Instituto Superior de Economia e Gestão
UNIVERSIDADE TÉCNICA DE LISBOA
DESDE 1911

MASTER OF SCIENCE

FINANCE (FINANCIAL INSTITUTIONS)

MASTER´S FINAL PAPER

MASTER THESIS

EVALUATING RISKS IN PUBLIC PRIVATE PARTNERSHIPS: THE CASE OF THE PORTUGUESE ROAD SECTOR

MÁRIO JORGE CORREIA FERNANDES

August-2012

Instituto Superior de Economia e Gestão
UNIVERSIDADE TÉCNICA DE LISBOA
DESDE 1911

MASTER OF SCIENCE

FINANCE (FINANCIAL INSTITUTIONS)

MASTER´S FINAL PAPER

MASTER THESIS

EVALUATING RISKS IN PUBLIC PRIVATE PARTNERSHIPS: THE CASE OF THE PORTUGUESE ROAD SECTOR

MÁRIO JORGE CORREIA FERNANDES

SUPERVISION:
Professor Mestre Joaquim José Miranda Sarmento

August-2012

List of Acronyms

APV – Adjusted Present Value

EIB – European Investment Bank

IEP – Instituto de Estradas de Portugal (Portuguese Public Road Institute)

WB – World Bank

DGTF – *Direcção Geral de Tesouro e Finanças* (task-force under the Ministry of Finance)

DSCR – Debt Service Coverage Ratio

EBITDA – Earnings Before Interest, Taxes, Depreciation and Amortization

IRR – Internal Rate of Return

NAO – National Audit Office

NPV – Net Present Value

OECD – Organization for Economic Cooperation and Development

PFI – Private Finance Iniciative

PPP – Public-Private Partnership

PSC – Public Sector Comparator

SCUT – *Estrada Sem Custos para o Utilizador* (Without Costs to the User)

SPV – Special Purpose Vehicle

VfM – Value for Money

WACC – Weighted Avarage Cost of Capital

Abstract

Throughout the last few decades, it has been verified a significant raise in the use of Public-Private Partnerships, by part of the world's economic governments as an alternative in the management and financing of infrastructural investments to joust the problematic of the *infrastructure gap*. From the projects sponsors point of view, the capital investment's strategic decisions are fundamental, so that the feasibility studies of partnerships are a critical factor for operational success and their management. However, for these agents, the risk-return question is preponderant, due to the soaring of financial, political and market risks, which will organize the imperative of application of new evaluation methods, as the case of the IRR-at-Risk, Cash Flow-at-Risk and the NPV-at-Risk, where the latter combines the dual issue of risk-return and the average weighted cost of capital. Therefore, this investigation aims to proceed to the application of the listed methods for the Public-Private road institutions in Portugal. Based in a sample from the 7 SCUT and 7 new concessions (highways), we will seek to apply the decision methods of risk-return in order to prove that these can provide better decisions in matters of risk and investments analysis compared to the methods of traditional financial evaluation. The results show that, for the sponsors, the methods of risk-return provides better decisions if include the element of risk in projects.

KEY WORDS: Public-Private Partnerships; CF-at-Risk; Current methods of financial valuation; Financial modeling; IRR-at-Risk, NPV-at-Risk; Project Finance; Risk and management analysis.

JEL Classification System: G38 - Government Policy and Regulation; H54 - Infrastructures; Other Public Investment and Capital Stock;

Resumo

Ao longo das últimas décadas tem se verificado um aumento significativo, por uma parte da governação económica mundial, ao recurso de PPP, como alternativa em matéria de gestão e de financiamento de investimentos infra-estrtuturais, de modo a combater a problemática do *the infrastructure gap*. Do ponto de vista dos sponsors (patrocinadores) dos projectos, as decisões estratégicas de investimento de capital são fundamentais, pelo que os estudos de viabilidade das parcerias são um dos factores críticos para o sucesso operacional e de gestão dos mesmos. Porém, para estes agentes, a questão de retorno-risco é preponderante, dados os elevados riscos financeiros, políticos e de mercado, o que irá originar o imperativo de aplicação de novos métodos de avaliação, como o caso do IRR-at-Risk, Cash Flow-at-Risk e do NPV-at-Risk, sendo que este último combina a questão dupla de retorno-risco e o custo médio ponderado do capital. Assim, esta investigação tem como objectivo proceder à aplicação dos métodos indicados às PPP rodoviárias em Portugal. Com base numa amostra de 7 SCUT e 7 Auto-Estradas, procurar-se-á aplicar os métodos de decisão de retorno-risco, de modo a comprovar que o estes poderão fornecer melhores decisões em matéria de análise de risco e de investimentos, comparativamente aos métodos de avaliação financeira tradicionais. Os resultados denotam que os métodos de retorno-risco, para os sponsors, fornecem melhores decisões ao incluirem a component de risco nos projectos.

PALAVRAS-CHAVE: Parcerias Público-Privadas; Análise e gestão de risco; CF-at-Risk; IRR-at-Risk; Modelação financeira; Métodos de avaliação financeira corrente; NPV-at-Risk; Project Finance.

JEL Classification System: G38 – Políticas governamentais e regulamentação; H54 - infraestruturas; Outros investimentos públicos e stock de capital;

ACKONWLEDEGEMENTS

In this special point of my academic and personal life, I would like to take this section to give thanks to all those who, in some way, contributed for this project by giving me support throughout the time I needed to complete my Master's thesis.

I couldn't mention a better person first than the Master Teacher Joaquim Miranda Sarmento, thank you for the guidance and permanent availability to help me during the process of preparing this dissertation.

For the help and personal reference in the field of quantitative methods, I would like to thank to Doctor Professor Ana Amaro.

To my mother for the reference model of honesty and integrity that she is to me and to my father who always encouraged me to go further.

To my grandfather, José Manuel Chandlier Correia for being such a big reference to me.

To my Master: Professor José Paulo Oliveira, for the opportunity of our friendship. Who also is my main reference in the field of macroeconomics and international monetary economics, being the reason why I developed a taste for these areas of the economy. I would also like to thank for the unconditional support, as well as the motivation that enabled me to achieve the academic, professional and human excellence.

To all those who I didn't had the opportunity to mention as I should, but never forgotten.

To God, by his very existence!
To all, my sincere appreciation!

Table of Contents

Index of Figures

Index of Tables

Index of Appendices

Index of Equations

I. Introduction

In a detailed analysis of the last decades, it can be noticed that the Governments of various develop (or in development) world economies have witnessed a problem concerning the need for the creation of infrastructures or their renewal. It results in negative impacts not only on economic growth, but also in terms of job creation and significant improvements in the welfare of economic agents. In this context, emerged the concept of Public-Private Partnerships (PPP) and it should be noted that these are closely associated to the existence of a limited public resources. The problematic of *the infrastructure gap,* and therefore their own partnerships, gains special relevance at a time like the present, where public resources of the most important European and world economies are heavily conditioned by the constraints on fiscal policy and combating the high public indebtedness.

As a very broad universe of various definitions for PPP, it is possible to appeal to the definition given by the Organisation for Economic Co-operation and Development (OECD, 2008) which understands the partnerships as: "*an agreement between a public entity and one or more private partners (which may include the operators and financiers), in which the private sector ensures the provision of a service or building an infrastructure in order to achieve the proposed objectives by the public sector, while giving ensuring a return on capital invested by private sector, which can only be achieved if the risk allocated to the private sector is optimized*". This point takes on special emphasis on a scenario in which, usually, the states can obtain a lower cost of financing than the private agents, so the difference in financing costs should be overcome by greater efficiency in managing the risks associated with PPP.

