincrisis1	2,259 (68%)	538 (39% of overruns project sample) (24% of *fincrisis1* sample)	0.76%	0.07	-45%	39%	8%
troika	478 (14%)	78 (6% of overruns project sample) (16% of *troika* sample)	0.44%	0.05	-25%	28%	6%
Hypothesis IV – Project determinants (control)							
largeproj	5 (0.3%)	5 (1% of overruns project sample) (100% of *largeproj* sample)	11.9%	0.03	8%	16%	12%
edu	606 (18%)	235 (17% of overrun project sample) (39% of *edu* sample)	3.2%	0.07	-20%	47%	10%
transp	822 (25%)	266 (19% of overruns project sample) (32% of *transp* sample)	2.3%	0.09	-45%	39%	12%
econf	585 (18%)	232 (17% of overruns project sample) (40% of *econf* sample)	3.4%	0.09	-39%	47%	11%

Subsample	Nº Obs (N=3,338)	Nº Obs with overruns (N=1,365) (=41%)	Cost deviation (%) – Mean (=3.7%)	St. Dev (=0.09)	Min (=-45%)	Max (=48%)	Cost deviation (%) – Mean (overruns subsample) (=11.2%)
socialf	1,325 (40%)	632 (46% of of overruns project sample) (48% of *socialf* sample)	4.9%	0.09	-31%	48%	12%

Table 46 – Parametric and Nonparametric tests - Cost deviations – local government projects final subsample study

This table presents the results of the two sample T-test (parametric test) and the Mann-Whitney test (nonparametric test). For both tests, we considered a p-value of 0.1 (* means variables is statistically significant). As our data is not totally normal, we also decided to use the Mann-Whitney test that does assume any properties regarding the distribution of the dependent variable in the analysis. Nonparametric tests or distribution-free tests are tests that have the advantage of not requiring the assumption of normality or the assumption of homogeneity of variance. Nonparametric tests compare medians instead of means. Accordingly, if the data has a small number of outliers, then their influence is negated. Likewise, the Mann-Whitney test is more powerful than the T-test while maintaining a preferred type I error rate (wrongly rejecting the null hypothesis). Source: Own table.

	T-test (reject Ho if p-value < 0.1)	**Mann-Whitney test (accept with statistical significance if p-value<0.1)**
ely	0.01*	0.00*
munely	0.01*	0.00*
regely	0.48	0.04*
govrw	0.10*	0.87
govmaj	0.01*	0.00*
law2008	0.00*	0.00*
largeproj	0.01*	0.37
edu	0.11	0.03*
transp	0.00*	0.00*
econf	0.46	0.91
socialf	0.00*	0.00*

Table 47 – GLM Results - Cost deviations – local government projects final subsample study

This table presents the results of a GLM regression. Results were similar to using an OLS regression. We were only able to collect data on large projects for 2,714 observations. Regarding regressions with year effects, and as a number of critical variables are not time dependent, the applicable procedure was of removing from the GLM regression all independent variables where is possible to record a different value in each registered observation year (e.g., *gdpg*). This way we only use in these regressions, the already described dummy variables as independent variables. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project), with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
Hypothesis I – Political determinants						
govrw	0.0196***	0.0311**	-0.0041	-0.0750***		
	(0.0065)	(0.0125)	(0.0071)	(0.0084)		
govmaj					-0.0379***	-0.0207**
					(0.0059)	(0.0086)
Hypothesis II – Governance determinants						
deltarlaw		0.0006		-0.0125***		-0.0011
		(0.0017)		(0.0012)		(0.0011)
deltacorrp	-0.0011		-0.0128***			
	(0.0015)		(0.0015)			
deltagoveff					0.0042***	
					(0.0005)	
law2008	-0.1357***	-0.1317***			-0.1471***	-0.1373***
	(0.0053)	(0.0056)			(0.0056)	(0.0077)
Hypothesis III – Economic determinants						
gdpg	-0.0003	-0.0136***	-0.0174***	-0.0269***	-0.0178***	-0.0172***
	(0.0020)	(0.0017)	(0.0022)	(0.0016)	(0.0011)	(0.0011)
publicinv		0.0474***		0.0558***	0.0310***	0.0428***
		(0.0028)		(0.0029)	(0.0033)	(0.0036)
infl	-0.0070***	0.0021	0.0035*	0.0351***	0.0043**	0.0050*
	(0.0019)	(0.0039)	(0.0020)	(0.0028)	(0.0020)	(0.0028)
fincrisis			-0.1265***	-0.1126***		
			(0.0054)	(0.0039)		
Hypothesis IV – Project determinants (control)						
largeproj	0.0006					
	(0.0105)					
Constant	0.1371***	-0.0965***	0.0961***	-0.1751***	-0.0020	-0.0616**
	(0.0042)	(0.0143)	(0.0039)	(0.0137)	(0.0190)	(0.0253)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.3855	0.2757	0.2426	0.2749	0.2856	0.2752
Observations	2,714	3,338	3,338	3,338	3,338	3,338

Table 48 – Tobit Results - Cost deviations – local government projects final subsample study

This table presents the results of a Tobit regression, with censoring at the left side, at 0% (only projects with positive cost deviation, i.e., with cost overruns). We ran these regressions with time effects (using only those variables that do not change over time) and results were similar. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project). We also run, for control purpose a negative binomial regression with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
Hypothesis I – Political determinants						
govrw	0.0190***	0.0370**	-0.0154	-0.1172***		
	(0.0071)	(0.0171)	(0.0095)	(0.0150)		
govmaj					-0.0562***	-0.0063
					(0.0082)	(0.0131)
Hypothesis II – Governance determinants						
deltarlaw		0.0017		-0.0175***		-0.0020
		(0.0023)		(0.0020)		(0.0016)
deltacorrp	0.0004		-0.0247***			
	(0.0021)		(0.0027)			
deltagoveff					0.0098***	
					(0.0011)	
law2008	-0.2111***	-0.2368***			-0.2587***	-0.2306***
	(0.0080)	(0.0091)			(0.0092)	(0.0120)
Hypothesis III – Economic determinants						
gdpg	0.0005	-0.0269***	-0.0359***	-0.0468***	-0.0318***	-0.0309***
	(0.0026)	(0.0027)	(0.0033)	(0.0027)	(0.0019)	(0.0019)
publicinv		0.0910***		0.0992***	0.0585***	0.0910***
		(0.0049)		(0.0047)	(0.0060)	(0.0064)
infl	-0.0142***	0.0019	0.0023	0.0496***	0.0054*	0.0109**
	(0.0024)	(0.0057)	(0.0030)	(0.0050)	(0.0031)	(0.0047)
fincrisis			-0.2474***	-0.2076***		
			(0.0102)	(0.0074)		
Hypothesis IV – Project determinants (control)						
largeproj	-0.0000					
	(0.0146)					
Constant	0.1561***	-0.2838***	0.0940***	-0.3792***	-0.1181***	-0.2926***
	(0.0059)	(0.0242)	(0.0073)	(0.0235)	(0.0322)	(0.0427)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	2,714	3,338	3,338	3,338	3,338	3,338

Table 49 – Negative Binomial Results - Cost deviations – local government projects final subsample study

This table presents the results of a negative binomial regression. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
Hypothesis I – Political determinants						
govrw	0.0911	-0.0678	0.0496	-0.9006***		
	(0.0694)	(0.1016)	(0.0965)	(0.1248)		
govmaj					-0.5340***	0.2445***
					(0.0755)	(0.0932)
Hypothesis II – Governance determinants						
deltarlaw		-0.0201		-0.1282***		-0.0344***
		(0.0142)		(0.0171)		(0.0115)
deltacorrp	0.0133		-0.1011***			
	(0.0255)		(0.0294)			
deltagoveff					0.1129***	
					(0.0129)	
law2008	-2.0730***	-1.9810***			-2.4320***	-1.8558***
	(0.1108)	(0.1115)			(0.1336)	(0.1207)
Hypothesis III – Economic determinants						
gdpg	-0.0126	-0.2075***	-0.2347***	-0.3655***	-0.2252***	-0.2032***
	(0.0214)	(0.0282)	(0.0261)	(0.0322)	(0.0215)	(0.0223)
publicinv		0.7450***		0.7175***	0.3919***	0.8362***
		(0.0527)		(0.0496)	(0.0633)	(0.0681)
infl	-0.1653***	0.0297	-0.0202	0.2943***	-0.0733*	0.0814
	(0.0316)	(0.0510)	(0.0326)	(0.0502)	(0.0422)	(0.0504)
fincrisis			-1.9835***	-1.9118***		
			(0.0978)	(0.1037)		
Hypothesis IV – Project determinants (control)						
largeproj	-0.0349					
	(0.1421)					
Constant	-1.6217***	-5.2844***	-2.1755***	-5.4906***	-3.3004***	-5.9767***
	(0.0939)	(0.2304)	(0.0824)	(0.2198)	(0.3314)	(0.3743)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	2,202	2,826	2,826	2,826	2,826	2,826

Table 50 –Probit Results - Cost deviations – local government projects final subsample study

This table presents the results of a probit model regression, using the cost overruns as a dependent variable (i.e., 0 - if the project had a negative or zero cost deviation; 1 – if the project had a positive cost deviation). Panel A shows the coefficients, and Panel B the marginal effects. Logit models were calculated and yields similar results. For that reason, results were omitted. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the loginitialcost (log of the initial cost of each project) with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns	(4) Cost Overruns	(5) Cost Overruns	(6) Cost Overruns
PANEL A – Coefficients						
Hypothesis I – Political determinants						
govrw	0.4191**	3.3483***	-0.3335***	-1.5839***		
	(0.1870)	(0.8643)	(0.0907)	(0.1996)		
govmaj					-0.4976***	-0.9990***
					(0.0960)	(0.3242)
Hypothesis II– Governance determinants						
deltarlaw		0.3704***		-0.2408***		0.0826**
		(0.0990)		(0.0280)		(0.0348)
deltacorrp	0.0028		-0.3507***			
	(0.0399)		(0.0347)			
deltagoveff					0.1022***	
					(0.0114)	
law2008	-2.8443***	-3.7516***			-2.5538***	-3.0970***
	(0.1520)	(0.4721)			(0.1058)	(0.3287)
Hypothesis III – Economic determinants						
gdpg	0.0396	-0.1689***	-0.4736***	-0.6710***	-0.3927***	-0.4327***
	(0.0553)	(0.0415)	(0.0420)	(0.0399)	(0.0212)	(0.0356)
publicinv		1.2864***		1.5148***	0.8130***	0.9137***
		(0.1089)		(0.0785)	(0.0642)	(0.0695)
infl	-0.2006***	-0.7132***	0.0849***	0.7738***	0.1643***	-0.0823
	(0.0514)	(0.2250)	(0.0286)	(0.0661)	(0.0352)	(0.0906)
fincrisis			-2.4779***	-2.4617***		
			(0.1336)	(0.1068)		
Hypothesis IV – Project determinants (control)						
largeproj	0.1883					
	(0.2607)					
Constant	2.2434***	-2.7537***	0.8884***	-5.9808***	-2.2858***	-1.5346**
	(0.1231)	(0.2589)	(0.0770)	(0.3377)	(0.3436)	(0.7310)

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns	(4) Cost Overruns	(5) Cost Overruns	(6) Cost Overruns
			PANEL B – Marginal Effects			
			Hypothesis I – Political determinants			
govrw	0.158**	0.798***	-0.125***	-0.496***		
	(0.0673)	(0.0562)	(0.0327)	(0.0420)		
govmaj					-0.195***	-0.382***
					(0.0371)	(0.1150)
			Hypothesis II – Governance determinants			
deltarlaw		0.146***		-0.0952***		0.0323**
		(0.0396)		(0.0112)		(0.0137)
deltacorrp	0.00107		-0.136***			
	(0.0156)		(0.0135)			
deltagoveff					0.0399***	
					(0.0044)	
law2008	-0.778***	-0.938***			-0.791***	-0.874***
	(0.0200)	(0.0337)			(0.0190)	(0.0410)
			Hypothesis III – Economic determinants			
gdpg	0.0155	-0.0666***	-0.183***	-0.265***	-0.153***	-0.169***
	(0.0216)	(0.0162)	(0.0163)	(0.0161)	(0.0084)	(0.0142)
publicinv		0.508***		0.599***	0.317***	0.358***
		(0.0448)		(0.0320)	(0.0253)	(0.0271)
infl	-0.0784***	-0.281***	0.0329***	0.306***	0.0641***	-0.0322
	(0.0200)	(0.0899)	(0.0111)	(0.0265)	(0.0138)	(0.0355)
fincrisis			-0.782***	-0.782***		
			(0.0251)	(0.0199)		
			Hypothesis IV – Project determinants (control)			
largeproj	0.0718					
	(0.0964)					
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.4316	0.2395	0.1697	0.2745	0.2356	0.2214
Observations	2,714	3,338	3,338	3,338	3,338	3,338

Table 51 – IV Reg Results - Cost deviations – local government projects final subsample study

This table presents the results of a IV OLS regression (Instrumented Variable OLS) to perform a single-equation instrumental-variables regression. The goal is to fit a linear model where three of the regressors are endogenously determined. The model instrumented variables are identified with the indication of (IV) after the variable name and will be our endogenous variables. The *elylag*, *ely* and *elylead* instrument variables are the exogenous variables used with the remaining exogenous variables (*govrw*, *govmaj*, *law2008*, *gdpg*, *publicinv*, *infl*, *fincrisis* and *largeproj*). The goal is to test the indirect effect of election years (*elylag*, *ely* and *elylead*), together with the remaining exogenous variables on the endogenous variables. A two-stage least squares estimator is used.

Additional tests were carrie out using the predicted residuals (not formally reported, but consistent with the findings) which consisted in running the previous OLS and probit regressions, and then taking the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %
Instrument variables:		munelylag / munely / munelylead	
		Hypothesis I – Political determinants	
govrw	-0.0098	-0.0829***	
	(0.0263)	(0.0141)	
govmaj			-0.0596***
			(0.0222)
		Hypothesis II – Governance determinants	
deltarlaw (IV)	-0.0050*	-0.0187***	-0.0081***
	(0.0030)	(0.0017)	(0.0017)
deltacorrp (IV)	-0.0007	0.0173***	0.0505***
	(0.0031)	(0.0032)	(0.0086)
deltagoveff (IV)	0.0016	-0.0024*	-0.0024
	(0.0012)	(0.0014)	(0.0017)
law2008	-0.1292***		
	(0.0079)		
		Hypothesis III – Economic determinants	
gdpg	-0.0062	-0.0067**	0.0206***
	(0.0043)	(0.0029)	(0.0046)
publicinv	0.0095*	0.0563***	0.0761***
	(0.0050)	(0.0061)	(0.0089)
infl	0.0064	0.0343***	0.0026
	(0.0068)	(0.0039)	(0.0058)
fincrisis		-0.0550***	-0.0300***
		(0.0069)	(0.0075)

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %
Hypothesis IV – Project determinants (control)			
largeproj	-0.0012		
	(0.0106)		
Constant	0.0731***	-0.1899***	-0.1950***
	(0.0255)	(0.0273)	(0.0291)
Wald Test	0.0000	0.0000	0.0000
Observations	2,714	3,338	3,338

Table 52 – IV Probit Results - Cost deviations – local government projects final subsample study

This table presents the results of a IV Probit regression (Instrumented Variable Probit). The model instrumented variables are identified with the indication of (IV) after the variable name and are our endogenous variables. The *troika, munely* and *munelylead* instrument variables are the exogenous variables used with the remaining exogenous variables (*govrw, govmaj, law2008, gdpg, publicinv, infl, fincrisis* and *largeproj*). The goal is to test the indirect effect of election years (*troika, ely* and *elylead*), together with the remaining exogenous variables on the endogenous variables. A Newey's two-step estimator is used. Additional tests were carried out using the predicted residuals (not formally reported, but consistent with the findings) which consisted in running the previous OLS and probit regressions, and then taking the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns
Instrument variables:		*troika / munely / munelylead*	
	Hypothesis I – Political determinants		
govrw	1.2178	-14.3644***	
	(1.9902)	(2.8245)	
govmaj			4.6639***
			(0.4465)
	Hypothesis II – Governance determinants		
deltarlaw (IV)	0.1298	-3.1651***	-1.1560***
	(0.5436)	(0.6077)	(0.1045)
deltacorrp (IV)	-0.0246	-1.2056***	-0.5407***
	(0.2040)	(0.3562)	(0.0994)
deltagoveff (IV)	-0.0293	1.6500***	0.7877***
	(0.3952)	(0.3673)	(0.0889)
law2008	-3.4910***		
	(1.0458)		
	Hypothesis III – Economic determinants		
gdpg	-0.0377	-1.8023***	-0.3080***
	(0.2810)	(0.3614)	(0.0521)
publicinv	0.3413	-3.5318***	0.1493
	(0.9126)	(1.0950)	(0.1318)
infl	-0.3507	3.5159***	1.2131***
	(0.4299)	(0.6104)	(0.1022)
fincrisis1		-1.9432***	-0.9638***
		(0.2502)	(0.1107)
	Hypothesis IV – Project determinants (control)		
largeproj	0.1297		
	(0.3217)		
Constant	1.2935	12.2301***	-4.8826***
	(3.2141)	(4.0845)	(0.5222)
Wald Test	0.0000	0.0000	0.0000
Observations	2,714	3,338	3,338

Table 53 – GLM Fractional response model Results - Cost deviations – local government projects final subsample study

This table presents a GLM fractional response model regression using *cdevp* as dependent variable (only positive values – 2,826 observations, with 636 observations when using the *largeproj* variable). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
Hypothesis I – Political determinants						
govrw	0.9047***	0.0424	1.1193***	1.6371		
	(0.2438)	(0.6570)	(0.1039)	(1.2684)		
govmaj					0.1155	-6.9652***
					(0.2421)	(2.0506)
Hypothesis II – Governance determinants						
deltarlaw		-0.1765*		-0.0683		-0.1276***
		(0.0935)		(0.0423)		(0.0315)
deltacorrp	-0.1791		-0.0630			
	(0.1153)		(0.0615)			
deltagoveff					0.0937	
					(0.0673)	
law2008	-2.9598	-1.9309***			-3.9911***	-2.7353***
	(2.4394)	(3.0148)			(1.5926)	(1.0585)
Hypothesis III – Economic determinants						
gdpg	0.0951**	0.1923	0.2415***	0.3880	0.0962	0.1056
	(0.0374)	(0.2964)	(0.0392)	(0.3670)	(0.1530)	(0.0780)
publicinv		0.2284**		0.4918***	-0.1657	0.1363
		(0.1144)		(0.1891)	(0.1827)	(0.4502)
infl	-0.2008	0.2157	0.0540**	-0.5479	0.2235**	-0.2887
	(0.1402)	(0.1925)	(0.0230)	(0.5496)	(0.0933)	(0.2094)
fincrisis			0.2466*	-3.4559***		
			(0.1313)	(4.4744)		
Hypothesis IV – Project determinants (control)						
largeproj	-0.0334					
	(0.0967)					
Constant	-1.2770***	-3.3788***	-1.7242***	-4.4223***	-1.1044	-1.5225
	(0.1383)	(1.1913)	(0.1336)	(0.5765)	(0.7256)	(2.0068)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.09	0.08	0.08	0.07	0.09	0.08
Observations	2,202	2,826	2,826	2,826	2,826	2,826

Table 54 – Probit Fractional response model Results - Cost deviations – local government projects final subsample study

This table presents a fractional response Probit model regression for the conditional mean, using *cdevprob* as dependent variable (values are 0 or 1). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns	(4) Cost Overruns
		Marginal effects		
		Hypothesis I – Political determinants		
govrw	0.158**	0.798***	-0.125***	
	(0.0673)	(0.0562)	(0.0327)	
govmaj				-0.195***
				(0.0371)
		Hypothesis II – Governance determinants		
deltarlaw		0.146***		
		(0.0396)		
deltacorrp	0.00107		-0.136***	
	(0.0156)		(0.0135)	
deltagoveff				0.0399***
				(0.00442)
law2008	-0.778***	-0.938***		-0.791***
	(0.0200)	(0.0337)		(0.0190)
		Hypothesis III – Economic determinants		
gdpg	0.0155	-0.0666***	-0.183***	-0.153***
	(0.0216)	(0.0162)	(0.0163)	(0.00838)
publicinv		0.508***		0.317***
		(0.0448)		(0.0253)
infl	-0.0784***	-0.281***	0.0329***	0.0641***
	(0.0200)	(0.0899)	(0.0111)	(0.0138)
fincrisis			-0.782***	
			(0.0251)	
		Hypothesis IV – Project determinants (control)		
largeproj	0.0718			
	(0.0964)			
Wald Test	0.0000	0.0000	0.0000	0.0000
R^2	0.43	0.24	0.17	0.24
Observations	2,714	3,338	3,338	3,338

Table 55 – Descriptive results – Time deviations – final sample study

This table present the results of time deviations for the variables described in Section 6, which comprises the study of the determinants for time deviations using the final sample of collected observations. This sample includes all sectors and subsectors analysed in our research. A positive number in time deviations represent a time overrun, while a negative number represent a completion time below the initial forecasted time. Source: Own table.