Thus, the central question of this research opportunity lies in a more detailed analysis to the imperative to make the use and application of new methods of financial evaluation and risk of PPP for all stakeholders (governments, financial institutions and sponsors), but mainly for the partnership's sponsors. Starting from the question of allocation of risk in these projects between public and private sector, and considering that the primary objective of the private sector involves the maximization of enterprise value, focus on matter that traditional valuation methods do not recognize the financial, political or market risks. Thus, emerge the method of NPV-at-Risk, as alternative method of weighted average cost of capital and risk-return, to face the strategic decisions of capital investment. In this context, there are also the methods of the IRR-at-Risk and the CF-at-Risk, both also determined with the aid of Monte Carlo simulations. To this end, it will proceed to the use of cumulative probability density functions of the cash flows, of each project, for a given level of significance. Therefore, in the second chapter, we will conduct a review of the literature on major issues of PPP and decisions methods of risk-return projects. So, the fundamental concepts around PPP and the Project Finance will be reviewed and will also focus on a review of the risk factor in hiring of PPP. On the other hand, also important, the analysis of the major literature in relation to the main current methods of financial evaluation on these projects from the perspective of each of the agents involved. In the third chapter, to conclude the literature review, we will proceed to the analysis of the experience of partnerships in the Portuguese economy, more specifically in the road transport sector. Following the literature review and the portuguese experience in PPP, in the fourth chapter, it will be briefly introduced the main methods to be applied as the case of VaR, IRR-at-Risk, CF-at-Risk and NPV-at-Risk and the process of Monte Carlo simulation for determining them. Based on a sample of 7 SCUT and 7 Highways, it will be applied the decision methods of risk-return and, parallel to this, these will be compared with the VaR of each respective project. The innovation in this opportunity of research relates to the combination of the results achieved with the current methods of financial evaluation (and their cumulative probability density functions) with the traditional evaluation methods to a whole unexplored sector grouping all metrics “at-Risk” available for evaluation of such projects.

Finally, it will be found in the last chapter the main conclusions drawn based on a study on the application of methods of return-risk decision of the PPP in the field of SCUT and new Highways (new sub-concessions) in Portugal. The research results seem to reflect that the methods provide better risk-return relationship between the return of the PPP and the inherent risk of the projects. The methods developed and applied to the national road sector attempt to demonstrate that they can overcome the difficulties in measuring and quantifying the exposure of the various risks that the PPP face.

Using statistical tools, the return-risk methods allowed us to determine minimum values for the financial metrics, with a confidence level of 90% and 95%. Only one project denotes possibility of financial infeasibility, to the significance level of 5%. It was also determined the level of risk exposure of each PPP, adjusted to present value of payments to concessionaires. In regard to this matter, there was a great uniformity in the results obtained.

Thereby, these contribute to better strategic decisions for capital investment given the possibility of interaction between the components of returns achieved and assumed risks. It will be also presented the main limitations underlying to the present opportunity of research and, secondly, it will be introduced a set of suggestions for futures researches associated to the subject of new decision methods of risk-return of such projects.

II. A brief survey of literature

2.1. Public Private Partnerships and Project Finance

At present, with a large number of agencies and institutions using the concept of PPPs arise, therefore, several possible definitions for this type of project. The European Commission defines PPP as the *"transfer of investment projects to the private sector, traditionally executed and financed by the public sector"* (European Commission, 2004). Underlying this definition, beyond the fact that the implementation and funding responsibilities belong to the private the question of occurring the provision of a service and, secondly, the allocation of risks between the State and private agents (International Monetary Fund, 2004). Thus PPPs involve several participants in order to obtain a stable relationship between the public and private entity (Akintoye, Beck and Hardcastle, 2003 and Ke, Liu and Wang, 2008).

A form of financing, such as the Project Finance, appears to be one of the possibilities to circumvent the problem of the infrastructure gap (Deloitte, 2007). Understands the Project Finance as the alternative that aims to mitigate the risk of financing and still sharing their optimization by adjusting the debt characteristics to the types of cash flows of the project (Kleimeier and Megginson, 2000 and Kleimeier and Hainz, 2006). From the relationship between PPP and Project Finance arises the fact that the projects are financed by a company newly created for the sole purpose of developing the activity of the partnership in question (Special Purpose Vehicle) with a high debt-to-equity ratio, accompanied by more private companies (see appendix I), whose objective is the generation of cash flows for the project and to the shareholders of the same (Grimsey and Lewis, 2000 and Ye, 2009). These future cash flows are the only possible guarantee of funding allocated to lender agents, justifying the concept of non recourse debt financing (Comer, 1996, World Bank, 2000; Grimsey and Lewis, 2000 and Blanc-Brude and Strange, 2007). The Project Finance also presents several advantages (see appendix II), such as tax benefits, the high indebtedness of the Special Purpose Vehicle division and the accounts of the various companies that are shareholders (Yescombe, 2002). Esty (2003) points out that the debt will not be reported on the balance of the shareholders as an important motivation of Project Finance.

However, in most cases, the private sector presents a equity and financing cost higher than the financing cost reached by the public sector. So, to face the traditional *procurement*, it will have to present efficiency gains which allow the creation of the *Value for Money* (Grimsey and Lewis, 2007). Associated to the VfM it is the idea that private agents can have more efficiently than the public sector, leading to add value to the project (Grimsey and Lewis, 2000; Grimsey and Lewis, 2005 and Shaoul, 2005). Thereby, VfM will be always generated when the cost associated to the Public Sector Comparator (PSC), executed and financed by the Public Sector exceeds the partnership. The PSC it's understood as the present net value of an analysed project from the standpoint of the traditional procurement regime, to face a service level, previously determined and that such analysis takes into account the extension of the life cycle of the project, as the underlying risks (Frastrich and Grimscheid, 2007 and Girmscheid, 2006). This justifies the fact that several authors are supporters of the idea that the PPP should not proceed without the confrontation between VfM and PSC resulting in a surplus value compared to traditional procurement, as it shows in appendix III (Grimsey, 2004; Sousa, 2008; Moralos and Amekudzi, 2008 and Sarmento, 2010).

Given the complexity, scale and long period of concession, the PPP include risks difficult to analyse and control, so that each risk will be allocated to the part best able to manage it (Wang, Tiong, Ting e Ashley, 2000; Akintoye, Beck e Hardcastle, 2003; Efficiency Unit, 2003 e Ke, Liu e Wang, 2008). Note that the public sector has the responsibility to review the analysis of project conception, its contractual framework and often also the payment of cash flows to the private entity (depending on the continuity of the periodic payments quality of service performed). This will minimize the consequences of hypothetical risks of demand, which could affect the quality of service provided by the infrastructure. The private sector, in its turn, depending on the contractual mould of each established PPP, lies with multiple responsibilities, such as the process of obtaining financing, construction and management of infrastructures or its maintenance/renewal. Hereupon, the PPP seek to maximize the capabilities of private, because evidence suggests that the private agents can cope with the budgetary limitations set and, still, accomplish the schedule agreed with the public sector, in addition of also be responsible for the maintenance of the infrastructure created by them, so that these efficiency patterns are always available for the users (pwc, 2005). In the UK, the report of the National Audit Office (NAO) concluded that, to date, only 22% of partnerships had extra costs and 24% of them needed additional time to be completed. For projects with the traditional model of procurement, the results were 73%

and 70%, respectively (NAO, 2003). Therefore, to obtain efficiency gains to justify the differences in financing costs and margins to achieve positive financial results, the private sector should be more efficient throughout the various phases of the project, as in the phase of investment, planning, infrastructure management, maintenance or renewal and also in risks management (Spackman, 2002 and United States Department of Transportation, 2008).