Subsample	Nº Obs (N=161)	Nº Obs with overruns (N=118) (=73%)	Time deviation (%) – Mean (=36.7%)	St. Dev (=0.33)	Min (=-44%)	Max (=100%)	Time deviation (%) – Mean (overruns subsample) (=50.5%)
Hypothesis I – Political determinants							
ely	57 (35%)	35 (30% of overruns project sample) (61% of *ely* sample)	29.6%	0.34	-44%	99%	49%
elylag	57 (35%)	42 (36% of overruns project sample) (74% of *elylag* sample)	35.9%	0.34	-2%	100%	49%
elylead	45 (28%)	36 (31% of overruns project sample) (80% of *elylead* sample)	40.4%	0.33	-5%	97%	51%
regely	39 (24%)	29 (25% of overruns project sample) (74% of *regely* sample)	36.6%	0.33	0%	99%	49%
regelylag	54 (34%)	35 (30% of overruns project sample) (65% of *regelylag* sample)	30.4%	0.34	-44%	97%	48%
regelylead	24 (15%)	18 (15% of overruns project sample) (75% of *regelylead* sample)	43.1%	0.35	-5%	99%	58%
munely	31 (19%)	26 (22% of overruns project sample) (84% of *munely* sample)	47.5%	0.31	0%	99%	57%
munelylag	34 (21%)	26 (22% of overruns project sample) (76% of *munelylag* sample)	36.9%	0.31	-5%	94%	49%

Subsample	Nº Obs (N=161)	Nº Obs with overruns (N=118) (=73%)	Time deviation (%) – Mean (=36.7%)	St. Dev (=0.33)	Min (=-44%)	Max (=100%)	Time deviation (%) – Mean (overruns subsample) (=50.5%)
munelylead	48 (30%)	38 (32% of overruns project sample) (79% of *munelylead* sample)	39.6%	0.32	-2%	100%	50%
govrw	53 (33%)	39 (33% of overruns project sample) (74% of *govrw* sample)	30.2%	0.30	-5%	94%	41%
govmaj	75 (47%)	66 (56% of overruns project sample) (88% of *govmaj* sample)	48.8%	0.30	0%	99%	55%
Hypothesis II – Governance determinants							
law2008	32 (20%)	22 (19% of overruns project sample) (69% of *law2008* sample)	28.1%	0.32	-5%	97%	41%
Hypothesis III – Economic determinants							
fincrisis1	57 (35%)	44 (37% of overruns project sample) (77% of *fincrisis1* sample)	37.3%	0.33	-5%	99%	49%
troika	9 (6%)	4 (3% of overruns project sample) (44% of *troika* sample)	7.6%	0.20	-5%	59%	20%
Hypothesis IV – Project determinants (control)							
largeproj	1 (1%)	1 (1% of overruns project sample) (100% of *largeproj* sample)	50.0%	0.00	50%	50%	50%
edu	15 (9%)	12 (10% of overrun project sample) (80% of *edu* sample)	37.5%	0.25	0%	87%	47%
transp	48 (30%)	38 (32% of overruns project sample) (79% of *transp* sample)	32.2%	0.27	0%	95%	41%
econf	29 (18%)	23 (19% of overruns project sample) (79% of *econf* sample)	46.5%	0.39	-44%	100%	61%

Subsample	Nº Obs (N=161)	Nº Obs with overruns (N=118) (=73%)	Time deviation (%) – Mean (=36.7%)	St. Dev (=0.33)	Min (=-44%)	Max (=100%)	Time deviation (%) – Mean (overruns subsample) (=50.5%)
socialf	69 (43%)	45 (38% of of overruns project sample) (65% of *socialf* sample)	35.4%	0.35	-5%	99%	55%
notcgov	85 (53%)	70 (59% of overruns project sample) (82% of *notcgov* sample)	43.2%	0.33	0%	99%	52%

Table 56 – Parametric and Nonparametric - Time deviations – final sample study

This table presents the results of the two sample T-test (parametric test) and the Mann-Whitney test (nonparametric test). For both tests, we considered a p-value of 0.1 (* means variables is statistically significative). As our data is not totally normal, we also decided to use the Mann-Whitney test which assumes any properties regarding the distribution of the dependent variable in the analysis. Nonparametric tests or distribution-free tests are tests that have the advantage of not requiring the assumption of normality or the assumption of homogeneity of variance. Nonparametric tests compare medians instead of means. This makes that if the data has a small number of outliers, their influence is negated. Likewise, the Mann-Whitney test is more powerful than the T-test, while maintaining a preferred type I error rate (wrongly rejecting the null hypothesis). Source: Own table.

	T-test (reject Ho if p-value < 0.1)	**Mann-Whitney test (accept with statistical significance if p-value<0.1)**
ely	0.10*	0.03*
govrw	0.01	0.09*
govmaj	0.00*	0.00*
law2008	0.12	0.09*
largeproj	0.90	0.89
edu	0.93	0.87
transp	0.22	0.43
econf	0.20	0.09*
socialf	0.71	0.52
notcgov	0.08*	0.00*

Table 57 –GLM Results - Time deviations – final sample study

This table presents the results of a GLM regression. Results were similar to using an OLS regression. We were only able to collect data on large projects for 153 observations. Regarding regressions with year effects, and since a number of critical variables are not time dependent the applicable procedure was to remove from the GLM regression all independent variables where is possible to record a different value in each registered observation year (e.g. *gdpg*). This way we only use in these regressions, as independent variables, the above-described dummy variables. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the (log of the initial cost of each project) with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table

VARIABLES	(1) Time Deviation %	(2) Time Deviation %	(3) Time Deviation %	(4) Time Deviation %	(5) Time Deviation %	(6) Time Deviation %
Hypothesis I – Political determinants						
govrw	-0.1837***	-0.1237*	-0.1859***	-0.1513**	-0.0797	-0.0492
	(0.0649)	(0.0670)	(0.0683)	(0.0677)	(0.0686)	(0.0774)
govmaj					0.1499***	0.1370**
					(0.0567)	(0.0581)
Hypothesis II – Governance determinants						
deltarlaw		0.0153		0.0111		0.0103
		(0.0107)		(0.0106)		(0.0109)
deltacorrp	0.0063		0.0116			
	(0.0210)		(0.0209)			
law2008	-0.2601***	-0.2735***			-0.1955**	-0.2039**
	(0.0806)	(0.0794)			(0.0818)	(0.0810)
Hypothesis III – Economic determinants						
gdpg	-0.0424**	-0.0430**	-0.0442**	-0.0389**	-0.0306*	-0.0272
	(0.0200)	(0.0196)	(0.0208)	(0.0193)	(0.0180)	(0.0188)
publicinv		-0.0065		-0.0276		
		(0.0404)		(0.0397)		
infl	0.0105	0.0081	0.0132**	0.0109	0.0095	0.0072
	(0.0068)	(0.0090)	(0.0064)	(0.0076)	(0.0096)	(0.0115)
fincrisis			-0.2209**	-0.2276***		
			(0.0858)	(0.0792)		
Hypothesis IV – Project determinants (control)						
largeproj	0.0364					
	(0.0570)					
educ	-0.0516	-0.0414	0.0056	0.0187	-0.0571	-0.0497
	(0.0753)	(0.0755)	(0.0717)	(0.0730)	(0.0711)	(0.0710)
transp	-0.0108	-0.0024	0.0065	0.0012	-0.0232	-0.0279
	(0.0610)	(0.0577)	(0.0579)	(0.0568)	(0.0581)	(0.0577)
econf	0.2029***	0.1679**	0.1558**	0.1554**	0.1587**	0.1625**
	(0.0774)	(0.0737)	(0.0760)	(0.0750)	(0.0744)	(0.0737)
notcgov	0.1131*	0.1280**	0.1439**	0.1433**	0.1040*	0.1083**
	(0.0586)	(0.0571)	(0.0576)	(0.0586)	(0.0555)	(0.0550)
Constant	0.4034***	0.4242**	0.3905***	0.5007***	0.2912***	0.2982***
	(0.0646)	(0.1675)	(0.0636)	(0.1667)	(0.0715)	(0.0720)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.2071	0.1888	0.1688	0.1748	0.2062	0.2103
Observations	153	161	161	161	161	161

Table 58 –Tobit Results - Time deviations – final sample study

This table presents the results of a Tobit regression, with censoring at the left side, at 0% (only projects with positive time deviation, i.e., with time overruns). We ran these regressions with time effects (using only the variables that do not change over time) and results were similar. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Time Deviation %	(2) Time Deviation %	(3) Time Deviation %	(4) Time Deviation %	(5) Time Deviation %	(6) Time Deviation %
			Hypothesis I – Political determinants			
govrw	-0.2198**	-0.1300	-0.2216**	-0.1614*	-0.0798	-0.0299
	(0.0850)	(0.0870)	(0.0913)	(0.0895)	(0.0861)	(0.0988)
govmaj					0.2054***	0.1851***
					(0.0692)	(0.0703)
			Hypothesis II – Governance determinants			
deltarlaw		0.0238		0.0188		0.0170
		(0.0146)		(0.0147)		(0.0149)
deltacorrp	0.0068		0.0162			
	(0.0273)		(0.0272)			
law2008	-0.3310***	-0.3464***			-0.2446**	-0.2543**
	(0.1057)	(0.1061)			(0.1076)	(0.1050)
			Hypothesis III – Economic determinants			
gdpg	-0.0560**	-0.0553**	-0.0580**	-0.0495**	-0.0403*	-0.0347
	(0.0256)	(0.0247)	(0.0265)	(0.0243)	(0.0232)	(0.0243)
publicinv		-0.0100		-0.0369		
		(0.0517)		(0.0509)		
infl	0.0099	0.0066	0.0136	0.0101	0.0093	0.0058
	(0.0097)	(0.0127)	(0.0092)	(0.0109)	(0.0134)	(0.0160)
fincrisis			-0.2790**	-0.2838***		
			(0.1094)	(0.1024)		
			Hypothesis IV – Project determinants (control)			
largeproj	0.0583					
	(0.0752)					
educ	-0.0413	-0.0197	0.0377	0.0575	-0.0419	-0.0293
	(0.0994)	(0.1011)	(0.0969)	(0.0980)	(0.0962)	(0.0962)
transp	0.0367	0.0483	0.0626	0.0523	0.0249	0.0166
	(0.0800)	(0.0785)	(0.0794)	(0.0779)	(0.0783)	(0.0779)
econf	0.2601***	0.2464***	0.2277**	0.2301**	0.2338***	0.2408***
	(0.0925)	(0.0891)	(0.0901)	(0.0908)	(0.0896)	(0.0889)
notcgov	0.1615**	0.1763**	0.1950***	0.1958**	0.1440**	0.1525**
	(0.0779)	(0.0759)	(0.0745)	(0.0769)	(0.0715)	(0.0714)
Constant	0.3302***	0.3596	0.3119***	0.4551**	0.1736*	0.1816*
	(0.0916)	(0.2213)	(0.0900)	(0.2193)	(0.1036)	(0.1028)
Wald Test	0.0000	0.0000	0.0004	0.0003	0.0000	0.0000
Observations	153	161	161	161	161	161

Table 59 – Probit Results - Time deviations – final sample study

This table presents the results of a probit model regression, using the time overruns as a dependent variable (i.e., 0 - if the project had a negative or zero time deviation; 1 – if the project had a positive time deviation). Panel A shows the coefficients, and Panel B the marginal effects. Logit models were calculated and yields similar results. For that reason, results were omitted. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial time of each project) with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Time Overruns	(2) Time Overruns	(3) Time Overruns	(4) Time Overruns	(5) Time Overruns	(6) Time Overruns
			PANEL A – Coefficients			
			Hypothesis I – Political determinants			
govrw	-0.4697	0.0002	-0.4838	-0.1261	0.0436	0.2907
	(0.3361)	(0.3327)	(0.3592)	(0.3530)	(0.3384)	(0.3808)
govmaj					0.7000***	0.5927**
					(0.2696)	(0.2918)
			Hypothesis II– Governance determinants			
deltarlaw		0.1043**		0.0904*		0.0784
		(0.0526)		(0.0518)		(0.0528)
deltacorrp	0.0170		0.0194			
	(0.1033)		(0.0976)			
law2008	-0.7883*	-0.9168**			-0.4383	-0.5576
	(0.4303)	(0.4211)			(0.3811)	(0.3989)
			Hypothesis III – Economic determinants			
gdpg	-0.1647	-0.1507	-0.2001*	-0.1464	-0.0949	-0.0685
	(0.1041)	(0.0999)	(0.1080)	(0.1013)	(0.0836)	(0.0892)
publicinv		0.0104		-0.0606		
		(0.2104)		(0.2043)		
infl	-0.0082	-0.0291	0.0015	-0.0208	-0.0136	-0.0292
	(0.0388)	(0.0428)	(0.0392)	(0.0402)	(0.0422)	(0.0487)
fincrisis2			-0.8005*	-0.8501**		
			(0.4215)	(0.4048)		
			Hypothesis IV – Project determinants (control)			
largeproj	0.3672					
	(0.2943)					
educ	0.0823	0.1528	0.2684	0.3473	0.0661	0.1206
	(0.4407)	(0.4314)	(0.4126)	(0.4028)	(0.4408)	(0.4258)
transp	0.5735*	0.6400**	0.7085**	0.6454**	0.5423*	0.5109
	(0.3177)	(0.3212)	(0.3278)	(0.3252)	(0.3142)	(0.3184)
econf	0.9465**	0.7248**	0.6807**	0.6945**	0.6885**	0.7151**
	(0.4371)	(0.3172)	(0.3404)	(0.3216)	(0.3232)	(0.3178)
notcgov	0.6483**	0.7127**	0.7463**	0.7811**	0.5485**	0.5966**
	(0.2847)	(0.2907)	(0.2927)	(0.3118)	(0.2753)	(0.2828)
Constant	0.4738	0.4574	0.5332	0.7567	0.0179	0.0709
	(0.3312)	(0.8204)	(0.3331)	(0.8197)	(0.3757)	(0.3910)

VARIABLES	(1) Time Overruns	(2) Time Overruns	(3) Time Overruns	(4) Time Overruns	(5) Time Overruns	(6) Time Overruns
			PANEL B – Marginal Effects			
			Hypothesis I – Political determinants			
govrw	-0.144	5.12E-05	-0.157	-0.0392	0.0133	0.0854
	(0.1070)	(0.1020)	(0.1200)	(0.1110)	(0.1030)	(0.1090)
govmaj					0.209***	0.177**
					(0.0783)	(0.0856)
			Hypothesis II – Governance determinants			
deltarlaw		0.0320**		0.0277*		0.024
		(0.0161)		(0.0156)		(0.0161)
deltacorrp	0.00496		0.00597			
	(0.0303)		(0.0301)			
law2008	-0.264*	-0.322**			-0.146	-0.188
	(0.1540)	(0.1530)			(0.1350)	(0.1430)
			Hypothesis III – Economic determinants			
gdpg	-0.0482	-0.0462	-0.0617*	-0.0448	-0.0291	-0.0209
	(0.0301)	(0.0306)	(0.0328)	(0.0304)	(0.0255)	(0.0271)
publicinv		0.00319		-0.0185		
		(0.0645)		(0.0627)		
infl	-0.00241	-0.00893	0.000473	-0.00635	-0.00417	-0.00892
	(0.0113)	(0.0131)	(0.0121)	(0.0123)	(0.0130)	(0.0149)
fincrisis			-0.272*	-0.288**		
			(0.1490)	(0.1410)		
			Hypothesis IV – Project determinants (control)			
largeproj	0.101					
	(0.0761)					
educ	0.0235	0.0447	0.0759	0.0948	0.0199	0.0355
	(0.1220)	(0.1200)	(0.1060)	(0.0969)	(0.1300)	(0.1210)
transp	0.153**	0.176**	0.194**	0.177**	0.152*	0.144*
	(0.0750)	(0.0766)	(0.0754)	(0.0766)	(0.0783)	(0.0801)
econf	0.202***	0.182***	0.175**	0.176***	0.175***	0.180***
	(0.0623)	(0.0639)	(0.0698)	(0.0656)	(0.0660)	(0.0641)
notcgov	0.194**	0.219**	0.231***	0.240***	0.169**	0.183**
	(0.0838)	(0.0863)	(0.0873)	(0.0910)	(0.0832)	(0.0845)
Wald Test	0.0444	0.0145	0.0334	0.0236	0.0030	0,0027
R^2	0.1375	0.1505	0.1329	0.1486	0.1556	0.1664
Observations	153	161	161	161	161	161

Table 60 – IV Reg Results - Time deviations – final sample study

This table presents the results of a IV OLS regression (Instrumented Variable OLS) to perform a single-equation instrumental-variables regression. The goal is to fit a linear model where three of the regressors are endogenously determined. The model instrumented variables are identified with the indication of (IV) after the variable name and these are our endogenous variables. The *elylag, ely* and *elylead* instrument variables are the exogenous variables used with the remaining exogenous variables (*govrw, govmaj, law2008, gdpg, publicinv, infl, fincrisis, largeproj, edu, transp, econf, notcgov* and *pescolarar*). The goal is to test the indirect effect of election years (*elylag, ely* and *elylead*) together with the remaining exogenous variables on the endogenous variables. A two-stage least squares estimator is used.

Additional tests were carried out using the predicted residuals (not formally reported, but consistent with the findings) which consisted in running the previous OLS and probit regressions, and then taking the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Time Deviation %	(2) Time Deviation %	(3) Time Deviation %
Instrument variables:		elylag / ely / elylead	
		Hypothesis I – Political determinants	
govrw	-0.3302***	-0.5228***	
	(0.1235)	(0.1953)	
govmaj			0.3641***
			(0.1292)
		Hypothesis II – Governance determinants	
deltarlaw (IV)	-0.0041	-0.0300	0.0189
	(0.0235)	(0.0334)	(0.0180)
deltacorrp (IV)	-0.0452	-0.0511	-0.0680
	(0.0504)	(0.0563)	(0.0515)
deltagoveff (IV)	-0.0310	-0.0522***	-0.0451***
	(0.0215)	(0.0195)	(0.0173)
law2008	-0.2527**		
	(0.1263)		
		Hypothesis III – Economic determinants	
gdpg	-0.0556*	-0.0750**	-0.0203
	(0.0296)	(0.0331)	(0.0193)
publicinv	-0.0283	-0.0965	
	(0.0732)	(0.0938)	
infl	0.0147*	0.0214*	0.0032
	(0.0085)	(0.0117)	(0.0151)
fincrisis		-0.2711**	-0.1869**
		(0.1062)	(0.0785)

VARIABLES	(1) Time Deviation %	(2) Time Deviation %	(3) Time Deviation %
	Hypothesis IV – Project determinants (control)		
largeproj	0.0361		
	(0.0637)		
educ	-0.0877	-0.0925	-0.0918
	(0.0877)	(0.0818)	(0.0806)
transp	-0.0358	-0.0061	-0.1266*
	(0.0747)	(0.0834)	(0.0701)
econf	0.1966***	0.0600	0.0496
	(0.0753)	(0.0927)	(0.0883)
notcgov	0.0649	0.0878	0.0808
	(0.0665)	(0.0622)	(0.0591)
Constant	0.5999**	0.9773**	0.2640***
	(0.2909)	(0.4122)	(0.0995)
Wald Test	0.0000	0.0000	0.0000
Observations	153	161	161

Table 61 – IV Probit Results - Time deviations – final sample study

This table presents the results of a IV Probit regression (Instrumented Variable Probit). The model instrumented variables are identified with the indication of (IV) after the variable name and are our endogenous variables. The *troika, ely* and *elylead* instrument variables are the exogenous variables used with the remaining exogenous variables (*govrw, govmaj, law2008, gdpg, publicinv, infl, fincrisis, largeproj, edu, transp, econf* and *notcgov*). The goal is to test the indirect effect of election years (*troika, ely* and *elylead*) together with the remaining exogenous variables on the endogenous variables. A Newey's two-step estimator is used. Additional tests were carried out using the predicted residuals (not formally reported, but consistent with the findings) which consisted in running the previous OLS and probit regressions, and then taking the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Time Overruns	(2) Time Overruns	(3) Time Overruns
Instrument variables:		*troika / ely / elylead*	
	Hypothesis I – Political determinants		
govrw	-2.2248	-4.6089*	
	(1.3644)	(2.6185)	
govmaj			2.0937
			(24.9614)
	Hypothesis II – Governance determinants		
deltarlaw (IV)	-1.3604	0.0744	30.1408
	(1.4091)	(0.7338)	(917.2692)
deltacorrp (IV)	0.4744	-1.6500	-29.7228
	(1.1779)	(1.1012)	(885.8425)
deltaregulq (IV)	1.3314	-0.9280	-37.8569
	(1.5393)	(0.9534)	(1,148.7053)
law2008	-1.0112		
	(1.0320)		
	Hypothesis III – Economic determinants		
gdpg	0.4035	-1.3418	-21.6230
	(0.9116)	(0.8767)	(648.8252)
publicinv	-1.9071	-1.3806	
	(1.5398)	(1.1641)	
infl	-0.0390	0.2658	1.6474
	(0.1380)	(0.1816)	(49.2774)
fincrisis		-3.6172	-64.3339
		(2.2737)	(1,927.9006)
	Hypothesis IV – Project determinants (control)		
largeproj	0.0468		
	(0.7016)		
educ	0.7171	-0.3334	-9.2975
	(1.1186)	(0.9722)	(279.6439)
transp	-0.0579	2.3157*	28.2949
	(1.0686)	(1.2314)	(843.9354)

VARIABLES	(1) Time Overruns	(2) Time Overruns	(3) Time Overruns
econf	0.2679	0.5069	22.0026
	(0.9063)	(0.8869)	(661.2358)
notcgov	0.0557	0.9335	13.5919
	(0.7181)	(0.6908)	(396.5632)
Constant	10.5598	6.3203	-29.2425
	(8.5854)	(5.4651)	(866.1127)
Wald Test	0.0368	0.0011	0.0370
Observations	153	161	161

Table 62 – GLM Results - Cost deviations – time on cost study

This table presents the results of a GLM regression. Results were similar to using an OLS regression. We were only able to collect data on large projects for 207 observations. Regarding regressions with year effects, and since a number of critical variables are not time dependent the applicable procedure was to remove from the GLM regression all independent variables where is possible to record a different value in each registered observation year (e.g., *gdpg*). This way we will only use in these regressions, as independent variables, those dummy variables already described. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project) with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
tdevp	0.0257***	0.0253***	0.0251***	0.0247***	0.0255***	0.0255***
	(0.0083)	(0.0092)	(0.0083)	(0.0090)	(0.0080)	(0.0080)
Hypothesis I – Political determinants						
govrw	0.0080	0.0100	-0.0122	-0.0185		
	(0.0231)	(0.0343)	(0.0256)	(0.0354)		
govmaj					0.0466*	0.0507**
					(0.0249)	(0.0210)
Hypothesis II – Governance determinants						
deltarlaw		0.0051		0.0024		-0.0001
		(0.0045)		(0.0044)		(0.0032)
deltacorrp	0.0149**		0.0105		0.0021	
	(0.0066)		(0.0068)		(0.0081)	
law2008	-0.0505**	-0.0847***			-0.0585**	-0.0608***
	(0.0254)	(0.0216)			(0.0234)	(0.0233)
Hypothesis III – Economic determinants						
gdpg	-0.0019	-0.0075	-0.0084	-0.0125	-0.0047	-0.0053
	(0.0076)	(0.0081)	(0.0081)	(0.0086)	(0.0061)	(0.0052)
publicinv		-0.0021		-0.0041		
		(0.0158)		(0.0154)		
infl	0.0138**	0.0126*	0.0161**	0.0166**	0.0148***	0.0149***
	(0.0063)	(0.0072)	(0.0065)	(0.0073)	(0.0053)	(0.0053)
fincrisis			-0.0759***	-0.0953***		
			(0.0237)	(0.0187)		
Hypothesis IV – Project determinants (control)						
largeproj	-0.0024					
	(0.0279)					
educ	0.0410	0.0383	0.0529**	0.0539**	0.0321	0.0312
	(0.0261)	(0.0270)	(0.0260)	(0.0269)	(0.0292)	(0.0286)
transp	0.0062	0.0078	0.0058	0.0067	0.0073	0.0072
	(0.0278)	(0.0255)	(0.0255)	(0.0254)	(0.0242)	(0.0243)
econf	0.0283	0.0295	0.0278	0.0277	0.0269	0.0265

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
	(0.0239)	(0.0235)	(0.0234)	(0.0234)	(0.0233)	(0.0237)
notcgov	-0.0154	-0.0118	-0.0071	-0.0048	-0.0175	-0.0178
	(0.0209)	(0.0218)	(0.0211)	(0.0218)	(0.0205)	(0.0207)
Constant	0.1053***	0.1215*	0.1129***	0.1352*	0.0814***	0.0793***
	(0.0294)	(0.0709)	(0.0289)	(0.0701)	(0.0314)	(0.0303)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.1963	0.1900	0.2112	0.2065	0.2099	0.2097
Observations	207	208	208	208	208	208

Table 63 –Tobit Results - Cost deviations – time on cost study

This table presents the results of a Tobit regression, with censoring at the left side, at 0% (only projects with positive cost deviation, i.e., with cost overruns). We ran these regressions with time effects (using only the variables that do not change over time) and results were similar. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %	(4) Cost Deviation %	(5) Cost Deviation %	(6) Cost Deviation %
tdevp	0.0300***	0.0292***	0.0294***	0.0293***	0.0294***	0.0295***
	(0.0088)	(0.0098)	(0.0083)	(0.0092)	(0.0086)	(0.0085)
Hypothesis I – Political determinants						
govrw	-0.0005	-0.0050	0.0050	-0.0169		
	(0.0251)	(0.0350)	(0.0272)	(0.0366)		
govmaj					0.0557**	0.0573**
					(0.0272)	(0.0223)
Hypothesis II – Governance determinants						
deltarlaw		0.0038		0.0016		-0.0008
		(0.0045)		(0.0044)		(0.0034)
deltacorrp	0.0133*		0.0191***		-0.0006	
	(0.0074)		(0.0068)		(0.0091)	
law2008	-0.0652**	-0.1011***			-0.0725***	-0.0697***
	(0.0295)	(0.0254)			(0.0263)	(0.0250)
Hypothesis III – Economic determinants						
gdpg	-0.0010	-0.0092	0.0036	-0.0015	-0.0031	-0.0028
	(0.0081)	(0.0084)	(0.0079)	(0.0084)	(0.0067)	(0.0059)
publicinv		0.0063		-0.0222		
		(0.0179)		(0.0165)		
infl	0.0123**	0.0128*	0.0132**	0.0148**	0.0126**	0.0129**
	(0.0061)	(0.0073)	(0.0063)	(0.0072)	(0.0053)	(0.0053)
fincrisis			-0.0307	-0.0603***		
			(0.0253)	(0.0210)		
Hypothesis IV – Project determinants (control)						
largeproj	0.0159					
	(0.0261)					
educ	0.0406	0.0377	0.0470	0.0492	0.0335	0.0335
	(0.0286)	(0.0290)	(0.0291)	(0.0303)	(0.0322)	(0.0315)
transp	0.0054	0.0119	0.0117	0.0165	0.0107	0.0105
	(0.0269)	(0.0259)	(0.0261)	(0.0264)	(0.0243)	(0.0244)
econf	0.0299	0.0337	0.0313	0.0339	0.0299	0.0296
	(0.0248)	(0.0244)	(0.0242)	(0.0247)	(0.0244)	(0.0247)
notcgov	-0.0124	-0.0119	-0.0096	-0.0089	-0.0191	-0.0194
	(0.0233)	(0.0228)	(0.0218)	(0.0233)	(0.0214)	(0.0215)
Constant	0.0996***	0.0848	0.0916***	0.1924**	0.0746**	0.0722**
	(0.0325)	(0.0811)	(0.0316)	(0.0809)	(0.0325)	(0.0316)
Wald Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	207	208	208	208	208	208

Table 64 – Probit Results - Cost deviations – time on cost study

This table presents the results of a probit model regression, using the cost overruns as a dependent variable (i.e., 0 - if the project had a negative or zero cost deviation; 1 – if the project had a positive cost deviation). Panel A shows the coefficients, and Panel B the marginal effects. Logit models were calculated and yields similar results. For that reason, results were omitted. For control purposes, Regression 1 was also run by replacing the *largeproj* variable with the *loginitialcost* (log of the initial cost of each project) with similar results. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns	(4) Cost Overruns	(5) Cost Overruns
			PANEL A – Coefficients		
tdevp	0.3130*	0.3134*	0.3400*	0.2976*	0.2870*
	(0.1654)	(0.1728)	(0.1818)	(0.1596)	(0.1657)
			Hypothesis I – Political determinants		
govrw	0.0953	0.5204	0.1671		
	(0.2683)	(0.3340)	(0.2963)		
govmaj				0.8851***	0.3507
				(0.3136)	(0.2630)
			Hypothesis II– Governance determinants		
deltarlaw		0.1037**			0.0107
		(0.0480)			(0.0369)
deltacorrp	-0.0889		-0.0268	-0.2886**	
	(0.0999)		(0.0931)	(0.1137)	
law2008	-1.0652**	-1.0874***		-1.0328***	-0.6602**
	(0.4308)	(0.4045)		(0.3802)	(0.3204)
			Hypothesis III – Economic determinants		
gdpg	-0.1229	-0.1110	-0.0775	-0.1531*	-0.0497
	(0.0969)	(0.0914)	(0.0949)	(0.0830)	(0.0649)
publicinv		0.2523			
		(0.2135)			
infl				0.0959	0.0594
				(0.0658)	(0.0551)
fincrisis			-0.7639*		
			(0.3966)		
			Hypothesis IV – Project determinants (control)		
largeproj	0.2632				
	(0.2836)				
educ				0.2853	0.3903
				(0.4336)	(0.4148)
transp				0.3213	0.3156
				(0.3105)	(0.3089)
econf				0.5794	0.6740
				(0.4275)	(0.4319)
notcgov	0.5697**	0.5924**	0.6062**	0.4454*	0.5009*
	(0.2586)	(0.2534)	(0.2520)	(0.2567)	(0.2661)
Constant	0.7357**	-0.2773	0.7057**	0.0010	0.2673
	(0.3120)	(0.8558)	(0.2998)	(0.3611)	(0.3089)

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns	(4) Cost Overruns	(5) Cost Overruns
			PANEL B – Marginal Effects		
tdevp	0.0609**	0.0593**	0.0677**	0.0545**	0.0549*
	(0.0278)	(0.0285)	(0.0307)	(0.0258)	(0.0283)
			Hypothesis I – Political determinants		
govrw	0.0182	0.0889*	0.0322		
	(0.0504)	(0.0509)	(0.0553)		
govmaj				0.162***	0.0669
				(0.0591)	(0.0524)
			Hypothesis II – Governance determinants		
deltarlaw		0.0196**			0.00205
		(0.00860)			(0.00698)
deltacorrp	-0.0173		-0.00533	-0.0529***	
	(0.0187)		(0.0184)	(0.0197)	
law2008	-0.286**	-0.288**		-0.265**	-0.158*
	(0.135)	(0.125)		(0.113)	(0.0874)
			Hypothesis III – Economic determinants		
gdpg	-0.0239	-0.0210	-0.0154	-0.0281*	-0.00951
	(0.0185)	(0.0170)	(0.0188)	(0.0148)	(0.0125)
publicinv		0.0478			
		(0.0388)			
infl				0.0176	0.0114
				(0.0120)	(0.0109)
fincrisis2			-0.184*		
			(0.108)		
			Hypothesis IV – Project determinants (control)		
largeproj	0.0475				
	(0.0462)				
educ				0.0450	0.0610
				(0.0585)	(0.0527)
transp				0.0539	0.0555
				(0.0462)	(0.0480)
econf				0.0823*	0.0965**
				(0.0439)	(0.0425)
notcgov	0.118**	0.120**	0.129**	0.0859*	0.101*
	(0.0528)	(0.0489)	(0.0519)	(0.0489)	(0.0535)
Wald Test	0.0634	0.0476	0.0669	0.0262	0.0149
R^2	0.1451	0.1646	0.1348	0.1410	0.1882
Observations	207	208	208	208	208

Table 65 – IV Reg Results - Cost deviations – time on cost study

This table presents the results of a IV OLS (Instrumented Variable OLS) to perform a single-equation instrumental-variables regression. The goal is to fit a linear model where three of the regressors are endogenously determined. The model instrumented variables are identified with the indication of (IV) after the variable name and will be our endogenous variables. Instrument variables *elylag*, *ely* and *elylead* are the exogenous variables used with the remaining exogenous variables (*govrw*, *govmaj*, *law2008*, *gdpg*, *publicinv*, *infl*, *fincrisis*, *largeproj*, *edu*, *transp*, *econf*, *notcgov* and *pescolarar*). The goal is to test the indirect effect of election years (*elylag*, *ely* and *elylead*) together with the remaining exogenous variables on the endogenous variables. A two-stage least squares estimator is used.

Additional testes were made using the predicted residuals (not formally reported, but consistent with the findings) which consisted in running the previous OLS and probit regressions, and then taking the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %
Instrument variables:		*elylag / ely / elylead*	
tdevp	0.0260***	0.0256***	0.0238***
	(0.0093)	(0.0096)	(0.0084)
		Hypothesis I – Political determinants	
govrw	-0.1017	-0.2452**	
	(0.0723)	(0.1223)	
govmaj			0.1280***
			(0.0486)
		Hypothesis II – Governance determinants	
deltarlaw (IV)	-0.0091	-0.0238*	-0.0079*
	(0.0086)	(0.0136)	(0.0042)
deltacorrp (IV)	0.0094	-0.0072	-0.0133
	(0.0167)	(0.0221)	(0.0174)
deltagoveff (IV)	-0.0188**	-0.0264***	-0.0131**
	(0.0083)	(0.0094)	(0.0062)
law2008	-0.0224		
	(0.0407)		
		Hypothesis III – Economic determinants	
gdpg	-0.0128	-0.0335*	-0.0005
	(0.0145)	(0.0203)	(0.0065)
publicinv	0.0293	0.0057	
	(0.0243)	(0.0298)	
infl	0.0241**	0.0360**	0.0106**
	(0.0114)	(0.0153)	(0.0050)
fincrisis		-0.1022**	-0.0721**
		(0.0477)	(0.0295)

VARIABLES	(1) Cost Deviation %	(2) Cost Deviation %	(3) Cost Deviation %
Hypothesis IV – Project determinants (control)			
largeproj	-0.0033		
	(0.0281)		
educ	0.0118	0.0138	0.0242
	(0.0265)	(0.0279)	(0.0300)
transp	-0.0055	-0.0009	-0.0174
	(0.0280)	(0.0280)	(0.0252)
econf	0.0215	0.0286	0.0094
	(0.0253)	(0.0267)	(0.0248)
notcgov	-0.0310	-0.0384*	-0.0306
	(0.0206)	(0.0231)	(0.0197)
Constant	0.0153	0.1659	0.0803**
	(0.0980)	(0.1389)	(0.0332)
Wald Test	0.0000	0.0000	0.0000
Observations	207	208	208

Table 66 – IV Probit Results - Cost deviations – time on cost study

This table presents the results of a IV Probit (Instrumented Variable Probit). The model instrumented variables are identified with the indication of (IV) after the variable name and will be our endogenous variables. Instrument variables *troika*, *ely* and *elylead* are the exogenous variables used with the remaining exogenous variables (*govrw, govmaj, law2008, gdpg, publicinv, infl, fincrisis, largeproj, edu, transp, econf* and *notcgov*). The goal is to test the indirect effect of election years (*troika, ely* and *elylead*) together with the remaining exogenous variables on the endogenous variables. A Newey's two-step estimator is used. Additional tests were made using the predicted residuals (not formally reported, but consistent with the findings) which consisted in running the previous OLS and probit regressions, and then taking the predicted values and reintroducing them into the OLS and probit panel, thus estimating new equations with these instrumented variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Own table.

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns
Instrument variables:		*troika / ely / elylead*	
tdevp	0.5273**	0.6049**	0.3714
	(0.2280)	(0.2784)	(0.3537)
	Hypothesis I – Political determinants		
govrw	-7.0690*	-12.1397**	
	(3.6433)	(5.2353)	
govmaj			5.4391**
			(2.4856)
	Hypothesis II – Governance determinants		
deltarlaw (IV)	-1.4971	-3.2753*	1.1607
	(1.4868)	(1.9172)	(6.1855)
deltacorrp (IV)	-1.2247	-1.1564	-3.6674
	(0.9592)	(1.3934)	(5.8025)
deltaregulq (IV)	0.7266	2.0306	-1.8659
	(1.4603)	(1.9423)	(7.7040)
law2008	-2.2151**		
	(1.0819)		
	Hypothesis III – Economic determinants		
gdpg	-0.9635	-0.6902	-1.9850
	(0.8872)	(1.5122)	(4.8658)
publicinv	-2.0937	-4.7912*	
	(1.8037)	(2.5052)	
infl	1.4585*	2.1106**	1.5607**
	(0.8669)	(1.0358)	(0.7858)
fincrisis		-1.0926	-5.3619
		(2.8487)	(13.6705)

VARIABLES	(1) Cost Overruns	(2) Cost Overruns	(3) Cost Overruns
	Hypothesis IV – Project determinants (control)		
largeproj	0.2087		
	(0.7164)		
educ	0.2664	0.9218	-0.0090
	(1.1673)	(1.2627)	(1.4930)
transp	0.8803	1.0636	1.3485
	(0.7446)	(1.2940)	(4.0424)
econf	0.9040	0.8955	0.7238
	(0.6702)	(1.0547)	(2.8624)
notcgov	-0.2580	-0.9579	0.9010
	(0.8872)	(1.0890)	(1.9455)
Constant	8.5607	20.4437*	-6.3310
	(8.5870)	(11.7610)	(4.4380)
Wald Test	0.0084	0.0000	0.0065
Observations	207	208	208

Table 67 – SEM Results - Cost deviations – time on cost study

This table presents the standardised coefficients of our structural equation modelling. We use such coefficients to calculate indirect and total effects. "*Indirect effects equal the product of coefficients along any series of casual paths that link one variable to another. Total effects equal the sum of all direct and indirect effects linking two variables*" (Hamilton, 2012, p. 250). Therefore, these results allow us to conclude that *ceteris paribus,* one standard deviation increase in one of the model exogenous variable (*ely*, *troika*, *deltacorrp*, *deltarlaw* and *deltaregulq)* increases/decreases the predicted *cdevp* by its total effect (both through direct and indirect effects).

	Direct Effect on *cdevp*	Indirect Effect on *cdevp*			Total Effect on *cdevp*
tdevp	0,2169299				
ely	-0,1496514	-0,0533948 x 0,2169299	=	-0,01158293	-0,161234329
troika	-0,1786978	-0,0827939 x 0,2169299	=	-0,01796047	-0,196658272
deltacorrp	0,2991009	0,0791548 x 0,2169299	=	0,01717104	0,316271943
deltarlaw	-0,1172869	-0,0241146 x 0,2169299	=	-0,00523118	-0,122518078
deltaregulq	0,2452287	0,129243 x 0,2169299	=	0,02803667	0,273265371
Constant	1,255978	0,846745 x 0,2169299	=	0,18368431	1,439662308

Table 68 – GLM Results – Comparative Results

This table presents a comparison of the results of the GLM tests performed in Section 5 to Section 7. Studies are presented in the table columns and the independent variables in the table rows. A minus signal represents that the results of the variable in a specific study was statistically significative and contributed to a decrease in cost or time deviations and overruns, as applicable. A positive signal represents that the results of the variable in a specific study was statistically significative and contributed to an increase in cost or time deviations and overruns, as applicable. NS means that the variable was statistically not significative in such study. A blank space variable means that variable was not used in such specific study. Source: Own table.

GLM					
SECTION	5.1.	5.2.	5.3.	6.	7.
	General Sample	Transport Sample	Local government sample	General Sample	General Sample
VARIABLES	Cost Deviation %	Cost Deviation %	Cost Deviation %	Time Deviation %	Cost Deviation %
tdevp					+
Hypothesis I – Political determinants					
govrw	-	-	+/-	-	NS
govmaj	-	NS	-	+	+
Hypothesis II – Governance determinants					
deltarlaw	-	-	-	NS	NS
deltacorrp	-	-	-	NS	+
deltagoveff		+	+		
law2008	-	-	-	-	-
Hypothesis III – Economic determinants					
gdpg	-	-	-	-	NS
publicinv	+	+	+	NS	NS
infl	+/-	+	+/-	+	+
fincrisis	-	-	-	-	-
Hypothesis IV – Project determinants (control)					
largeproj	NS	NS	NS	NS	NS
educ	+			NS	+
transp	-			NS	NS
econf	-			+	NS
notcgov	+	+		+	NS
pescoalr	NS				
Constant	+/-	+/-	+/-	+	+

Table 69 – Tobit Results - Comparative Results

This table presents a comparison of the results of the Tobit tests performed in Section 5 to Section 7. Studies are presented in the table columns and the independent variables in the table rows. A minus signal represents that the results of the variable in a specific study was statistically significative and contributed to a decrease in cost or time deviations and overruns, as applicable. A positive signal represents that the results of the variable in a specific study was statistically significative and contributed to an increase in cost or time deviations and overruns, as applicable. NS means that the variable was statistically not significative in such study. A blank space variable means that variable was not used in such specific study. Source: Own table.