2.2. The risk factor in the hiring of Public-Private Partnerships

One of the basic characteristics of PPP relates to the transfer of responsibilities between the involved parts in the partnership: the public and private sector. In case of including the assumption of all risks being exogenous, then both parts would have the same ability to manage this exogeneity. But this issue isn’t verified in whole, so it gains special emphasis on analysing the trade-off between the allocated risk and existence of an incentive system. Despite the generally negative connotation around the concept of risk, there are an important difference between risk and uncertainty. Risk is randomness with knowable probabilities and uncertainty is randomness with unknowable probabilities (Knight, 1921). At the level of PPP, the risk is present through the uncertainty around several variables, such as operating and maintenance costs, additional investment, demand for infrastructure, among others, but may also provide opportunities for staff involved in the project (Froud, 2003). The private sector benefits of two important arguments, allowing higher efficiency compared to the public sector and explaining some of the risks transferred to the private: economies of scale and economies of knowledge. The economies of scale arise from the fact that the private sector is witnessing a frankly higher production with the possibility of dilution of fixed costs and resulting, *ceteris paribus*, in a more efficient production (Savas, 2000; Chong, Huet, Saussier and Steiner, 2006 and Sousa, 2008). The economies of knowledge, in their turn, are associated to the fact that the private sector benefits from the opportunity to specialize in a particular area or sector of, through the concept of *learning-by-doing* (Jin and Doloi, 2008). Despite the subjectivity of some topics in the allocation of risk, in contrast to the importance of the issue to the success of partnerships (Domberger, 1998; Klein, 1998 and Medda, 2004), the main and most cited criterion for the allocation of risk is to transfer it to the entity that is in the best place to manage it and make it at the lowest cost (Hood and Macgarvey, 2002; European Commission, 2003 and Grimsey and Lewis, 2004). Thus, in the presence of the imperative of the private agent being more efficient than the public sector, it's important to establish efficiency rule for the allocation of risk. This, from the theoretical point of view, seems to be quite simple: the public sector should not transfer all risks to which it is responsible, or take risks beyond their control (Akintoye, Beck and Hardcastle, 2003). It should therefore optimize the transfer of risk, to the detriment of the possibility of maximizing the risks being transferred, as denoted in appendix IV. This scenario would report to an increase of marginal costs for the public sector, so it is essential to ensure that the public benefit of such transferred risks exceed such financial marginal costs (Quiggin, 2004). In a hypothetical scenario of an inadequate transfer, in a case of excess of risk transferred to the private sector, it can result in a decrease of the private agents' number interested in the partnership and, on the other hand, stimulate opportunism of the remaining proponents (Zitron, 2006). Another study suggests that, based on the scenario given above, the performance of the private agent will decline (Holmstrom and Milgrom, 1991).

An analysis of careful risk assessment should witness several steps as set out in appendix V (Marques and Berger, 2010). Starting with the identification of the risks of PPP, although there is no consensus view of the classification of these, several authors point to a set of multiple risks possible to identify such as: (i) The technical risk on changes in engineering and design standards; (ii) the construction risk associated to buildings out of the established quality standards in the contract, differential additional costs compared to the budget or delays in infrastructural building; (iii) operational risk of the projects, many times justified by increases in costs of maintenance and operation; (iv) the risk of revenue due to hypothetical traffic breaks (in the case of roads or rails partnerships) or volatility in prices or demand for a good/service causing a shortfall of revenues; (v) financial risks, from an inability of correct coverage of revenue flows and financing costs; (vi) natural risks, through the possibility of calamities or natural disasters that cause damage to infrastructure; (vii) political risks in which political changes influence the regulatory policies of partners; (viii) hypothetical environmental risks, depending on the project in question and; (ix) the risk of failure of the partnership, given a combination of several risks. (Grimsey and Lewis, 2002; Farrel, 2003 and Marques e Berg, 2010). While the stage of allocation risks is based on the division between retained and transferred risks between the parts, the likelihood and impact quantification of risks will determine the level of occurrence and level of their result, so that each part must develop strategies for minimizing expected impacts of hazards. Authors like Asenova (2010) conclude, though, about the benefits of risk allocation in contracts of PPP, especially by the evidence that this allocation has improved the process of reducing costs. The author stresses that this provides incentives for good practices in managing PPP and also through reducing the need for inclusion of a process of renegotiation. Since the issue of risks allocation of a PPP is critical to determining the risks retained and to be transferred and even to determine the viability of the partnership, by studying the basis of certain evaluation methods, (Vega, 2011), longed to some alternative methods of return-risk that relate the evaluation of that transfer to the private (Wong, 2006), described in the following sub-chapter.

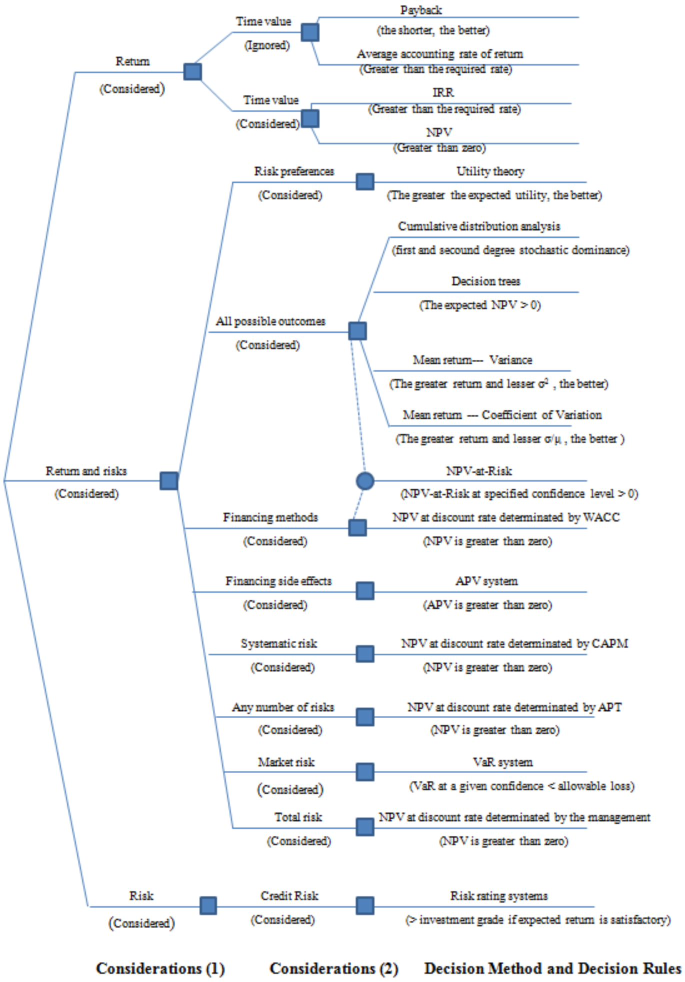
2.3. Financial modelling and current methods of financial evaluation

The process of financing a PPP involves four interdependent aspects, such as present in appendix VI: (i) the capital structure; (ii) the organizational structure; (iii) the architecture of the contract structured and (iv) enhancement of credit granted to the project (Ye, 2009). Because there are multiple sources and forms of financing for each component, it can be witnessed several financing structures for partnerships. Throughout the evolution of the financial literature, there was a broad consensus on three major categories of resources for financing of investment projects: (i) equity, (ii) subordinated debt (mezzanine, high yield and PIK) and (iii) senior debt (Bolton and Freixas, 2000). Given the equilibrium models of financial assets, such as the CAPM, different sources of funding, based on different exposures, results in different returns required by each lender (Sharpe, 1964; Lintner, 1965; Douglas, 1968; Black, 1972 and Fama and French, 2004). Given the optimization of capital structure, it will be possible to verify that the providers of *equity*, by assuming higher degrees of risk, require higher returns. Contrary to this, will be the lenders, which had been added to the senior debt that to levels of lower risk required a lower return as compared to *equity* providers. The subordinated debt, in the exposure panorama to risk-return is between the *equity* and senior debt. Note that, for lenders, the financing of equity comes from the sponsors of the partnership and it's possible to witness also the presence of an institutional investor.