	Tobit				
SECTION	5.1.	5.2.	5.3.	6.	7.
	General Sample	Transport Sample	Local government sample	General Sample	General Sample
VARIABLES	Cost Deviation %	Cost Deviation %	Cost Deviation %	Time Deviation %	Cost Deviation %
tdevp					+
Hypothesis I – Political determinants					
govrw	-	-	+/-	-	NS
govmaj	-	-	-	+	+
Hypothesis II – Governance determinants					
deltarlaw	-	-	-	NS	NS
deltacorrp	-	-	-	NS	+
deltagoveff		+	+		
law2008	-	-	-	-	-
Hypothesis III – Economic determinants					
gdpg	-	-	-	-	NS
publicinv	+	+	+	NS	NS
infl	+/-	+	+/-	NS	+
fincrisis	-	-	-	-	-
Hypothesis IV – Project determinants (control)					
largeproj	NS	NS	NS	NS	NS
educ	+			NS	NS
transp	-			NS	NS
econf	-			+	NS
notcgov	NS	NS		+	NS
pescoalr	+				
Constant	+/-	+/-	+/-	+	+

Table 70 –Probit Results - Comparative Results

This table presents a comparison of the results of the Probit tests performed in Section 5 to Section 7. Studies are presented in the table columns and the independent variables in the table rows. A minus signal represents that the results of the variable in a specific study was statistically significative and contributed to a decrease in cost or time deviations and overruns, as applicable. A positive signal represents that the results of the variable in a specific study was statistically significative and contributed to an increase in cost or time deviations and overruns, as applicable. NS means that the variable was statistically not significative in such study. A blank space variable means that variable was not used in such specific study. Source: Own table.

	Probit				
SECTION	5.1.	5.2.	5.3.	6.	7.
	General Sample	Transport Sample	Local government sample	General Sample	General Sample
VARIABLES	Cost Overruns	Cost Overruns	Cost Overruns	Time Overruns	Cost Overruns
tdevp					+
Hypothesis I – Political determinants					
govrw	-/+	-/+	+/-	NS	NS
govmaj	-	-	-	+	+
Hypothesis II – Governance determinants					
deltarlaw	+/-	-	+/-	+	+
deltacorrp	-	-	-	NS	-
deltagoveff		+	+		
law2008	-	-	-	-	-
Hypothesis III – Economic determinants					
gdpg	-	-	-	-	-
publicinv	+	+	+	NS	NS
infl	-/+	+	+/-	NS	NS
fincrisis	-	-	-	-	-
Hypothesis IV – Project determinants (control)					
largeproj	NS	NS	NS	NS	NS
educ	+			NS	NS
transp	-			+	NS
econf	-			+	NS
notcgov	-	NS		+	+
pescoalr	+				
Constant	+/-	+/-	+/-	+	+

Table 71 – IV Reg Results - Comparative Results

This table presents a comparison of the results of the IV Reg tests performed in Section 5 to Section 7. Studies are presented in the table columns and the independent variables in the table rows. A minus signal represents that the results of the variable in a specific study was statistically significative and contributed to a decrease in cost or time deviations and overruns, as applicable. A positive signal represents that the results of the variable in a specific study was statistically significative and contributed to an increase in cost or time deviations and overruns, as applicable. NS means that the variable was statistically not significative in such study. A blank space variable means that variable was not used in such specific study. Source: Own table.

IV Reg					
SECTION	5.1.	5.2.	5.3.	6.	7.
	General Sample	Transport Sample	Local government sample	General Sample	General Sample
VARIABLES	Cost Deviation %	Cost Deviation %	Cost Deviation %	Time Deviation %	Cost Deviation %
Instrument variables:	*elylag / ely / elylead*				
tdevp					+
Hypothesis I – Political determinants					
govrw	-	-	-	-	-
govmaj	NS	+	-	+	+
Hypothesis II – Governance determinants					
deltarlaw (IV)	-	-	-	NS	-
deltacorrp (IV)	-/+	-	+	NS	NS
deltagoveff (IV)	-/+	-	-	-	-
law2008	-	-	-	-	NS
Hypothesis III – Economic determinants					
gdpg	-/+	-	-/+	-	-
publicinv	+	+	+	NS	NS
infl	+	+	+	+	+
fincrisis	-	-	-	-	-
Hypothesis IV – Project determinants (control)					
largeproj	NS	NS	NS	NS	NS
educ	+			NS	NS
transp	-			-	NS
econf	-			+	NS
notcgov	+	+		NS	-
pescoalr	NS				NS
Constant	+/-	-	+/-	+	+

Table 72 – IV Probit Results - Comparative Results

This table presents a comparison of the results of the IV Probit tests performed in Section 5 to Section 7. Studies are presented in the table columns and the independent variables in the table rows. A minus signal represents that the results of the variable in a specific study was statistically significative and contributed to a decrease in cost or time deviations and overruns, as applicable. A positive signal represents that the results of the variable in a specific study was statistically significative and contributed to an increase in cost or time deviations and overruns, as applicable. NS means that the variable was statistically not significative in such study. A blank space variable means that variable was not used in such specific study. Source: Own table.

IV Probit					
SECTION	5.1.	5.2.	5.3.	6.	7.
	General Sample	Transport Sample	Local government sample	General Sample	General Sample
VARIABLES	Cost Overruns	Cost Overruns	Cost Overruns	Time Overruns	Cost Overruns
Instrument variables:	*troika / ely / elylead*		*troika / munely / munelylead*	*troika / ely / elylead*	
tdevp					+
Hypothesis I – Political determinants					
govrw	+	NS	-	-	-
govmaj	+	+	+	NS	+
Hypothesis II – Governance determinants					
deltarlaw (IV)	+/-	-	-	NS	-
deltacorrp (IV)	-	-	-	NS	NS
deltaregulq (IV)	-/+	NS	+	NS	NS
law2008	-	-	-	NS	-
Hypothesis III – Economic determinants					
gdpg	-	-	-	NS	NS
publicinv	+	NS	-	NS	-
infl	+	+	+	NS	+
fincrisis	-	-	-	NS	NS
Hypothesis IV – Project determinants (control)					
largeproj	-	NS	NS	NS	NS
educ	NS			NS	NS
transp	-			+	NS
econf	-			NS	NS
notcgov	NS	NS		NS	NS
pescoalr	+				
Constant	-	NS	+/-	NS	+

Figure 1– Relations between explanations, causes, and supporting theories

This figure presents a graphic illustration summary of the conclusions reached by Cantarelli et al. (2010). It represents the emerging literature relationships between theory, explanations, and causes for cost overruns. Source: Own Figure, adapted from Cantarelli et al. (2010).

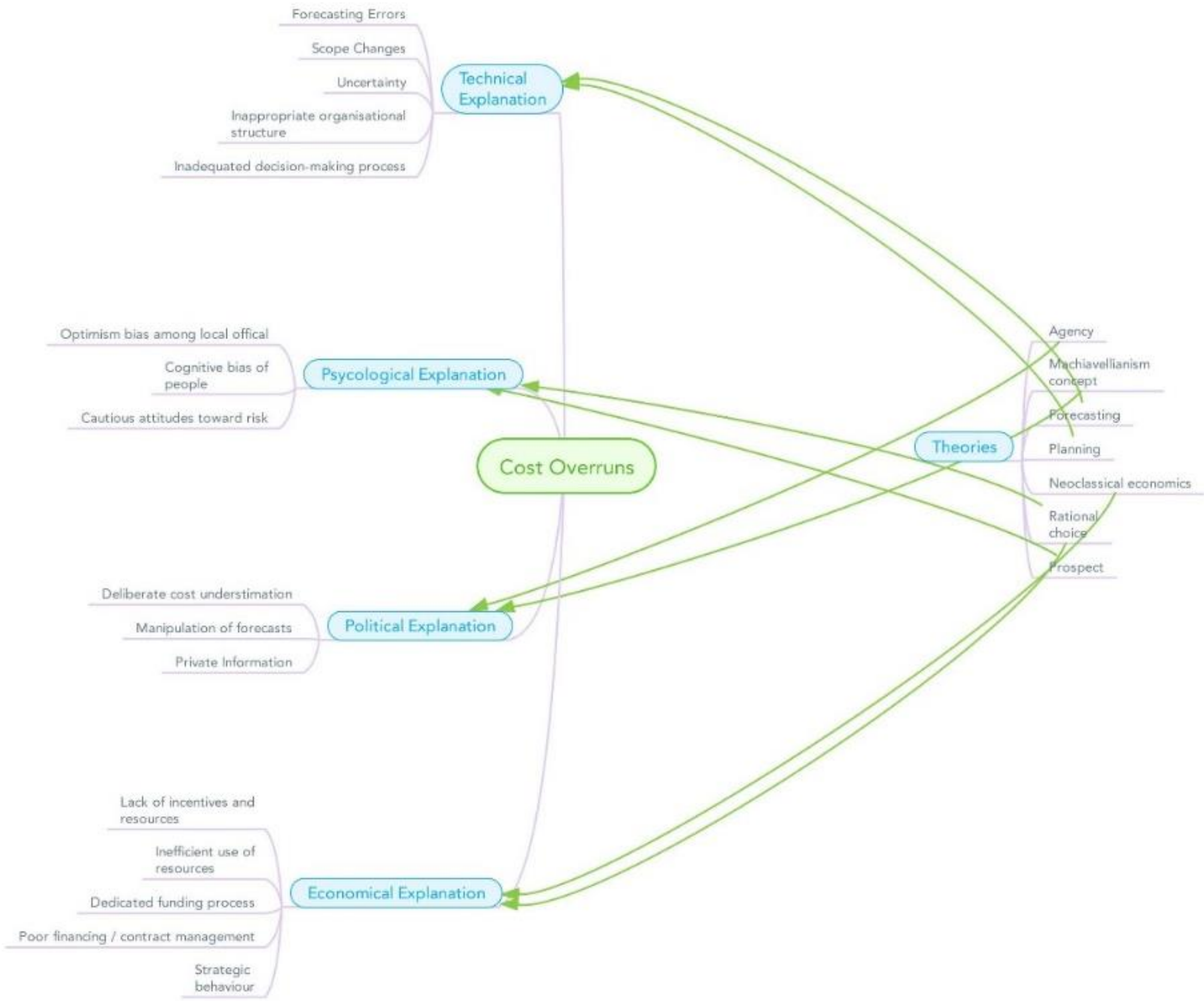


Figure 2 – Research Mind Mapping

This figure presents the research mind mapping diagramme of our research. It should be read from left to right. It starts with the theories and explanations that emerge from the literature review, then flows through the definition of the supporting hypotheses, and ends with the independent variables studied. Branch colours indicate the link between the literature review and theoretical framework built to sustain the chosen theories, formulated hypothesis and consequently the independent variables used. Source: Own Figure.

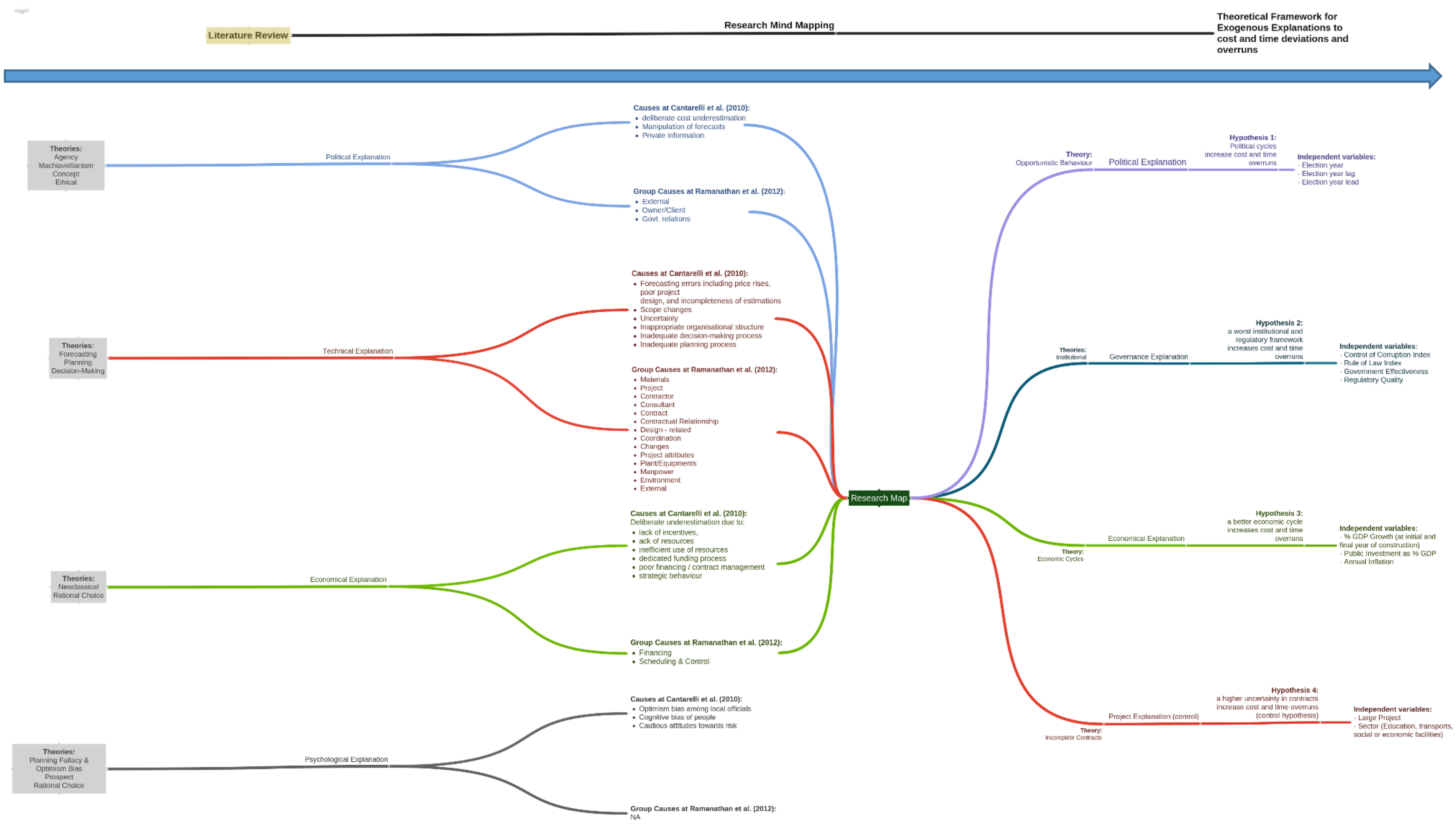


Figure 3 –Model of Conceptual Analysis

This figure presents the model of conceptual analysis that enable the identification of the existence of the conceptual ties that support the models developed. Branch colours indicate the link between the built theoretical framework and the studies carried out in our research. Colour scheme follows that of Figure 2. Source: Own Figure.

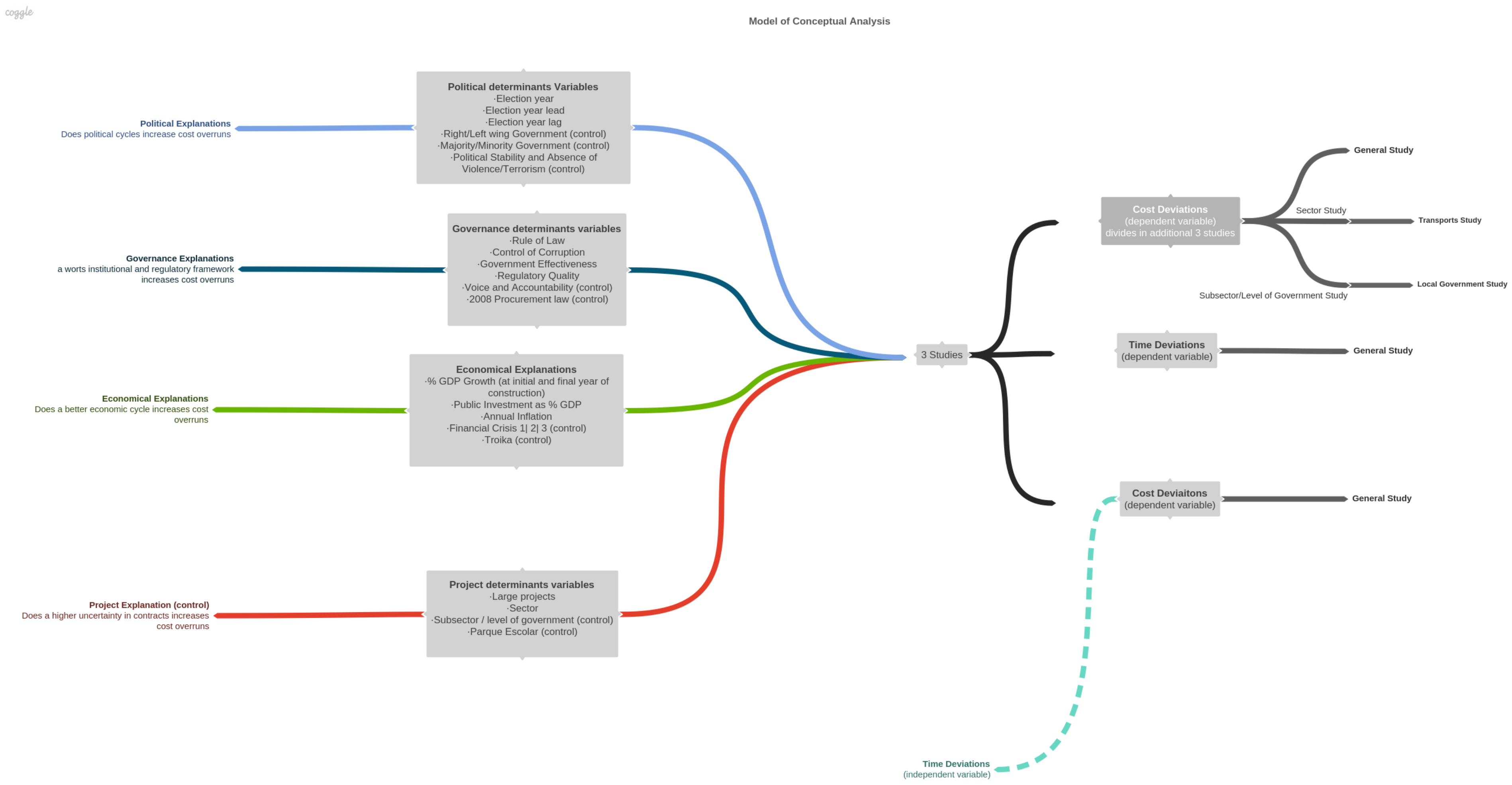


Figure 4 – Cost deviation - Leverage versus the squared residuals of data plot

This graph plots leverage against the squares of the normalised residuals. To plot this graph, we used the complete sample data (cost deviations complete sample). Additionally, the points were labelled on the graph with the *cdev* figures for each observation. This graph aims to identify that our sample seems to present some problems in terms of residuals distribution. The existence of outliers is immediately observed. We can observe that all the points presented in the left-higher or right-lower quadrants of the plot have either high leverage, or large residuals which are an indication of non-normality. This problem will be addressed before any econometric test is performed. Source: Stata.

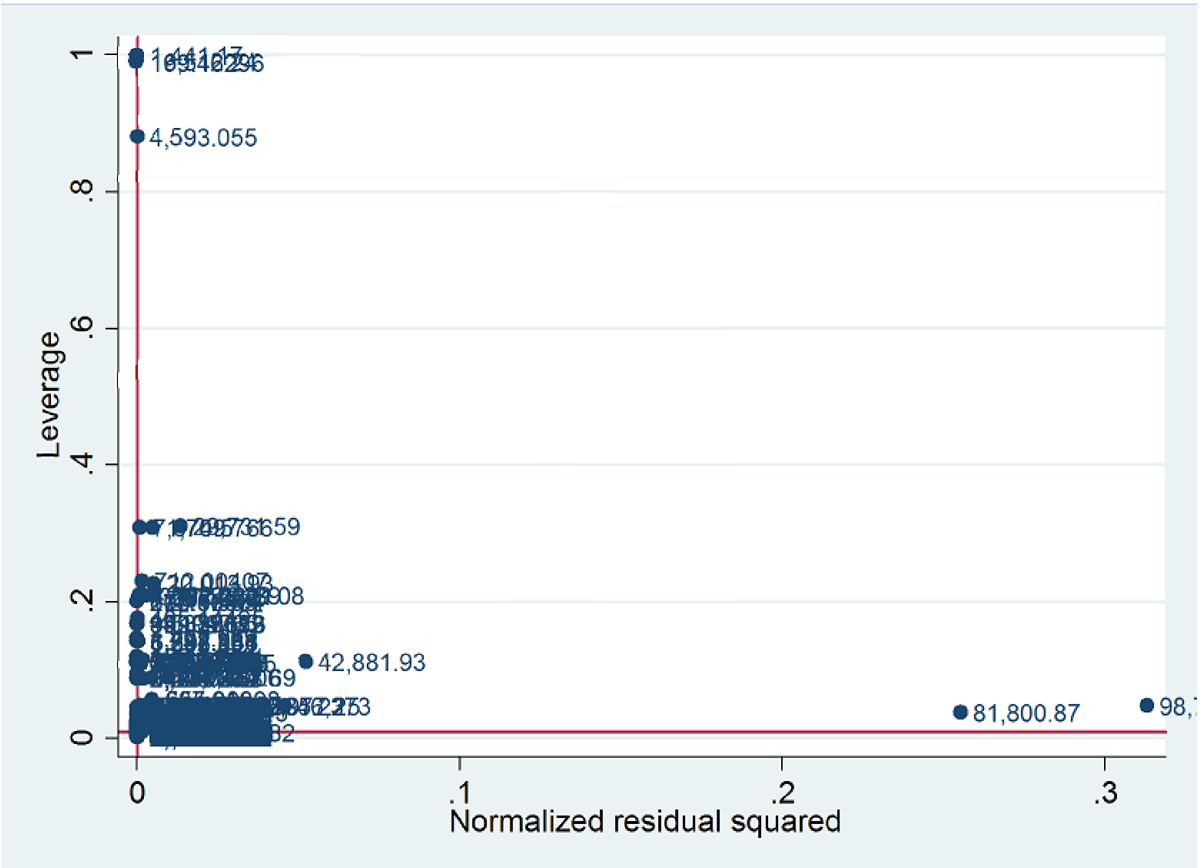


Figure 5 – Cost deviation – Univariate Kernel density plot

This figure presents a plot that aims to approximate the probability density of the variable. Additionally, a normal density is overlaid on the density estimate for comparison. To plot this graph, we used the complete sample data (cost deviations complete sample). This graph aims to identify that our sample seems to present some problems in terms of the residuals distribution. We can observe that the graph shows that the kernel density is more peaked than the normal distribution, which is an indication of non-normality. This problem will be addressed before any econometric test is performed. Source: Stata.