Given the senior debt, this is usually from commercial banking syndication or international agencies, such as the World Bank (WB) or the European Investment Bank (EIB). Thus, the optimal structure of capital of a partnership should be aware of the *trade-off* between risk and return in order to a better allocation of financial instruments to be used. Since it's unusual the total project financing, by the sponsors of the same, be performed by equity, as this business is not the *core business* of the shareholders, is also verified that the partnership will difficultly be fully funded by senior debt, given the nature of the *non recourse* of financing in PPP. So, there is always equity financing by the sponsors of the partnership, even to denote a connection to the project and that differential of the portion not funded by debt represents a cost that donors would not have to bear, in case of failure of the project (appendix VII and VIII). It's justified then a leverage ratio of the Special Purpose Vehicle in most cases exceeding 70% and in some cases this value will be close to 100% (Ye 2009). In terms of financial modelling, taking into consideration the time factor, it is noted that most partnerships are funded through long-term debt and usually these projects use, at an early stage, syndicated loans with higher earnings, because the refinancing, also in long term, will occur with lower wages, resulting in a decrease in the cost of total capital.

Cartlidge (2006) highlights the high costs of bidding for PPP and Private Finance Initiative (PFI) checked in the UK, fitting with the complexity of the financial modelling of projects (see appendix IX), referring also to other variables such as inflation, the legal aspects, tax changes and payment mechanisms. On the other hand, will be the methods of financial appraisal of PPP and *Private finance Initiative*. The most common methods to carry out a financial assessment of any proposed investment are the average accounting return, payback, IRR and also the NPV (Damodaran, 1997; Brealey and Myers, 2002). However, these methods are based on future cash flows, using various assumptions. Based on key characteristics of PPP, these projects have aspects that may turn the forecast of cash flows in a not so easy task, by the high capital expenditure required, the long waiting times and periods of very long leases (Ye and Tiong, 2000). On the basis of the requirement of current methods to this scenario, Ho and Liu (2002) presented a model for evaluating real options. Equally important seems to have been the contribution of Ranasinghe (1999), by presenting a model that would allow governments to assess the possibility of private agents to participate in infrastructural projects of public interest, based on risk and financial aspects of projects. However, even based on the imperative to address alternative methods for the evaluation in PPP, the main contribution came from Ye and Tion (2000), by introducing the concept of NPV-at-Risk, which is a method that in addiction to take into account the weighted Average Cost of capital also considers the double issue of return and risk. Systematically, the methods of evaluation of projects can be classified into a set of three broad categories: (i) methods based on returns, (ii) methods based on risk and (iii) methods based on returns and risk (Ye and Tiong, 2000). The main criticism of these methods is that these returns do not take into account the value of money in time. Although some methods use the value of money in time, by discounting cash flows, these were estimated or anticipated which turns them in not pre-defined cash flows. Note that this uncertainty leads to evaluation methods of projects based on risk. In a capital investment, Biderman (2006) defines risk as the possibility of loss or gain of the same due to the occurrence of certain unpredictable factors. Thus, this same uncertainty will bring risk in assessment of capital investment decisions. In the case of rating systems, the decision rule relates to the fact if the investment gets a classification of *investment grade*. However, note that the rating systems are limited to the measurement of credit risk (Stimpson, 1991) because they are related to the quality of investment and not to the attractiveness of the same (Hennessy, 1986). Given the risk-return methods, the most common are the adjusted risk methods, which witnesses a discount rate, as in the case of the CAPM, APT and WACC, because both methods aim to determine the discount rate in a scenario of uncertainty. Parallel to this, in an alternative way, will be some methods of return-risk, by probabilistic approach and statistics such as the coefficient of expected return or analysis of the cumulative distribution. NPV-at-Risk appears as a method that synthesizes the weighted average cost of capital with NPV expected to form a minimum value for this method of capital decision (Ye and Tiong, 2000).

Exhibit I: Methods and decision rules for capital investment decisions.

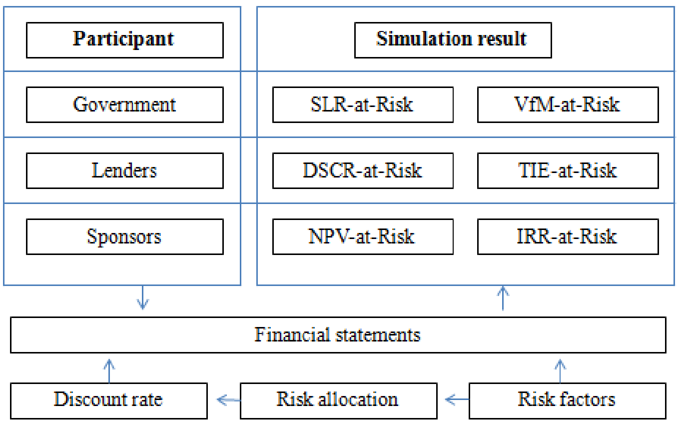


Source: Ye e Tiong, 2000.

Despite the contribution of the NPV-at-Risk, this method of strategic decision of capital investment, of return-risk, only reflects an added value for the feasibility analysis of the sponsors of the partnerships. Ke, Liu and Wang (2008) propose a table of methods for evaluating projects according to the type of agent involved in the partnership. Thus, the authors point out two main criteria/methods that each agent involved should put additional emphasis and all of them were developed based on the concept of NPV-at-Risk. Based on the perspective of governments were adopted the criteria of VFM-at-Risk and the SLR-at-Risk. According to the UK experience in PPP, these projects, in the public agent view are evaluated in the logic of added value for the public sector. The European Commission also follows this criterion and it’s contained in the *guidelines* for successful PPP, launched by Brussels and Australia. Meanwhile, the Taiwan government opts for the SLR criterion for evaluating such projects (THI Consultants Inc., 2001). Regarding the prospect of financial institutions (mainly banks), Ke Liu and Wang chose the criteria of DSCR-at-Risk and TIE-at-Risk. Note that these institutions, by financing infrastructural projects such as PPP and *Private Finance Initiative*, witness the *non-recourse* financing logic, so there is a big difference compared to conventional debt. So for the lenders, it will have to proceed to an analysis of indicators if an exact project can tackle the debt and deal with any contingencies. Compared to the first criterion, the DSCR must indicate if the project generates cash flows in order to the service of debt be fully covered, being usually greater than 1.05. The TIE relates to another indicator capable of measuring the ability of the agent borrower to cover interest on indebtedness, during the time that force the same debt. Often, the funding institutions require a TIE not inferior than 2. To determine the same, it will be taken into account the total EBITDA divided by interest on debt. (Yli-Olli and Virtanen, 1989 and Mansal, 2009).

To the sponsors of the partnership, underline the concept of microeconomics that points to the primary objective of private agents: the maximization of profits (Romer, 1990; Frank, 1994; Matsumura, 1998 and Epple and Romano, 1998). So, to determine the same maximizing results it will have to be taken into account the economic viability of the partnerships. Since there is a close proximity between the assessment of projects that are not PPP and these, the major difference is the fact that the period of cash flows forecast is the concession period of the partnership and the fact that in the results of the utility are included the payments made by the public entity. This way, it will be pointed the criteria of NPV-at-Risk and the IRR-at-Risk (Ke, Liu and Wang, 2008).

Exhibit II: Framework of the methods.



Source: Ke, Liu e Wang, 2008.

Some authors focus that the origin of VaR systems are associated with market risks (Dowd, 1998), not detrimental, but yet the extension of logic to other risks, such as cases of credit risk, liquidity or cash flows. These issues, especially after the contribution generated by the investigation of Ye and Tiong, allow us to draw a logical decision rule based on the fact that for the sponsors of partnerships, projects are economically and financially acceptable if, for the level of a reliable-α, the NPV-at-Risk is grather than zero. Note the multitude of possible outcomes for the uncertainty (Ke, Liu and Wang, 2008).

In terms of results after the application of current methods of financial evaluation, Ye and Tion applied the concept of NPV-at-Risk in two infrastructural projects, and for this, after determining the net cash-flow, proceeded to the use of Monte Carlo simulation of 1000 iterations. This methodology allowed the authors to graphically represent the value of the NPV of the projects according to their cumulative probability. They concluded, therefore, that the NPV-at-Risk can change the decisions of capital investment in PPP, since projects with NPV very considerable may cease to be after the application of the method, so that, even a project showed an NPV-at-Risk negative, while the other decreased significantly. In another study by Ke, Liu and Wang (2008), the authors applied the standard methods for each agent involved in the preparation of a PPP to build a bridge in Romania, whose lease has a term of 30 years. After using Monte Carlo simulation, the results show that, after the application of the current methods of evaluation, there was a slight increase of the values of the applied methods. Moreover, it appears that as the reliability percentage increase the indicators deteriorate, despite the chance of financial and economic infeasibility to one of the parts. Therefore, it is justified by the fact that several authors conclude that based on specific characteristics of the partnerships, these are subjected to more risk (compared to other types of infrastructure projects) and because of that, the current evaluation methods have gained special emphasis (Ye and Tiong, 2000 and Wong, 2006). The extension of the NPV-at-Risk method to other stakeholders will allow a more equitable evaluation of the partnerships in question so that the contract negotiations will be more easily accomplished and that the desired *Value for Money* will be more easily verified (Ke, Liu and Wang, 2008 and Mansal, 2009).

III. The Experience of Public-Private Road Partnerships in the Portuguese Economy

Portugal witnessed the first PPP with the project of *Vasco da Gama*' bridge in 1993 and, from that moment on, several new projects have emerged, mainly road partnerships. The remaining partnerships, afters the first, represent roughly 10 billion euros of private investment and 20 billion euros in state payments to the 30-year-term of the partnerships (Sarmento, 2010). In terms of economic and financial studies, which assess the feasibility of launching a PPP in the national territory, it is considered an inflation rate of 2%, while the discount rate, based on historical experience of industrialized economies, should be fixed in 4%. For the service actually provided in road partnerships, as well as the remuneration of the private agent, exists a set of four subdivisions possible to verify: (i) the traditional granting with real tolls, in which the private agent has the possibility of charging tolls to the users, without place for payments by the State to the private agent; (ii) the SCUT (motorways with no cost to user), in which there is a concession without tolling the user, i.e., the private agent do not charge tolls and receives, therefore, payments from the State due to existing traffic, accompanied by bands of traffic and where prices are previously agreed between them, (iii) the lease with tolling the ex-SCUT user, which may be characterized by the fact that the private agent charges the tolls but delivers them to the Roads of Portugal and then receive two payments: a payment of availability (justified by the very existence of infrastructure, with the scenario of possible deductions to those payments due to temporary outages, as the cases of accidents of maintenance works) and a payment for the service of collection of tolls to ex-SCUT (divided for purposes of financial reward for investment in billing gateways and to pay operating costs and maintenance) and (iv) sub concessions and *Túnel do Marão*, characterized by the fact that there is room for two types of payment: a payment due to the existence/availability of the track and another payment associated with the traffic, called payment of service (DGTF, 2011). By the end of 2011, were recorded 64 PPP in operation, were 13 of these partnerships were road. Still under construction, were approximately nine concessions and in any new contest. Given the process of launching the tender for the partnership and the Financial Close (signing of contract) this is quite long. This same slowness of the process is associated to several factors, such as the number of verified proposals or the technical complexity of these. For the case of PPP in Portugal, by the end of 2008, Sousa (2008) concluded that the average timeframe between the launch of the competition for the partnership and the Financial Close was 808 days. Since the sample of the research has presented contests between 1997 and 2008, the author concluded that the gap between the launch of the competition between the partnership and the Financial Close has been declining. For example, while the granting of the Central Coast highway (A17) presented a lengthy of 1926 days (after its launch in 1999), the granting of West Coast (with competition started in March 2008) had a length of 339 days until the signing of the concession contract. Another important issue to review concerns to shareholders of the utilities and roads and yet their market share. By the end of 2008, Mota-Engil, Engineering and Construction, SA held a market share of significantly 11.61% relating to 328 kilometres in highway concessions, by their position in the consortia. In second place in the share market was Brisa,SA with a market share of around 9.09% compared to 257 kilometres at dealerships concessionaires, such as could be seen in appendixes X and XI (Sousa, 2008).

IV. Method and Data

4.1. Methods of risk-return decision for the sponsors of Public-Private Partnerships

Since strategic decisions for capital investment are crucial to the success of the concessionaires of PPP, the sponsors tend to evaluate their projects based on operating and financial cash flows (Ke, Liu and Wang, 2008). Given the problems already mentioned, the need arose from the application of methods of risk-return for the assessment of PPP. So, it will be applied the Value-at-Risk, Cash flow-at-Risk, NPV-at-Risk and IRR-at-Risk. For these methods is necessary to resort to the methodology of Monte Carlo simulations. This method belongs to the class of the algorithms with the objective to carry out the repetition of the random sample in question and to compute the recorded results. Objectively, the method will seek to replace a physical or mathematician process by a probabilistic process. Random or pseudo-randomly sampling generated computationally will ensure the treatment of deterministic questions. (Fishman, 1995 and Du and Li, 2008) Thus, among the key stages required by the methodology should be included (i) the definition of variables to consider, (ii) the probability distributions of our random variables and also (iii) their cumulative probability functions of the variables in focus.