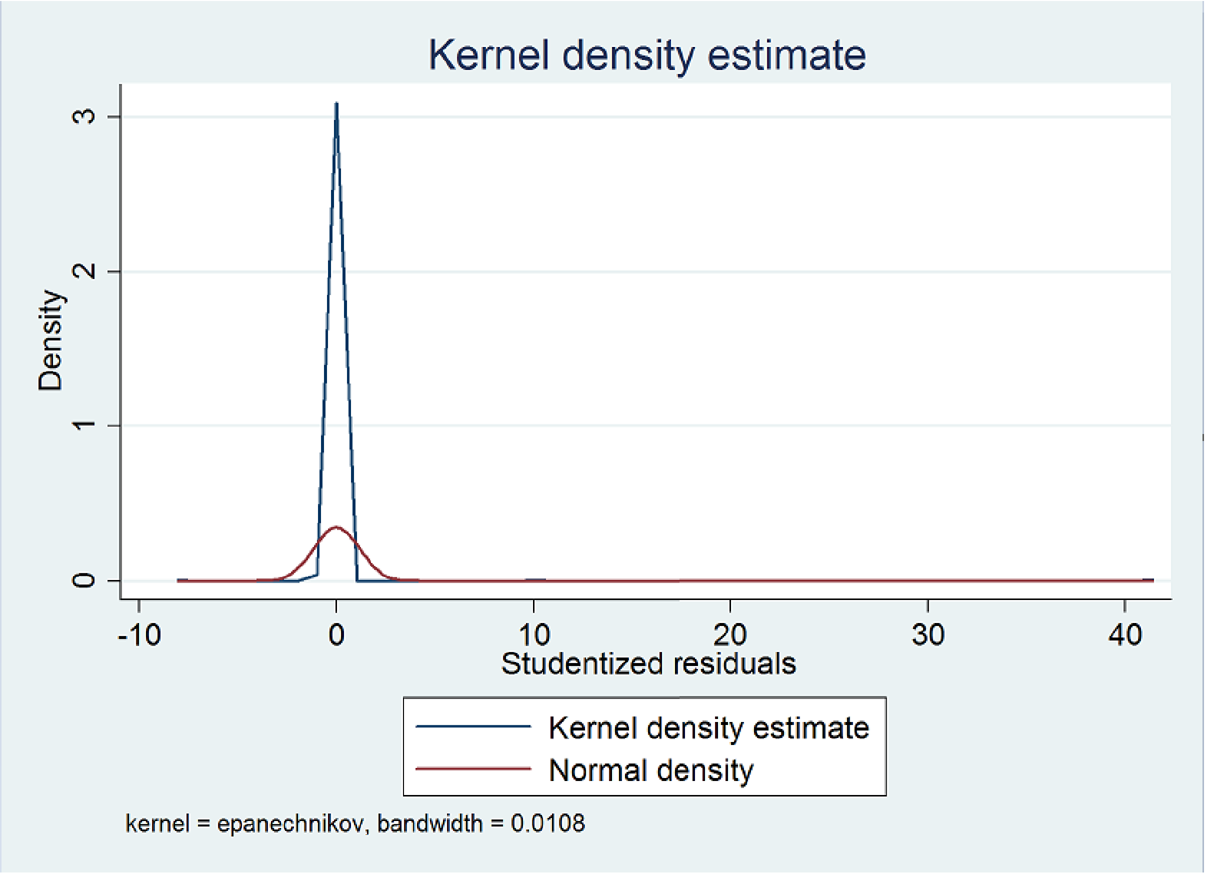


Figure 6 – Cost deviation - Normal probability plot

This figure presents a normal probability plot which plots the residuals against a fit line in order to analyse the distribution of variables. The graph aims to assess the normality of the bootstrap distribution by using a normal probability plot. To plot this graph, we used the complete sample data (cost deviations complete sample). This graph aims to identify that our sample seems to present some problems in terms of the residuals distribution since the spread of the points to the horizontal line on the normal probability plot is an indication of non-normality of the bootstrap distribution. This problem will be addressed before any econometric test is performed. Source: Stata.

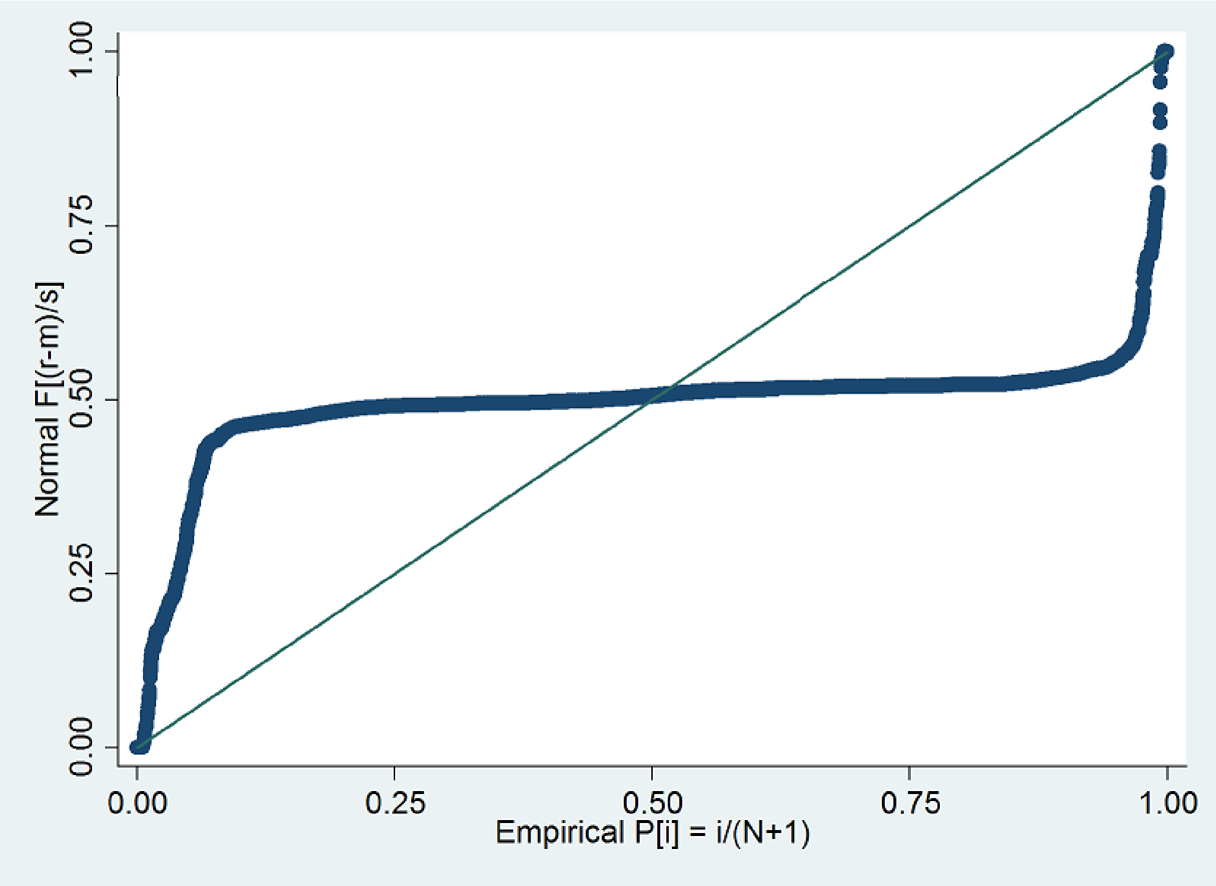


Figure 7 –Cost Deviation - Graph box plot for cdevp variable

This figure presents a boxplot for *cdevp.* The purpose of this plot is to confirm that *cdevp* has right skewness and to confirm the presence of outlier observations. To plot this graph, we used the complete sample data (cost deviations complete sample). This graph aims to identify outside points that may represent some problems in terms of the residuals distribution, as this is an indication of non-normality of the distribution. This problem will be addressed before any econometric test is performed. Source: Stata.

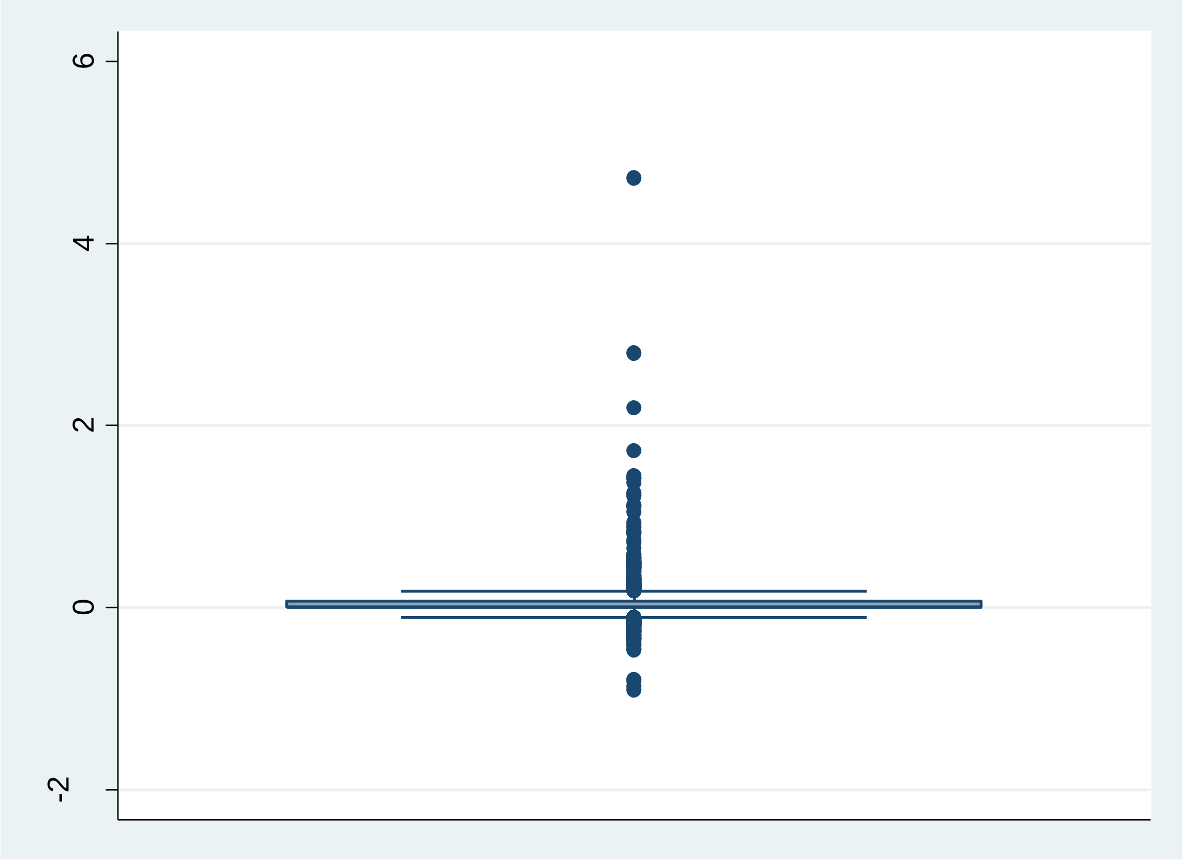


Figure 8 – Cost deviation - Leverage versus the squared residuals of data plot (after dropping outliers)

This graph plots leverage against the squares of the normalised residuals. To plot this graph, we used the complete sample data after dropping the outlier observations (cost deviation final sample). Additionally, the points were labelled on the graph with the *cdev* figures for each observation. This graph aims to identify that our sample continues to present some problems in terms of the residuals distribution. We can observe that all the points presented in the left-higher or right-lower quadrants of the plot have either high leverage, or large residuals which are an indication of non-normality. Source: Stata.

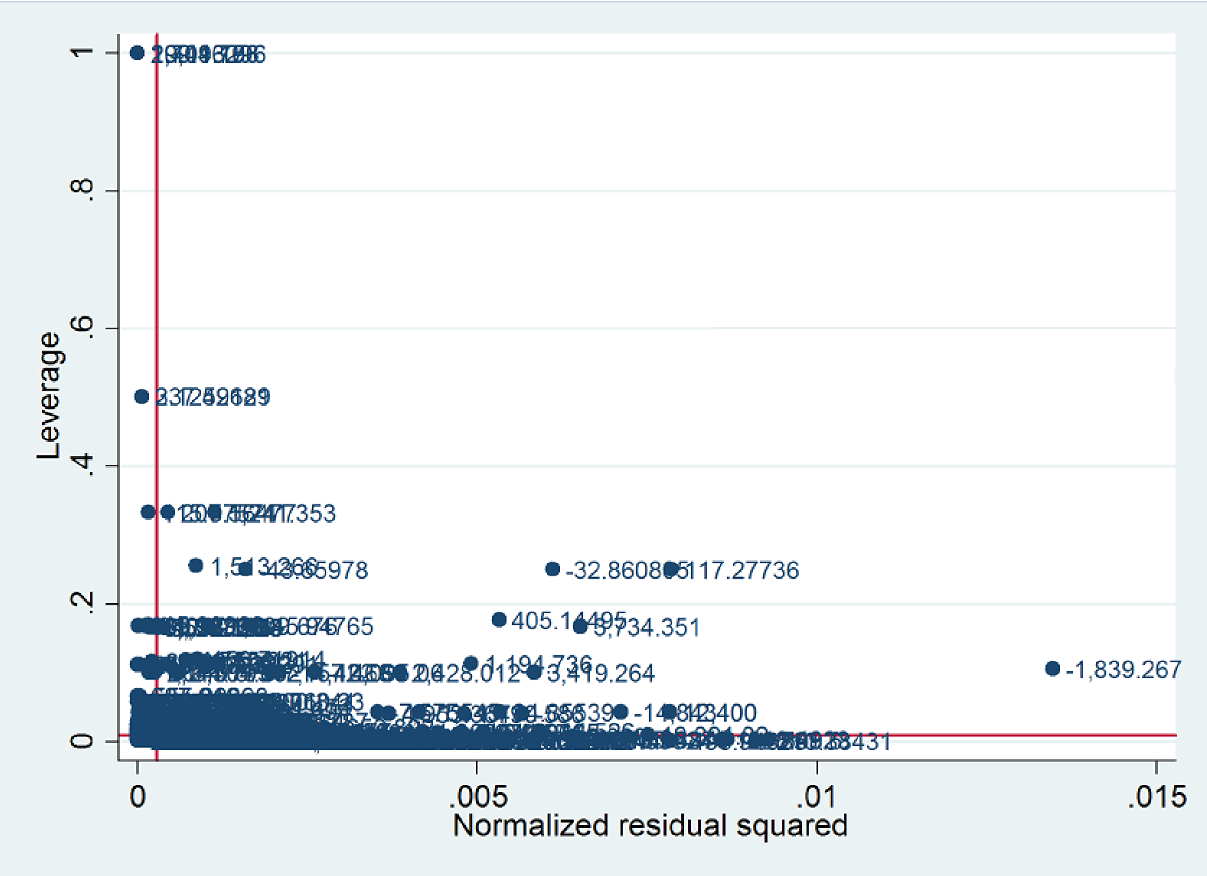


Figure 9 – Cost deviation – Univariate Kernel density plot (after dropping outliers)

This figure presents a plot that aims to approximate the probability density of the variable. Additionally, a normal density is overlaid on the density estimate for comparison. To plot this graph, we used the complete sample data after dropping the observations of the outliers (cost deviation final sample). The graph shows that the kernel density continues to be more peaked than the normal distribution. Source: Stata

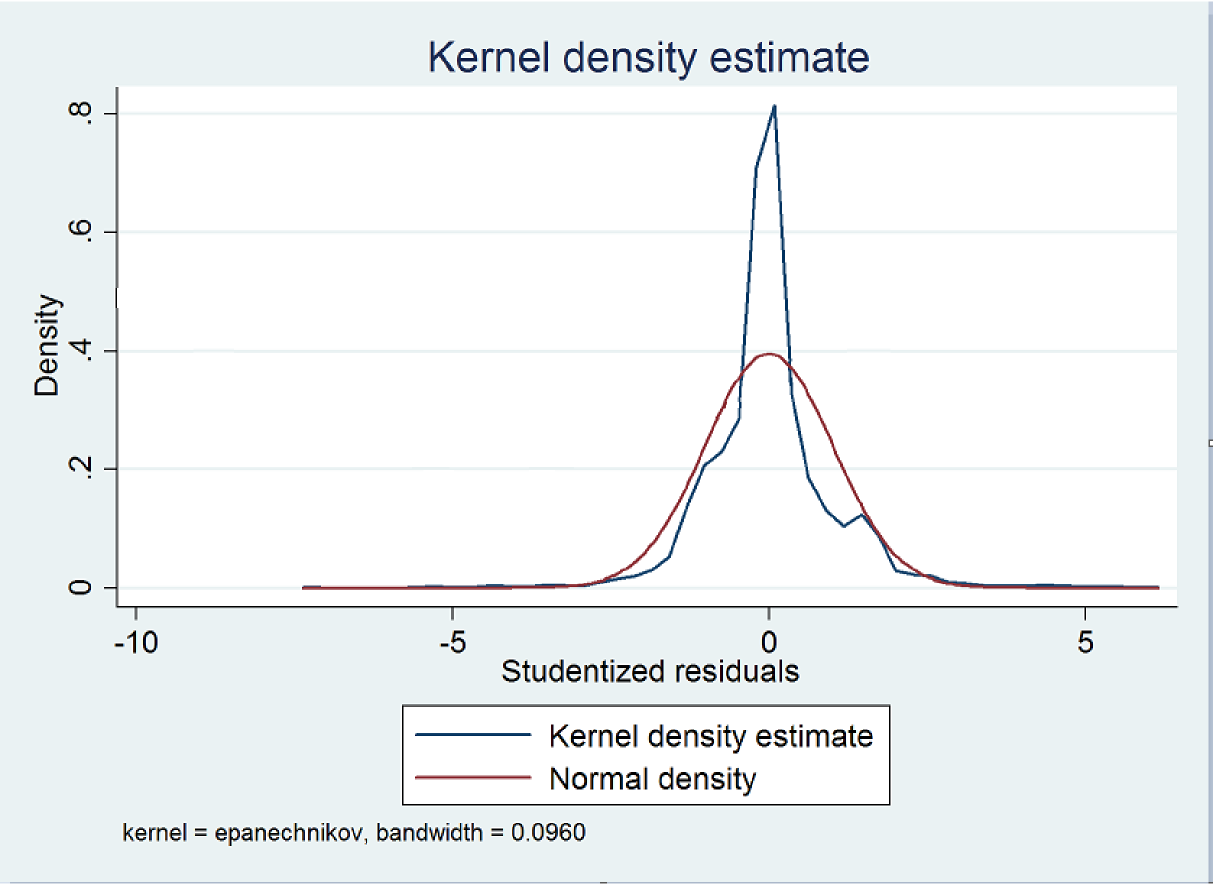


Figure 10 – Cost deviation - Normal probability plot (after dropping outliers)

This figure presents a normal probability plot which plots the residuals against a fit line in order to analyse the distribution of variables. The graph aims to assess the normality of the bootstrap distribution by using a normal probability plot. To plot this graph, we used the complete sample data after dropping the observations of the outliers (cost deviation final sample). This graph aims to identify that our sample seems to present some problems in terms of the residuals distribution. It is possible to observe that although the values fall more consistently along the diagonal line and with less significant or systematic departures, the residuals are still considered to fail a distribution close to a normal distribution. Source: Stata.

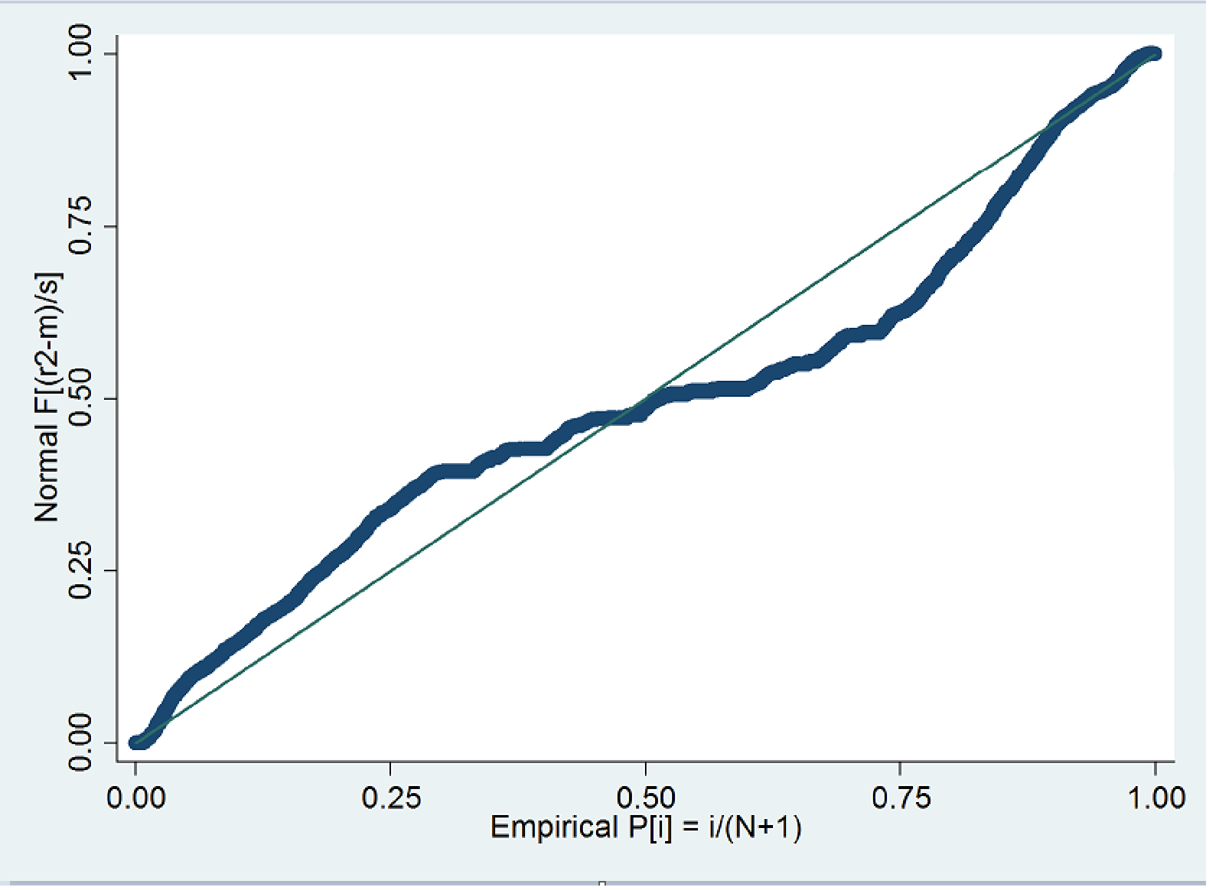


Figure 11 – Time deviation - Leverage versus the squared residuals of data plot

This graph plots leverage against the squares of the normalised residuals. To plot this graph, we used the complete sample data (time deviations complete sample). Additionally, the points were labelled on the graph with the *tdev* figures for each observation. This graph aims to identify that our sample seems to present some problems in terms of the residuals distribution. The existence of outliers is immediately observed. We can observe that all the points presented in the left-higher or right-lower quadrants of the plot have either high leverage or large residuals which are an indication of non-normality. This problem will be addressed before any econometric test is performed. Source: Stata.

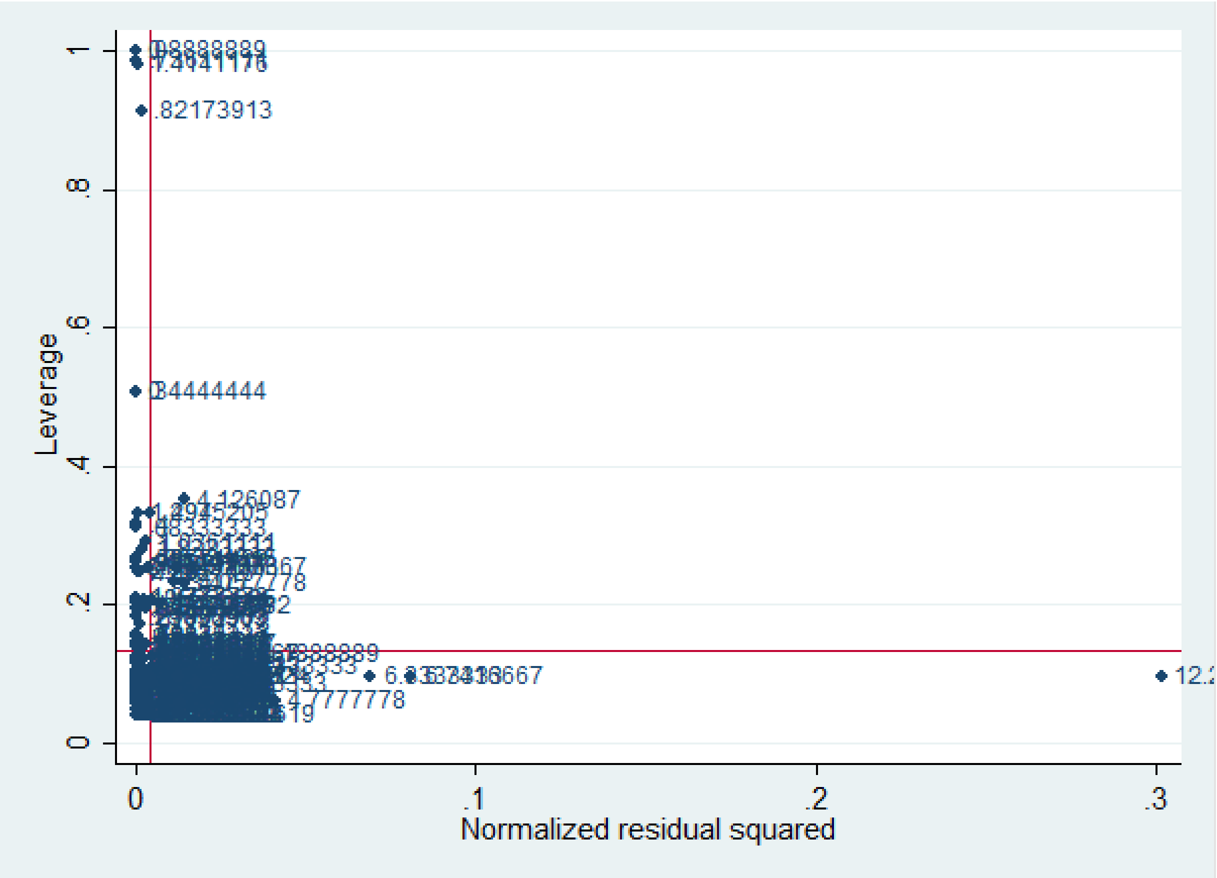


Figure 12 – Time deviation – Univariate Kernel density plot

This figure presents a plot that aims to approximate the probability density of the variable. Additionally, a normal density is overlaid on the density estimate for comparison. To plot this graph, we used the complete sample data (time deviations complete sample). This graph aims to identify that our sample seems to present some problems in terms of the residuals distribution. We can observe that the graph shows that the kernel density is more peaked than the normal distribution, which is an indication of non-normality. This problem will be addressed before any econometric test is performed. Source: Stata.

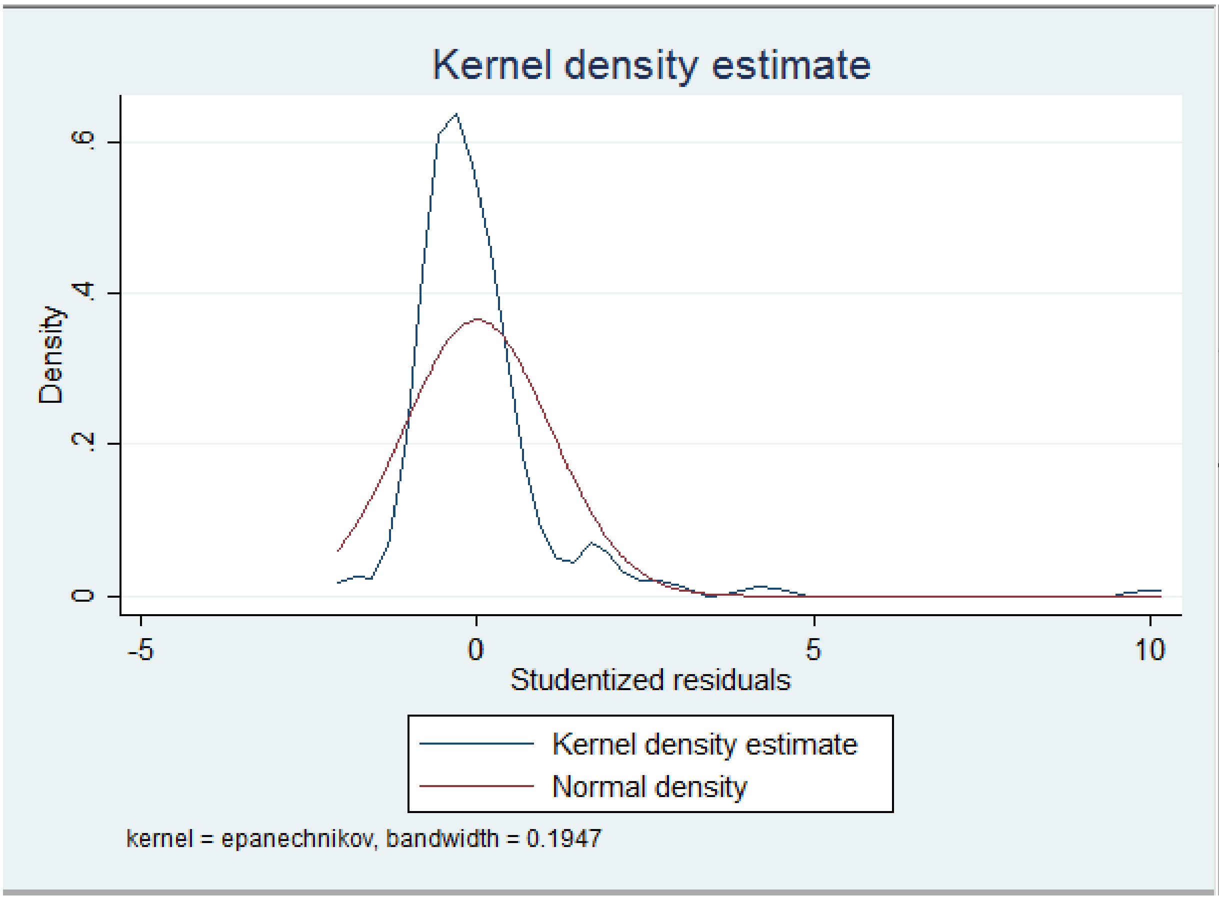


Figure 13 – Time deviation - Normal probability plot

This figure presents a normal probability plot which plots the residuals against a fit line in order to analyse the distribution of variables. The graph aims to assess the normality of the bootstrap distribution by using a normal probability plot. To plot this graph, we used the complete sample data (time deviations complete sample). This graph aims to identify that our sample seems to present some problems in terms of the residuals distribution, as the spread of the points to the horizontal line on the normal probability plot is an indication of non-normality of the bootstrap distribution. This problem will be addressed before any econometric test is performed. Source: Stata.

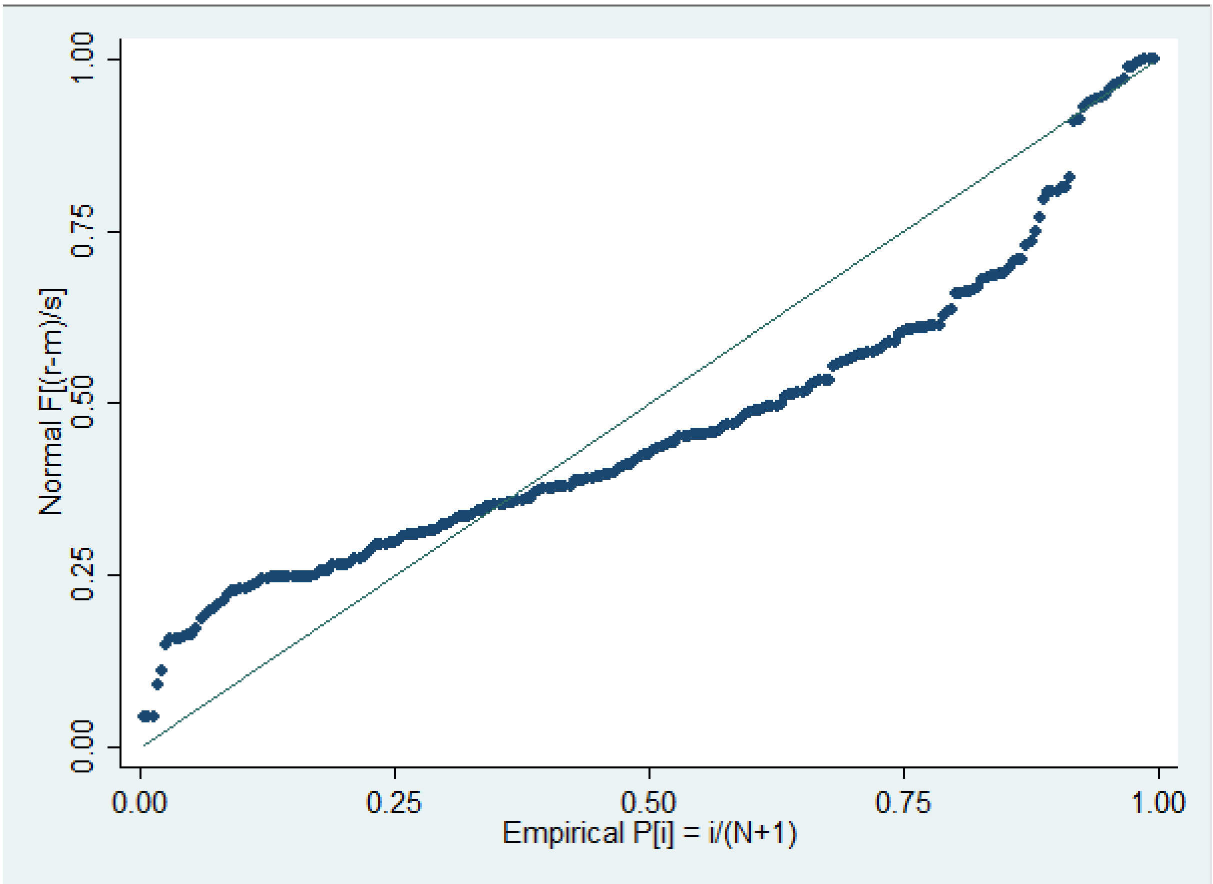


Figure 14 –Time Deviation - Graph box plot for tdevp variable

This figure presents a boxplot for *tdevp*. The purpose of this plot is to confirm that *tdevp* has right skewness and to confirm the presence of outlier observations. To plot this graph, we used the complete sample data (time deviations complete sample). This graph aims to identify outside points that may represent some problems in terms of the residuals distribution since it is an indication of non-normality of the distribution. This problem will be addressed before any econometric test is performed. Source: Stata.

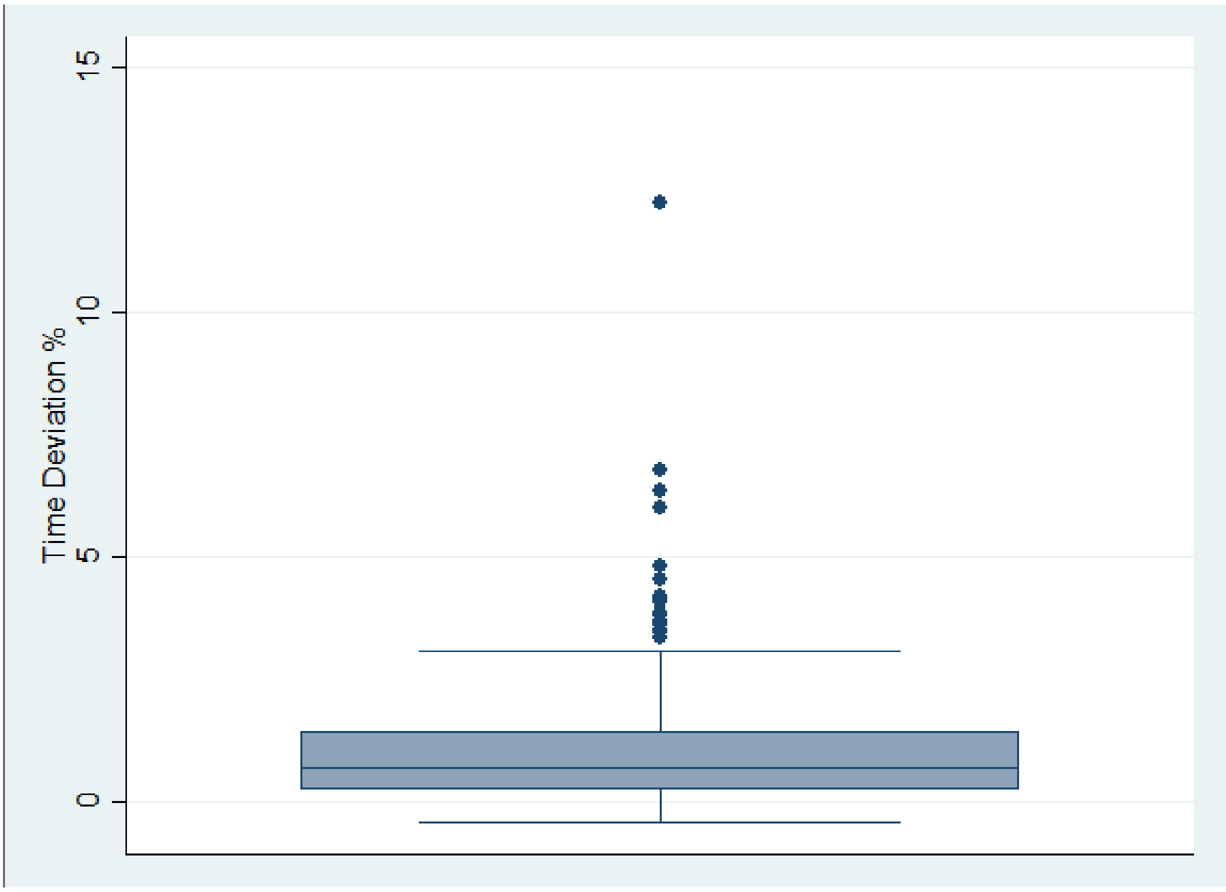


Figure 15 – Time deviation - Leverage versus the squared residuals of data plot (after dropping outliers)

This graph plots leverage against the squares of the normalised residuals. To plot this graph, we used the complete sample data after dropping the observations of outliers (time deviation final sample). Additionally, the points were labelled on the graph with the *tdev* figures for each observation. This graph aims to identify that our sample continues to present some problems in terms of the residuals distribution. We can observe that all the points presented in the left-higher or right-lower quadrants of the plot have either high leverage or large residuals, which are an indication of non-normality. Source: Stata.