4.1.1. Value-at-Risk

The first metric to be described is the Value-at-Risk, aiming to quantify and assess the exposure of a company, investment or project risk and uncertainty (Sharpe, 1970, Marshall and Siegel, 1996 and Linsmeier and Pearson, 2000). Formally, the Value-at-Risk attempts to quantify the worst expected loss over a certain time frame, in normal market conditions and to a certain level of confidence. We can also define this metric as represented by the quartile of the projected distribution of profit and loss, to the horizon under consideration (JP Morgan and Reuters, 1996). Take c as the confidence level predetermined, so that the Value-at-Risk will correspond to the lower tail of the distribution, $1-c$ (Jorion, 2000). Thus, this metric can assign to a certain level of confidence that will not lose more than a certain level of project, in an amount, for an also predetermined time frame. The estimate for the Value-at-Risk will be easier after the knowledge of the function of conditional probability based on the statistical definition of the metric itself, given by:

Equation I: Expression of VaR

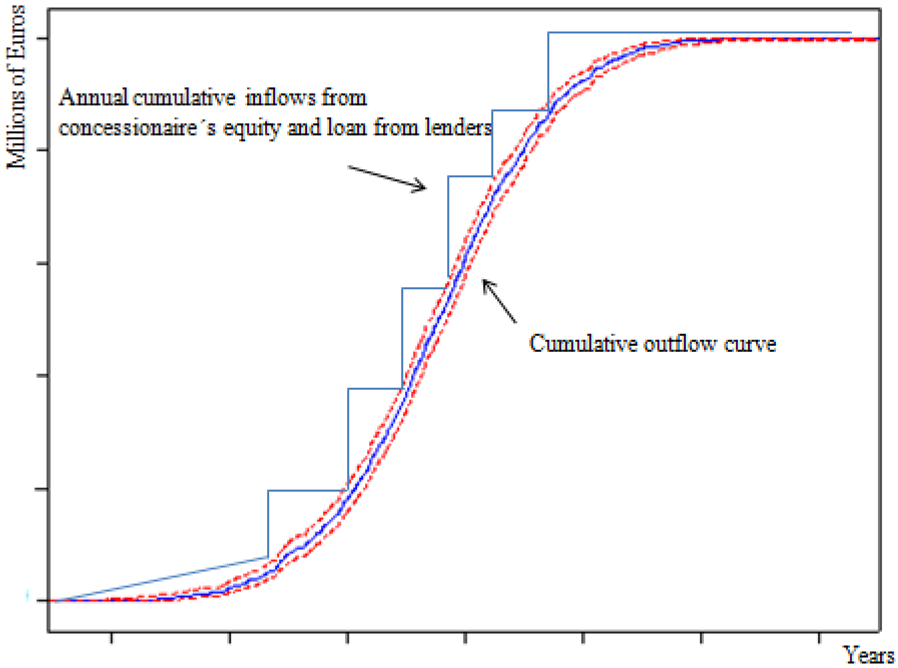
$$\Pr\left[\Delta \mathrm{P}(\mathrm{N}) < VaR\right] = \mathrm{F}\left[\Delta \mathrm{P}(-\mathrm{VaR})\right] = \int_{-\infty}^{-VaR} \mathrm{f}\left(\Delta \mathrm{P}(x)\right) \mathrm{d}\, x = 1 - \mathrm{c}$$

Where $\mathrm{F}\left[\Delta \mathrm{P}(.)\right]$ is the cumulative density function of revenues, $\mathrm{f}\left(\mathrm{P}(x)\right)$ probability density function of P, c the confidence level and finally ΔP(N) = ΔPt(N) the relative change occurred in the value of the project, over the time frame concerned, N. It should be stressed that ΔPt(N) = P(t + N) – Pt.P(t + N) will represent the natural logarithm of the project over time, t + N and Pt the natural logarithm of the moment t. Thus, the method of Monte Carlo simulations will proceed to use the observed changes in their market facts of the last “n” periods under review and therefore will generate “N” simulations for the value of a portfolio or project at a future date, given by t + N. However, there is still a need for specification of the stochastic process and the parameter that will ensure a better analysis of the dynamics of risk and uncertainty. Finally, the price of assets (the road infrastructure in the case of PPP in analysis) at time t + N, from the simulated factors, will give rise to the Value-at-Risk of partnerships.

4.1.2. Cash flow-at-Risk

Despite the close methodological proximity between the Value-at-Risk and Cash Flow-at-Risk, in fact there is a substantial difference between them. Under the PPP, it is noted that the metric of the Value-at-Risk aims the calculation of change in value, in amount, while the cash flows consummate the effectiveness of the partnership in question. Thus, the metric of cash flow-at-Risk, can be understood as well as a methodology of Monte Carlo simulation with a winder horizon, catching up with the evolution of the cash flows of the project. This method also based on statistical methodology, also reflects the evolution of various other determinants that affect costs, revenues and infrastructure of concessionaires and therefore the actual cash flows generated over time (Youngen, Guth, and Tennican Usher, 2001). On the other hand, it may avail itself of the cumulative distribution function of the cash flows of the projects to compare the outflows associated with the construction and maintenance of infrastructure and capital inflows on the capital and debt financing, depending on the capital structure adopted by each highway concessionaire, as denoted on figure 3.

Exhibit III: Cumulative *inflows* and *outflows* from concessionaire´s equity and loan from lenders.



Source: authors.

This way, there is a possibility of obtaining an approach to quantify the differential deviation between the cash flow actually recorded and cash flow planned and budgeted, caused by factors affecting the project risks, based on a certain level of trust and for a defined time horizon. However, for the correct application of the method, it is necessary to ensure a probability distribution for expected future cash flows of the project.

4.1.3. Net Present Value-at-Risk

From the various possible settings to find to describe the risk concept, it may assist itself of the risk while this is the half-variance of all the consequences (although only be taken by the risk of undesirable effects), which, together with the criterion of NPV, will result in a method of decision of risk-return. This way, the draft must be feasible if the differential between the average value of the NPV and the standard deviation of the same is greater than zero. Still, it should be included a level of confidence for the rule of investment decision. This culminates in NPV_{α} imperative for a given level of significance, to be greater than zero, instead of the previous condition. Accordingly, the new metric can be understood as the value in which α% of the possible NPV are inferior and in which 1- α% are superior (Ye and Tiong, 2000). A sensitive question concerns with the use of appropriated discount rate despite the traditional models of the CAPM and APT. Note that in both cases it would involve the determination of the betas of projects of the PPP, not so easy compared to a financial asset. Contrary to some metrics of financial evaluation, such as the CAPM and the APT, the WACC method is a metric that takes into account the different costs of capital, weighted by their respective weight. Note, however, that the costs of funding sources are precisely the expectable returns by investors and the PPP, having these, the specific characteristic of a reduced proportion of capital comparatively to the financial debt. Thus, the rate of return on capital will be given by the rate of return required by the sponsors of PPP, while the return of the financial debt may be regarded as the average interest rate of market to financial projects. Despite this, the WACC can not adequately represent the risk premium required, although it often takes place as being an approximation. However, this does not represent that the WACC can be validly used to deal with the issue of risk or uncertainty.