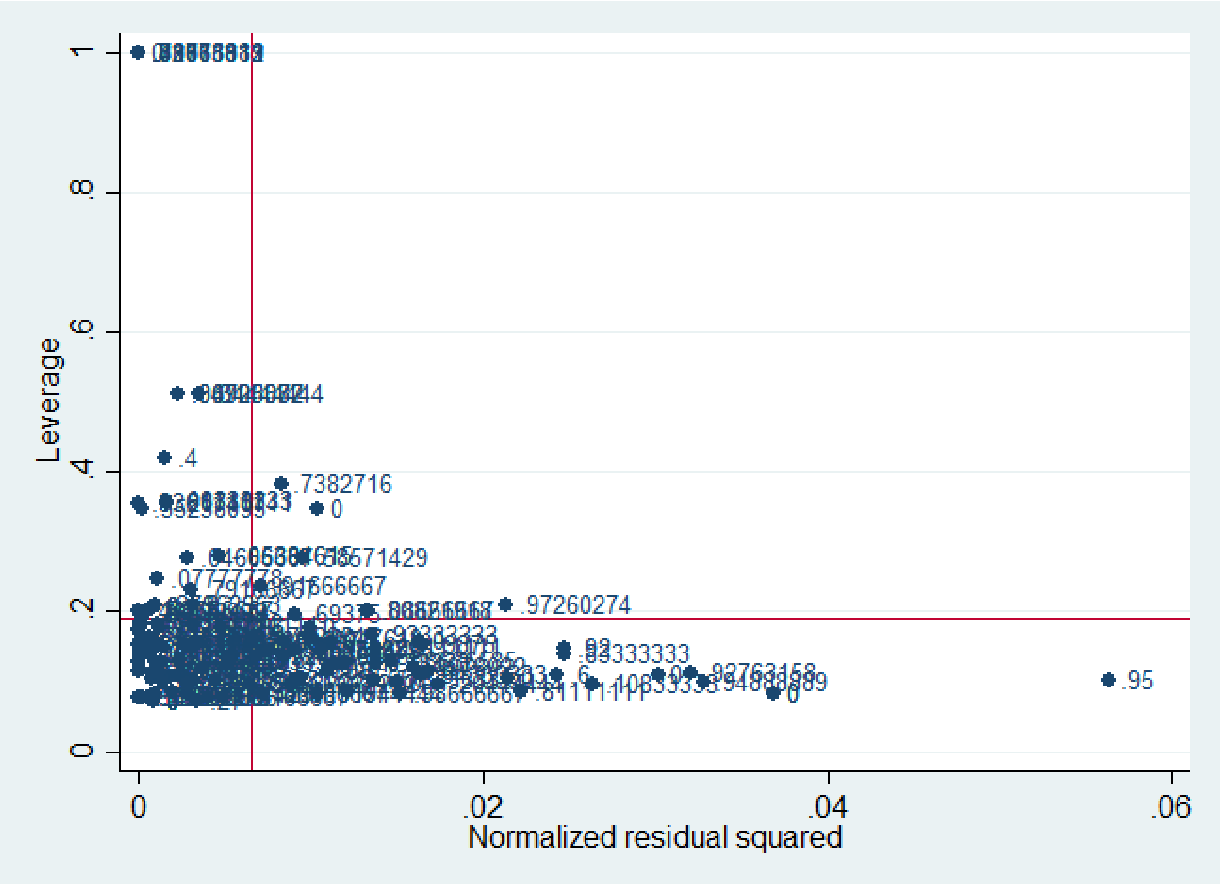


Figure 16 – Time deviation - Kernel density plot (after dropping outliers)

This figure presents a plot that aims to approximate the probability density of the variable. Additionally, a normal density is overlaid on the density estimate for comparison. To plot this graph, we used the complete sample data after dropping the outlier observations (time deviation final sample). The graph shows that the kernel density continues to be more peaked than the normal distribution. Source: Stata

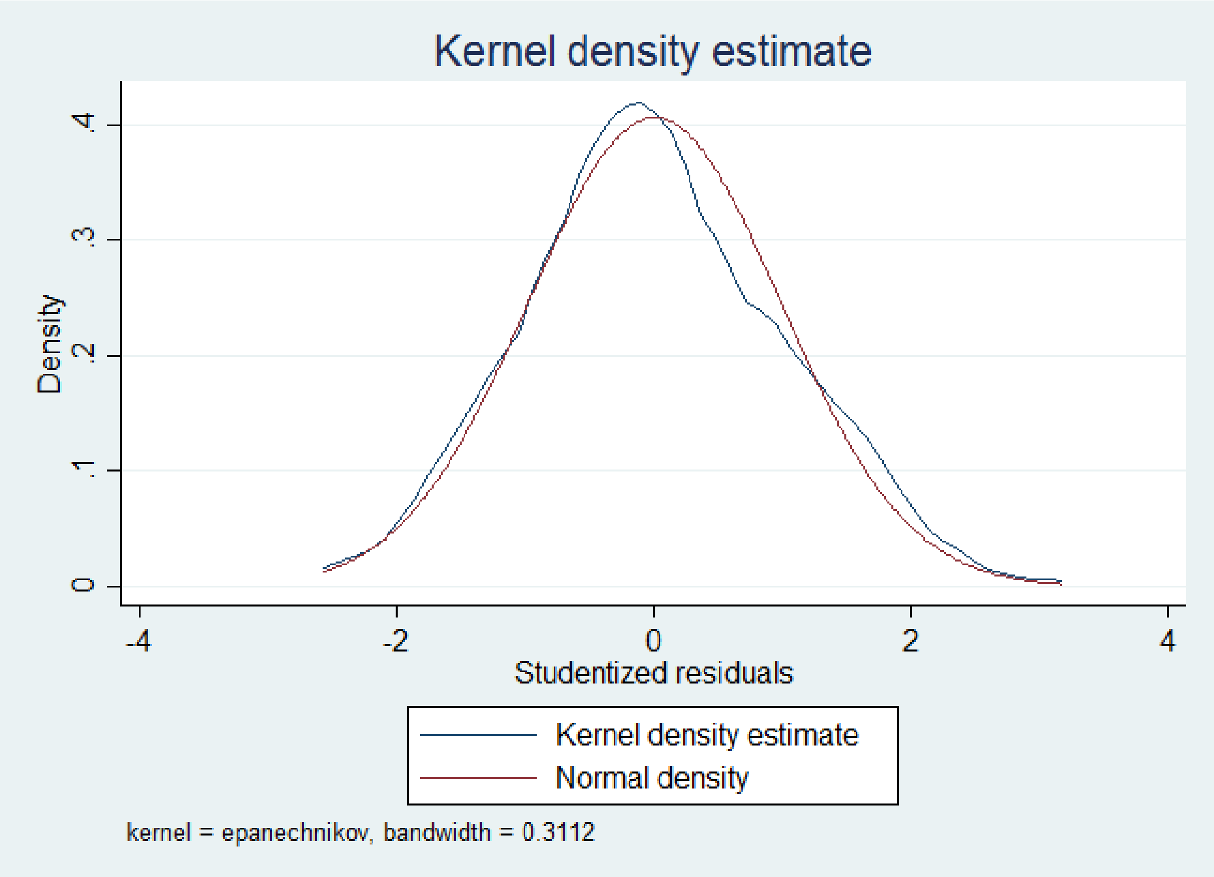


Figure 17 – Time deviation - Normal probability plot (after dropping outliers)

This figure presents a normal probability plot which plots the residuals against a fit line in order to analyse the distribution of variables. The graph aims to assess the normality of the bootstrap distribution by using a normal probability plot. To plot this graph, we used the complete sample data after dropping the outlier observations (time deviation final sample). This graph aims to identify that our sample seems to present some problems in terms of the residuals distribution. Is possible to observe that although the values fall more consistently along the diagonal line and with less significant or systematic departures, the residuals are still considered to fail a distribution close to a normal distribution. Source: Stata.

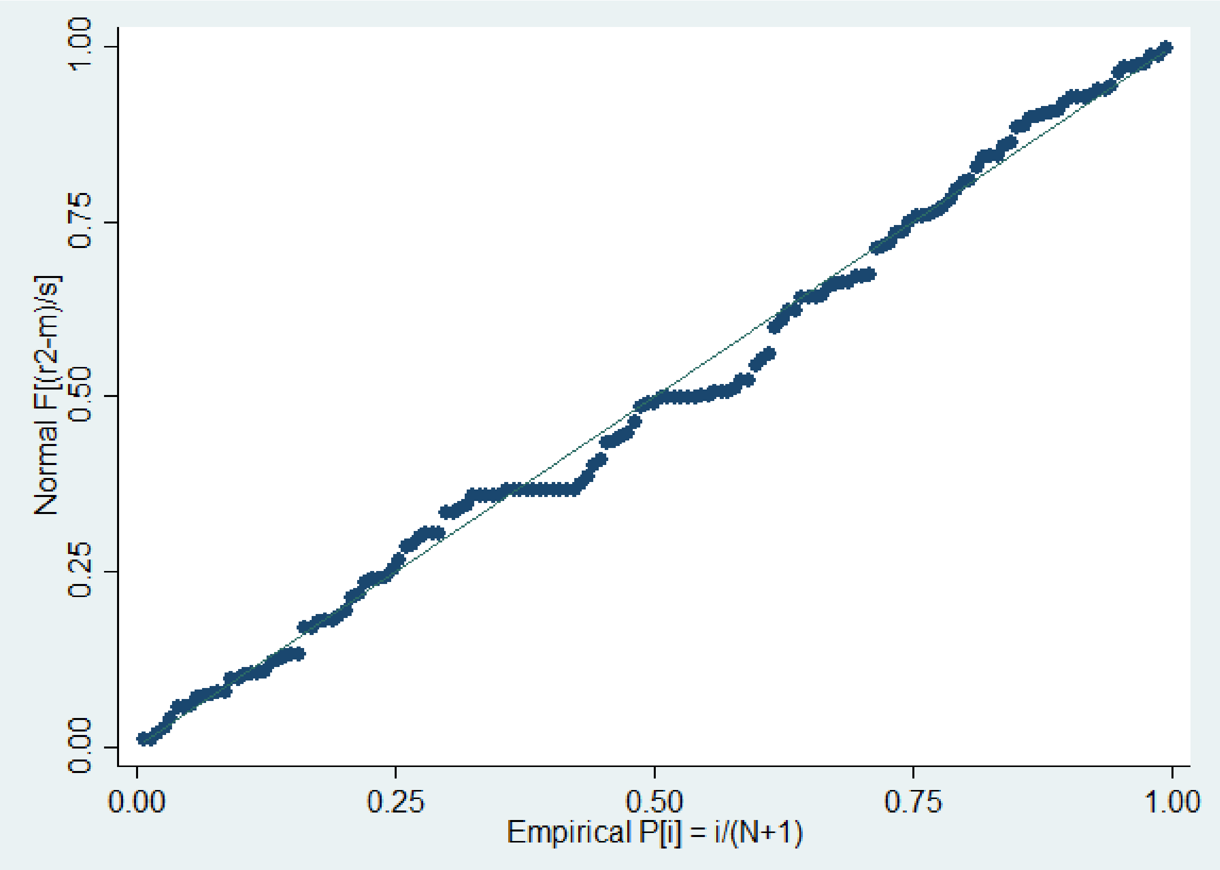


Figure 18 – Year Start and cost deviation correlation

This figure presents a scatter plot graph where X is the Year Start (year where the public project started construction) and Y is the cost deviation%. The fitted values line shows a negative correlation between these two variables.

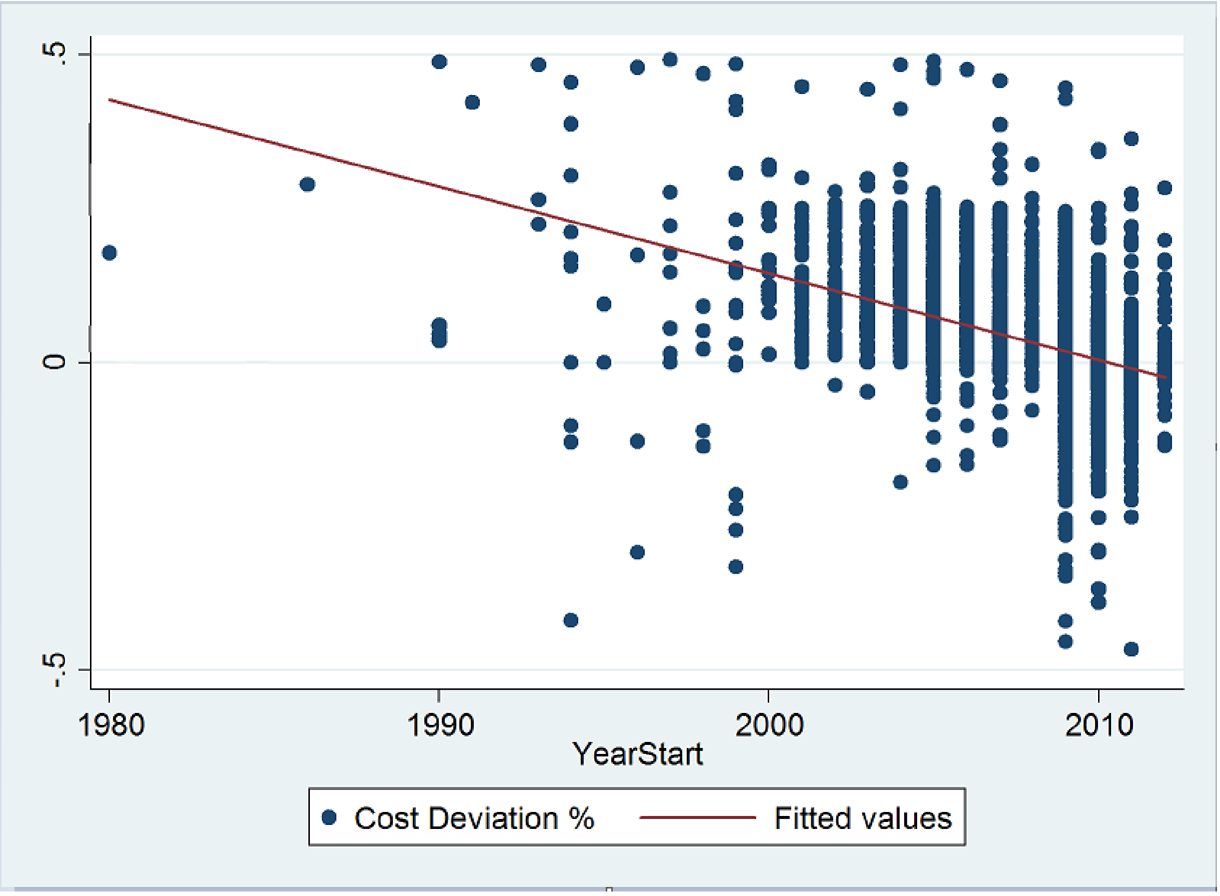


Figure 19 – Budget cost and cost deviation correlation

This figure presents a scatter plot graph where X is the budget cost (the log of the values) and Y is the cost deviation%. The fitted values line shows no evidence that large projects are more prone to deviations (positive or negative).

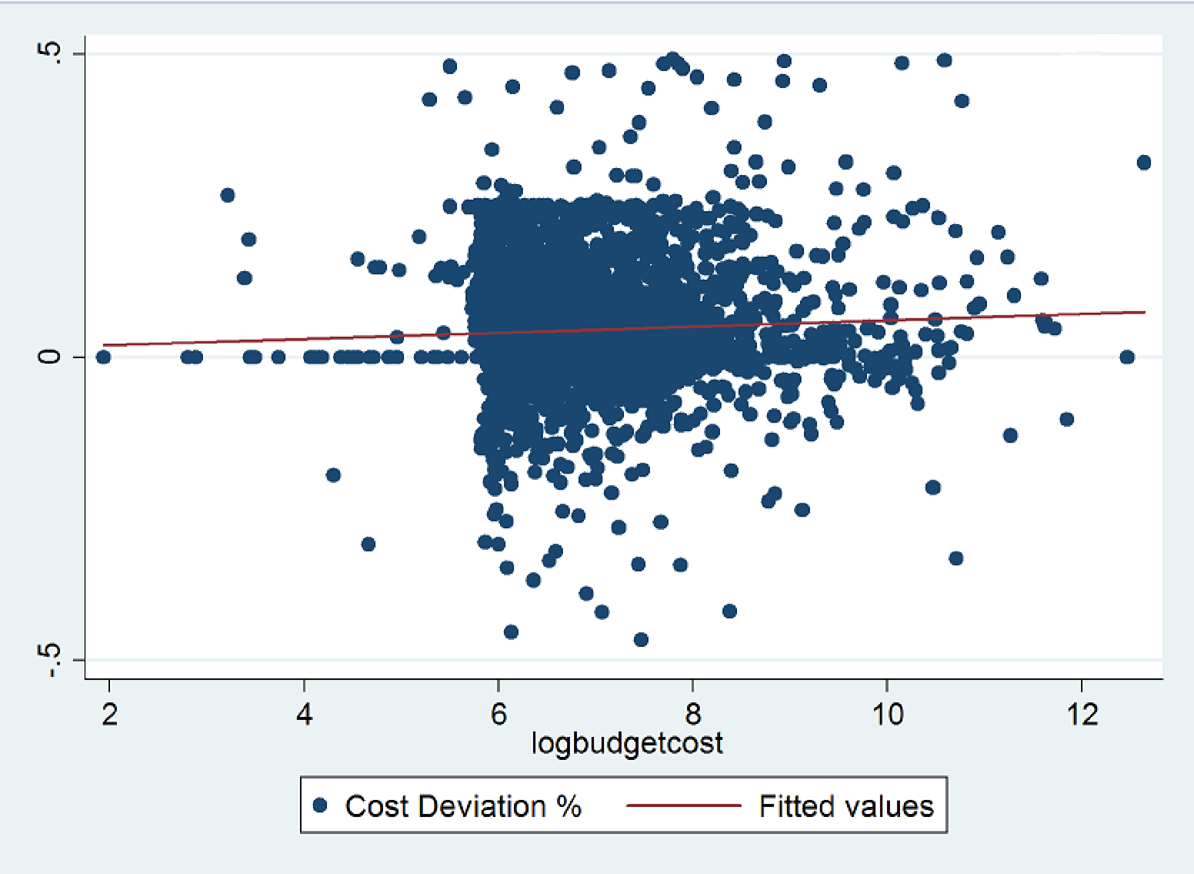


Figure 20 – Parque Escolar and cost deviation correlation

This figure presents a scatter plot graph where X is the Parque Escolar investment programme observations and Y is the cost deviation%. The fitted values line shows no evidence that Parque Escolar projects were more efficient in reducing cost deviations.

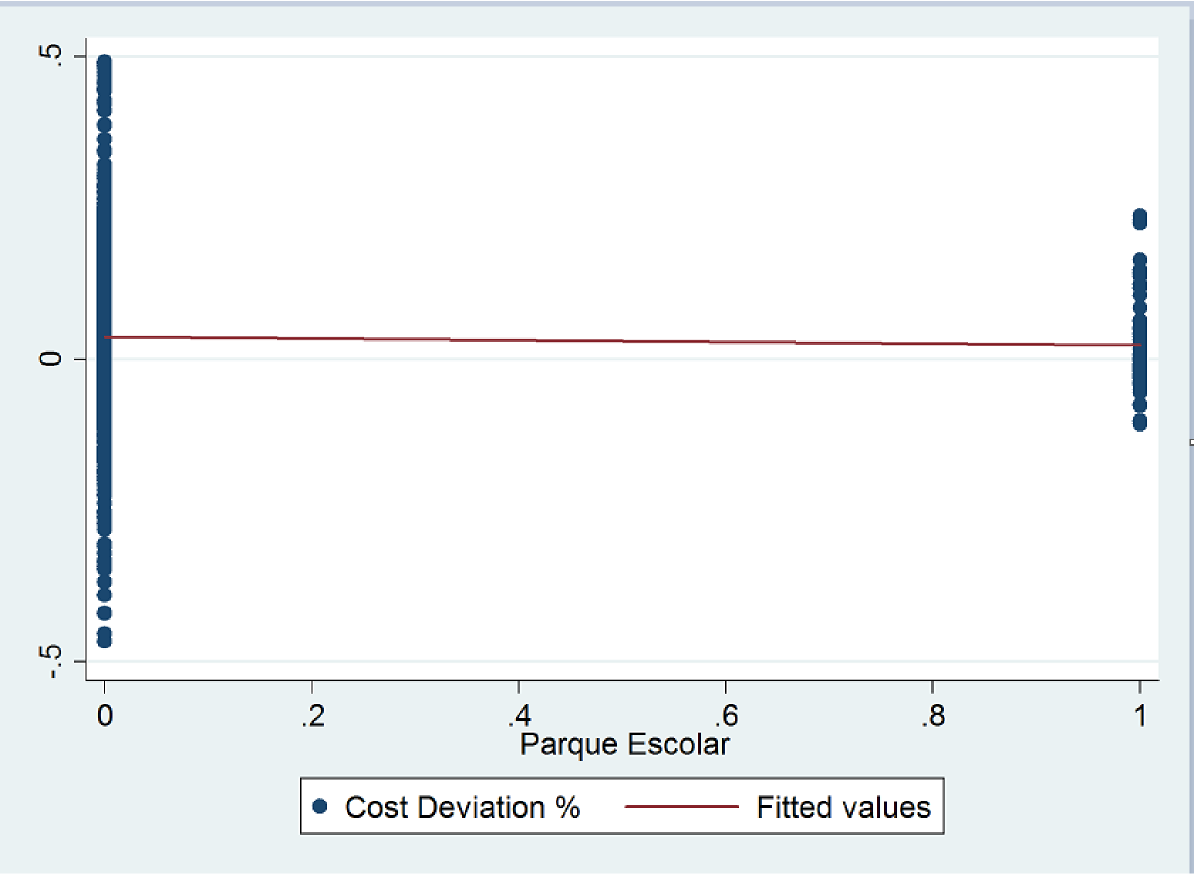


Figure 21 – Financial crisis and cost deviation correlation

This figure presents a scatter plot graph where X represents the 2008 Financial Crisis and Y is the cost deviation%. The fitted values line shows some negative correlation between these two variables. Cost deviations have decrease with the financial crisis.

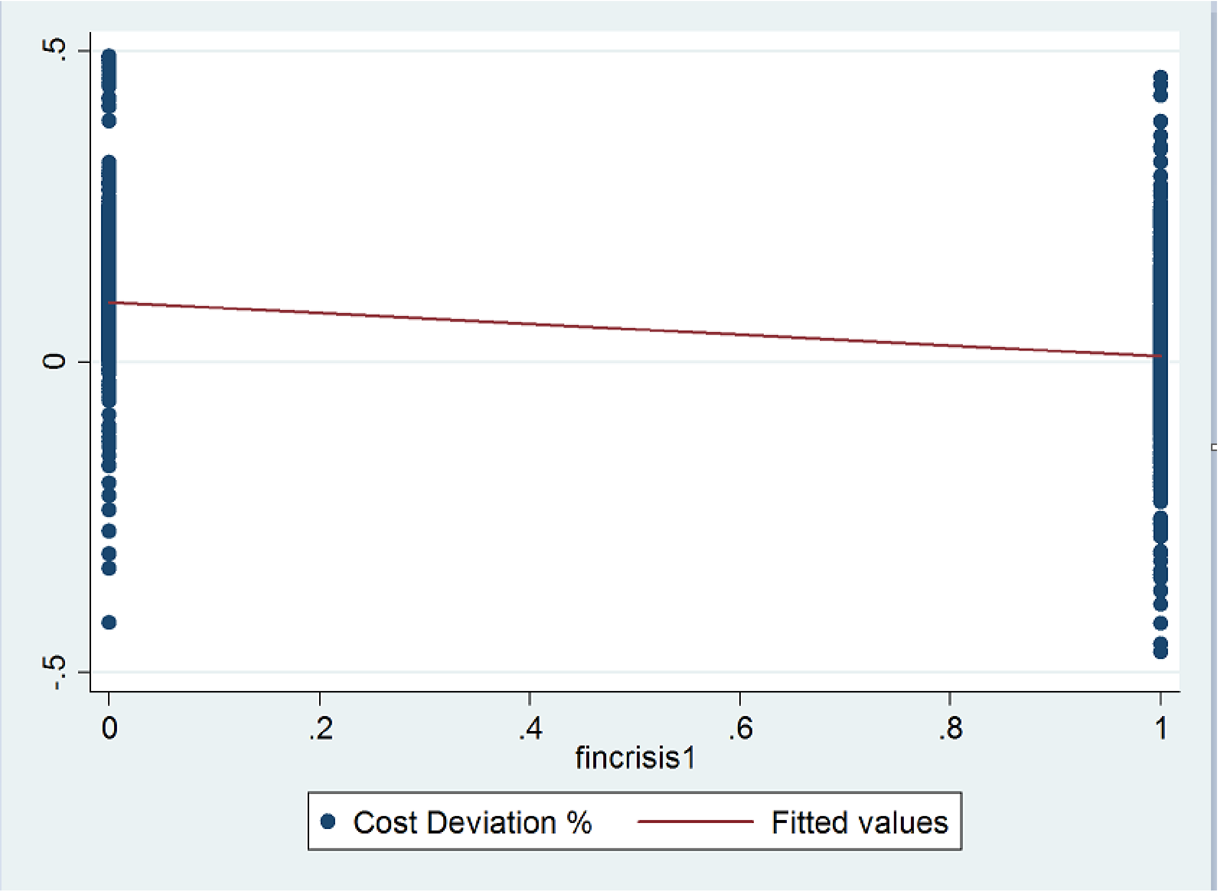


Figure 22 – Summary of the formulated Hypothesis

This figure presents a summary of the formulated hypothesis in our research and the expected impact on cost and time deviations. Source: Own Figure.

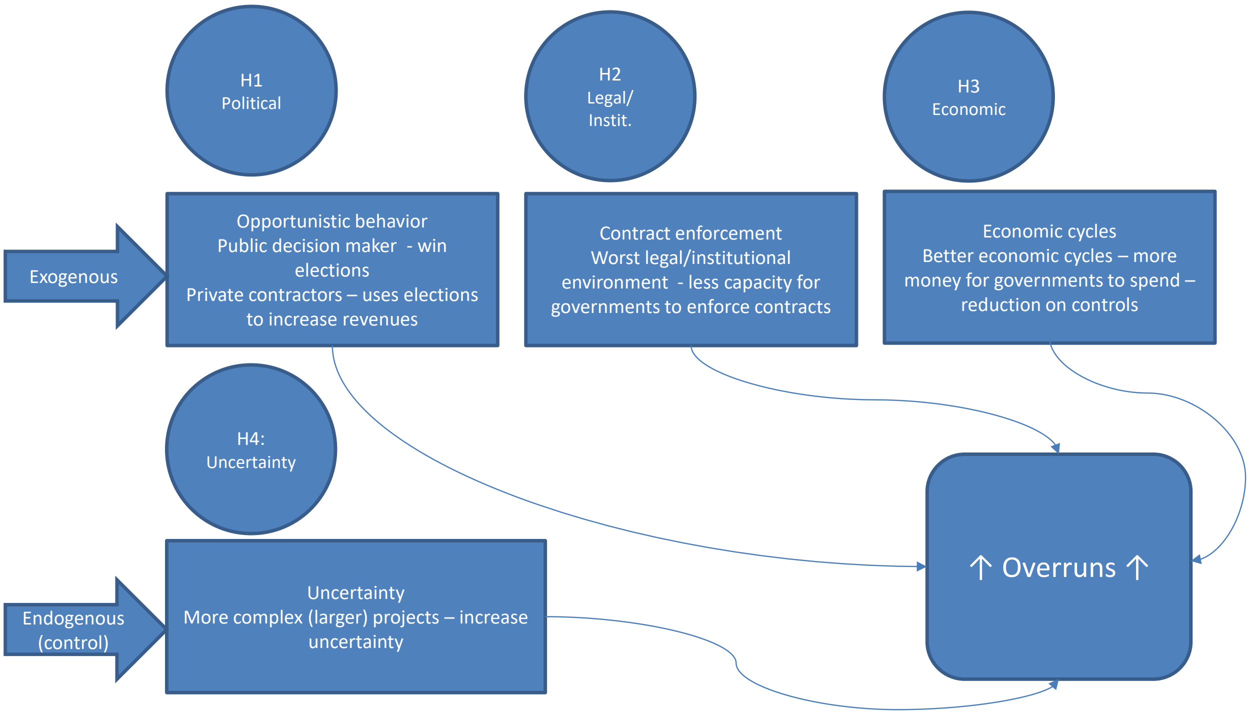


Figure 23 – Histogram cdevp – cost deviation final sample

This figure presents the histogram of the cost deviation for the complete final sample observations of 4,305 projects, overlaid by the Normal Distribution curve. The x-axis presents the cost deviation percentage of each project. The y-axis represents the number of projects with cost deviations by interval. Source: own figure.

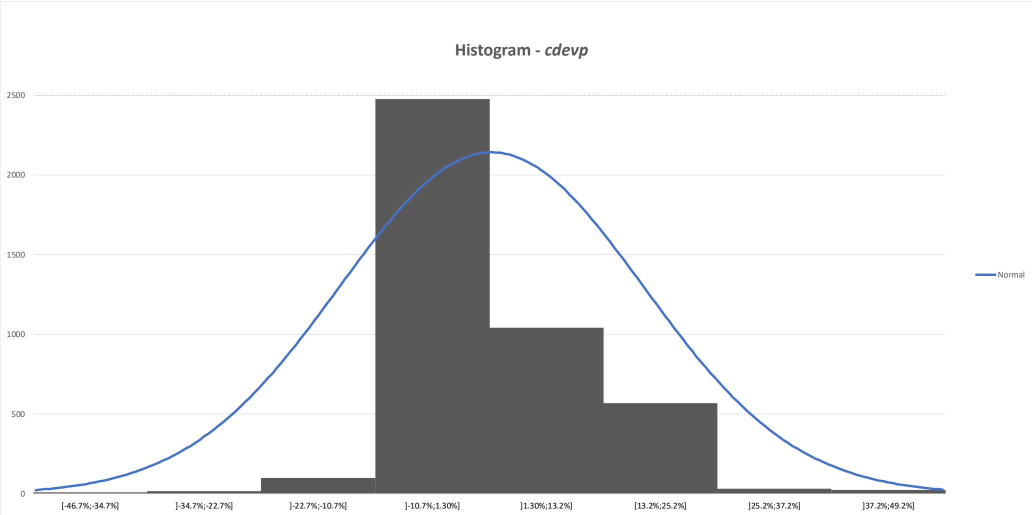


Figure 24 – Histogram cdevp – cost deviation transport sector final subsample

This figure presents the histogram of the cost deviation for the transport sector final subsample of 1,091 projects, overlaid by the Normal Distribution curve. The x-axis presents the cost deviation percentage of each project. The y-axis represents the number of projects with cost deviations by interval. Source: own figure.

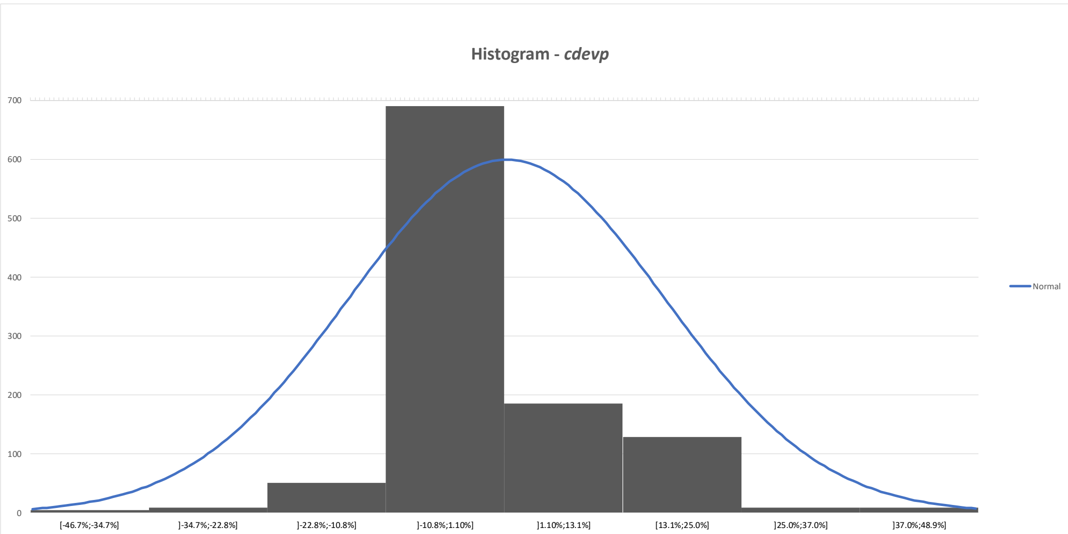


Figure 25 – Histogram cdevp – cost deviation local government projects final subsample

This figure presents the histogram of the cost deviation for the local government projects final subsample of 3,338 projects, overlaid by the Normal Distribution curve. The x-axis presents the cost deviation percentage of each project. The y-axis represents the number of projects with cost deviations by interval. Source: own figure.

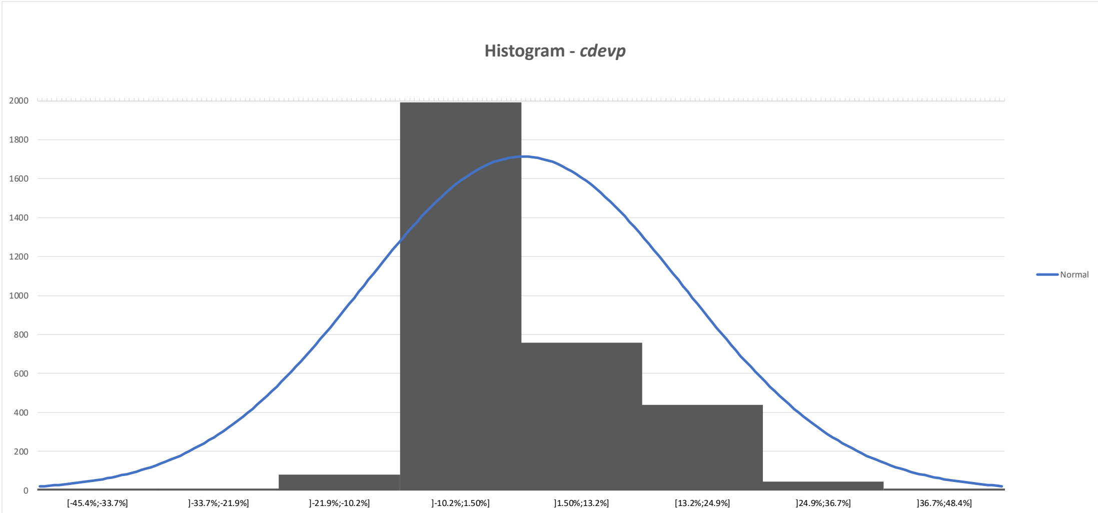


Figure 26 – Histogram tdevp - time deviations final sample

This figure presents the histogram of the time deviation for the final sample observations of 161 projects, overlaid by the Normal Distribution curve. The x-axis presents the time deviation percentage of each project. The y-axis represents the number of projects with time deviations by interval. Source: own figure.

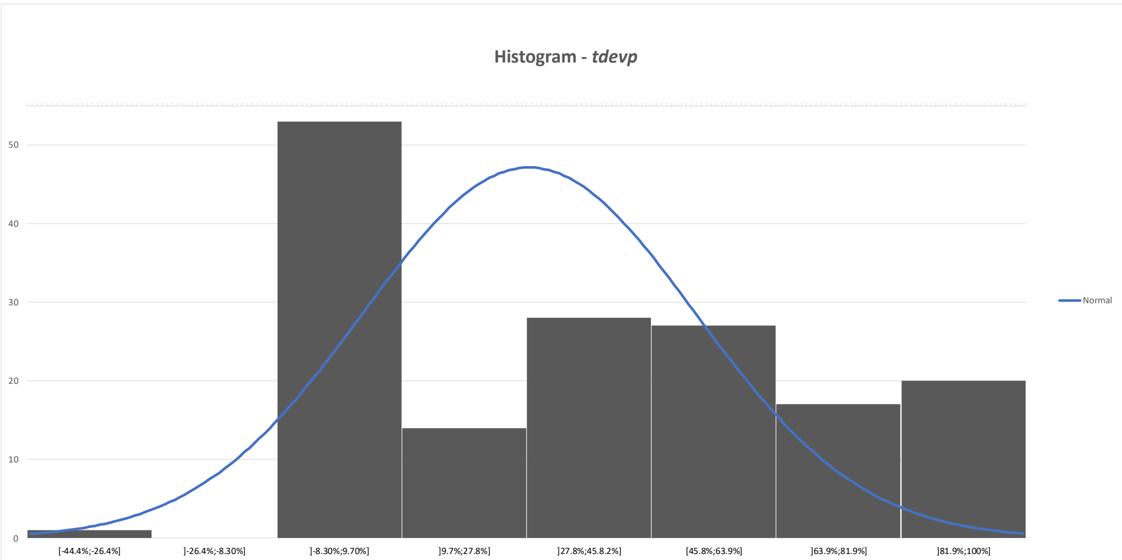


Figure 27 – Time deviation and cost deviation correlation

This figure presents a scatter plot graph where X is the time deviation % and Y is the cost deviation%. The fitted values line shows a positive correlation between these two variables.

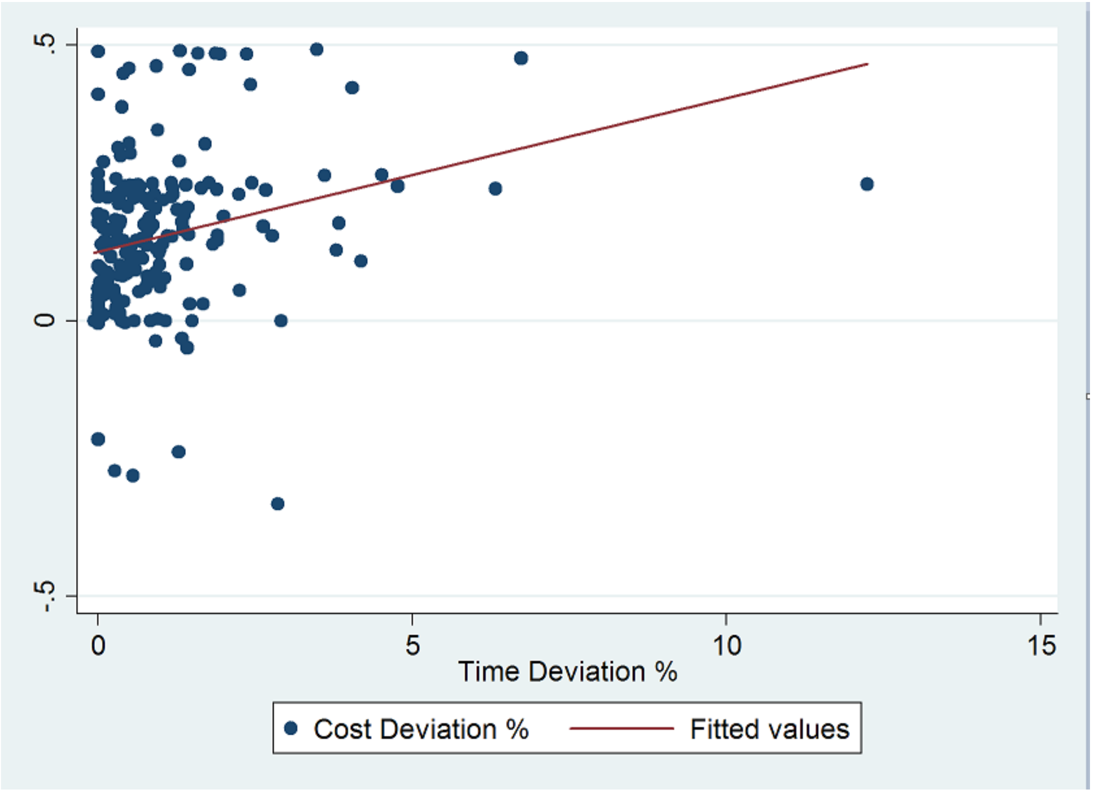
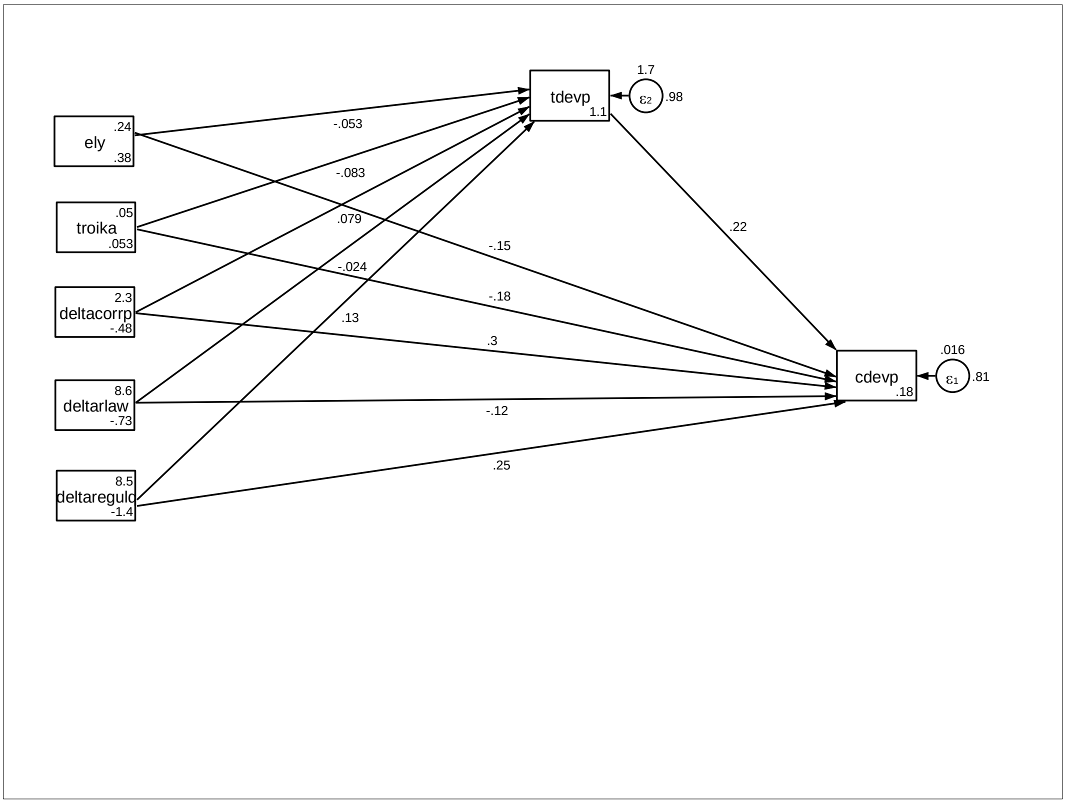


Figure 28 – Cost deviations – time on cost study – SEM Diagram

This figure presents a path diagram in which *tdevp* appears as an intervening variable affected by *ely*, *troika*, *deltacorrp*, *deltarlaw* and *deltaregulq*, but also as a predictor of *cdevp*. In this diagram causality flows from left to right. The boxes represent observed variables in our model. Indirect effects could follow any of the paths from each observed variable to *tdevp* and from *tdevp* to *cdevp*. Inside the box of each exogenous variable (*ely*, *troika*, *deltacorrp*, *deltarlaw* and *deltaregulq)* is indicated the variable's mean and variance. Inside each endogenous variable box is indicated their *y*-intercepts. In each path is presented the regression coefficients. The circles associated with each endogenous variable present the residual variance associated with the error terms ε1 (*tdevp*) and ε2 (*cdevp*) (Hamilton, 2012). Source: Own Figure.



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