Taking the probability density function of the returns of the project (see appendix XIII), f(NPV), the NPV-at-Risk is given by the integration between -∞ and NPVα, equalling the actual α, in it is turn, the level of trust for NPV null is given by the integral between -∞ and 0 (appendix XIV). Since the NPVs are normally distributed statistically, the NPV-at-Risk may be determined as mentioned above, such that:

Equation II: Expression of NPV-at-Risk

$$NPV\ at\ Risk = NPV\ médio - Z\ (\alpha) \cdot \sigma$$

where Z(α) represents the number of units of standard deviation associated with the predetermined confidence level, α. Moreover, taking F(NPV) as the cumulative distribution function, it will be able to proceed feature analysis of that distribution for percentiles for determining the metric NPV-at-Risk for a given level. As well as the confidence level associated with a null NPV (figure 4). In the case of the distribution of returns, f(NPV) or F(NPV) is not known, the Monte Carlo method may be a valid alternative to generate these distributions. The distribution function may be aided by the empirical distribution function. Fn(NPV) = (#NPVi ≤ NPV)/n, where #NPVi represents the multiple results of simulations (Ye and Tiong, 2000). This should lead to the determination of the percentile Fn-1(α) which will culminate in NPVα. Thus, within the Monte Carlo method, the NPV of net revenues generated by operation of the concessionaire in a given period T0=t, is still given by:

Equation III: Determination of NPV

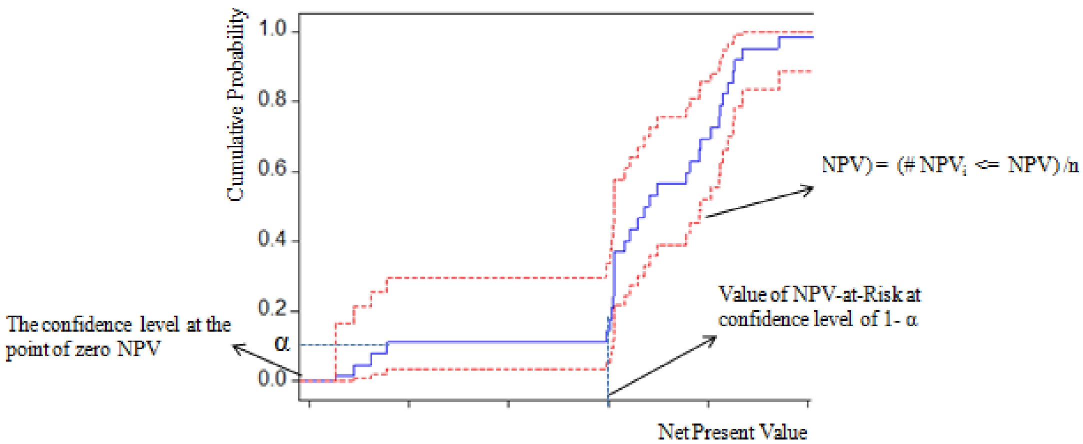
$$\mathrm{NPV}|\mathrm{T0} = \mathrm{t} \;\; = \frac{1}{(1+r)^{Tc}} \sum_{\mathrm{i}=1}^{\mathrm{t}} \frac{\mathrm{NCF}}{(1+\mathrm{r})^{\mathrm{i}}} = \frac{1}{(1+r)^{Tc}} \sum_{\mathrm{i}=1}^{\mathrm{t}} \frac{(\mathrm{Ii}^0 - \mathrm{Ci}^0)}{(1+\mathrm{r})^{\mathrm{i}}}$$

Equation IV: Determinação das Receitas iniciais da concessionária

$$I^0 = Qi^0 . Pi^0$$

where NCF_i represents the net cash flows, I_i^0 the revenues from baseline to the current moment, C_i^0 the operating and maintenance costs until the moment, r the discount rate in force, Q_i^0 the demand infrastructure and P_i^0 the price associated with the use of the road concession this year.

Exhibit IV: Calculation of NPV-at-Risk and confidence level based on simulation generated distribution.



Source: authors.

Since this metric is obtained this way, it will be possible to verify a scenario of estimation error, from some causes, such as (i) a cash flow model not adjusted to reality, (ii) a dysfunctional discount rate or finally (iii) a single sampling error. The use of the

Kolmogorov-Smirnov test, for example, may be a solution to validate the reliability of the distribution and the NPV-at-Risk. This test will seek to compare the distances between the empirical distribution function and theoretical distribution function in question, which constitute the null hypothesis, based on the following statistic test:

Equation V: Test statistic of *Kolmogorov-Smirnov*

$$D_n = \sup_x \left[\left| F_n(x) - F_0(x) \right| \right]$$

where F(x) and F_0(x) represent the empirical and theoretical functions, respectively and D_n the discordance between the two functions. Alternatively, the confidence bands can be determined by $d_{\alpha n} = d_\alpha/\sqrt{n}$, depending on the level of significance and the sample size (Lilliefors, 1967 and Justel, Peña and Zamar, 1997).

4.1.4. Internal Rate Return-at-Risk

The internal rate of return is, also, another of the methods used to evaluate strategic decisions of capital investment. Thus, this metric is based on a discount rate that will ensure a net present null value. In PPP, given the need for more efficient management by the private agents, the uncertainty is present in several stages of the partnership, since the building up process until the costs related to maintenance and operational infrastructure, passing through the revenue collection from road traffic. As in the metrics earlier discussed, the concept of risk and uncertainty in various stages of the PPP it will be present by the introduction of a significance level in the statistical approach and in the distribution of cash flows associated with each road infrastructure, which will culminate in the determination of the IRR-at-Risk with a certain degree of confidence.

4.2. Application of the current methods of evaluation of the Public-Private Partnerships

The current methods of financial evaluation, of risk-return for the sponsors of the PPP, will be applied to the reality of the Portuguese economy, specifically the road transport sector. The application of the methods NPV-at-Risk, CF-at-Risk, Value-at-

Risk and IRR-at-Risk will, consequently, have a set of fourteen road projects, being seven of these related to SUCT and the remaining seven of “new subconcessions” or “new highways”.

In total, we have an investment in national road infrastructure of 930 and 1.806 kilometres of SCUT concessions and Highways, respectively. In terms of capital expenditure, these road projects represent significantly, 6.359 ME (46% of which related to SCUT and 54% to Highway), whose concession period is, in the case of SCUT, thirty and forty years in the case of Highways. The research methodology will be based in developing present and future mappings of cash flows of the partnerships, to be possible to quantify the free cash flow of projects and thus determine the NPV of these. Subsequent to this mapping of cash flows, it will be applied the Monte Carlo method to simulate 1000 iterations, so that it’s possible to plot the cumulative density functions of the projects examined. To construct the map of cash flows of the project necessary to determine the return-risk metric to be applied, will be used some assumptions indicated below in Table 1.

Table I: Main assumptions assumed for the cash-flows models.

Main assumptions	
Years of CAPEX in SCUT/Highway	4/5 years
Operation and maintenance costs/Km	75.000€ [1]
Reinvestments, all 10 years	10% of CAPEX [1]
Taxes	25%
Monte Carlo simulations	1.000
Inflation rate	3%
Legal discount rate	6,08%
Subjective discount rate	5%

[1] capitalized with the inflation rate

The NPV of each PPP will be determined based on the WACC to update the cash flows of the projects. It will be also determined the NPV based on the legal discount rate and on the subjective rate. In appendixes XV and XVI it is also possible so see graphical representations of the mapping of cash flows, where it is possible to observe the dynamics associated with the evolution of such flows with the evolution of years of grant projects. The data relative to public sector payments to concessionaires are available from the reports of the Audit Court of Portugal while the capital expenditure report for the data of the Portuguese Public Road Institute (IEP) and by its licensees. In tables II and III are available the main financial information for each SCUT concession and highway.

Table II: Main informations about the SCUT concessions and the equity and financial structure (values in euros).

	Beira Interior	Interior Norte	Algarve	Costa de Prata	Grande Porto	Beiras litoral e alta	Norte Litoral
Beginning	13-09-1999	30-12-2000	11-05-2000	19-05-2000	0	29-04-2001	17-09-2001
Years of concession	30	30	30	30	30	30	30
Kilometers of concession	178	155	129	105	72	176	115
Contribution for the total - %	19,140%	16,667%	13,871%	11,290%	7,742%	18,925%	12,366%
Capex	438.000,00 €	499.000,00 €	243.000,00 €	298.000,00 €	465.000,00 €	753.000,00 €	228.000,00 €
Debt - %	90,60%	98,00%	83,10%	91,30%	87,00%	91,20%	76,00%
Debt	396.828,00 €	489.020,00 €	201.933,00 €	272.074,00 €	404.550,00 €	686.736,00 €	173.280,00 €
Equity - %	9,40%	2,00%	16,90%	8,70%	13,00%	8,80%	24,00%
Equity	41.172,00 €	9.980,00 €	41.067,00 €	25.926,00 €	60.450,00 €	66.264,00 €	54.720,00 €
Debt/Equtiy	9,638	49,000	4,917	10,494	6,692	10,364	3,167
Cost of Debt	8,83%	6,09%	6,30%	5,92%	5,70%	6,33%	7,38%
Cost of Equity	13,00%	13,18%	7,72%	11,89%	12,00%	13,10%	6,41%
tax	25%	25%	25%	25%	25%	25%	25%
WACC	7,22%	4,74%	5,23%	5,09%	5,28%	5,48%	5,75%

Source: Portuguese Public Road Institute (IEP).

Table III: Main informations about the new highways concessions and the equity and financial structure (values in euros).

	Pinhal Interior	AE transmontanas	Douro Interior	Baixo Alentejo	Baixo Tejo	Litoral Oeste	Algarve Litoral
Beginning	2007	2008	2008	2009	2009	2009	2009
Years of concession	40	40	40	40	40	40	40
Kilometers of concession	567	186	250	344	77	109	273
Contribution for the total - %	30,882%	10,131%	13,617%	18,736%	4,194%	5,937%	14,869%
Capex	958.000,00 €	542.000,00 €	649.000,00 €	390.000,00 €	276.000,00 €	452.000,00 €	168.000,00 €
Debt - %	85,00%	80,00%	81,00%	73,00%	86,00%	85,00%	61,00%
Debt	814.300,00 €	433.600,00 €	525.690,00 €	284.700,00 €	237.360,00 €	384.200,00 €	102.480,00 €
Equity - %	15,00%	20,00%	19,00%	27,00%	14,00%	15,00%	39,00%
Equity	143.700,00 €	108.400,00 €	123.310,00 €	105.300,00 €	38.640,00 €	67.800,00 €	65.520,00 €
Debt/Equtiy	5,667	4,000	4,263	2,704	6,143	5,667	1,564
Cost of Debt	6,30%	5,60%	6,30%	5,80%	5,80%	6,50%	7,20%
Cost of Equity	10%	10%	10%	10%	10%	10%	10%
tax	25%	25%	25%	25%	25%	25%	25%
WACC	5,52%	5,36%	5,73%	5,88%	5,14%	5,64%	7,19%

Source: Portuguese Public Road Institute (IEP).

V. Analysis and discussion of results

5.1. Traditional methods

After the sampling delimitation and methodological, as well as the characterization and presentation of the capital structure of each road partnership, it will be analysed and discussed the results obtained after the application of the current methods above. Note that this analysis due to the methodology of risk-return, when compared against the traditional methods of financial evaluation, will not have a nature of decision and of preference or choice of projects, but an interpretation and analysis of metrics applied.

Although this metric does not allow the distinction between preference between projects, the payback period in the case of SCUT, indicates that the payback is between nine and fifteen years. In the case of IRR and Accounting Rate Return (ARR), these do not allow distinguishing between the preferable SCUT. However, both rates are higher than the discount rates used (legal, subjective and by the WACC). For purposes of the NPV, we proceeded to update the cash flows based on various discount rates. In all SCUT it is verified that PPP are investible, since the respective NPV values are greater than zero. In the case of the coefficient of variance, it is important to note that this metric was used in preference to others (such as the method of mean-variance), because this power to judge the preference for projects. However, this method is also insufficient for decision effects. It is understood, therefore, the ability to make decisions as a possibility of analysis of the trade-off between return and risk.

For the case of new “sub concessions”, financial analysis with traditional metrics seems to indicate the same conclusions. All seem to reflect the financial viability of projects. The imperative of recovery periods on investment (payback) higher is justified by the fact that the new Highways report to time horizons of, roughly, 40 years. Compared to SCUT, there is the existence of several projects in which the net cash-flows are negatives although the present net values also be positive, and so, investible. In a hypothetical scenario of NPV lower than zero, it may justify a change in management practices of the concessionaire or in a limit scenario, a renegotiation of state payments to the concessionaire company.

Table IV: Results of tradicional methods applied to SCUT (values in thousands of euros).

	SCUT						
	Algarve	Beira Interior	Beira Literal e Alta	Costa da Prata	Grande Porto	Interior Norte	Norte litoral
***Payback period* (years)**	14	9	13	11	15	12	14
Accounting rate of return	22,01%	38,15%	22,22%	28,31%	18,08%	28,30%	39,77%
IRR (antes de impostos)	8,66%	16,03%	9,28%	12,16%	7,62%	10,52%	10,14%
IRR (depois de impostos)	6,43%	12,67%	6,99%	9,34%	5,55%	8,15%	8,10%
EBIT	919.993 €	2.356.450 €	2.923.335 €	1.328.508 €	1.593.425 €	2.224.108 €	1.325.323 €
Net Cash-Flow	657.856 €	1.883.957 €	2.111.035 €	1.007.041 €	1.091.806 €	1.685.812 €	1.079.368 €
Coefficient of Variance	0,20	0,50	0,39	0,51	0,42	0,39	0,23
NPV (WACC discount rate)	229.064 €	634.012 €	794.189 €	429.512 €	419.531 €	727.843 €	264.177 €
NPV (legal discount rate)	196.340 €	731.936 €	720.543 €	372.725 €	370.270 €	591.822 €	246.241 €
NPV (subjective discount rate)	238.975 €	841.462 €	859.854 €	435.035 €	445.307 €	698.753 €	309.019 €

Table V: Results of tradicional methods applied to new highways (values in thousands of euros).

	New Highways						
	Pinhal Interior	AE Transmontanas	Douro Interior	Baixo Alentejo	Baixo Tejo	Litoral Oeste	Algarve Litoral
***Payback period* (years)**	11	22	11	26	6	7	12
Accounting rate of return	312,08%	139,48%	21,69%	39,12%	102,70%	40,88%	61,33%
IRR (before taxes)	10,51%	8,20%	8,14%	8,02%	21,61%	17,75%	9,59%
IRR (after taxes)	6,52%	7,40%	4,06%	7,25%	15,90%	12,40%	8,81%
EBIT	2.587.662 €	790.453 €	1.640.336 €	337.928 €	1.161.967 €	1.322.530 €	318.062 €
Net Cash-Flow	1.095.358 €	-53.836 €	629.370 €	-269.587 €	732.034 €	618.437 €	56.364 €
Coefficient of Variance	0,47	0,62	0,55	0,58	0,44	0,28	0,56
NPV (WACC discount rate)	801.656 €	138.614 €	410.322 €	36.097 €	450.875 €	521.820 €	58.103 €
NPV (legal discount rate)	626.594 €	182.151 €	393.996 €	35.695 €	417.197 €	507.151 €	69.023 €
NPV (subjective discount rate)	711.836 €	144.376 €	445.872 €	37.831 €	456.167 €	543.630 €	79.640 €

Source: authors.

5.2. Risk-Return methods

However, given the limitations of traditional methods mentioned above, it was proceeded to the use of more vigorous an appropriated methods. Both methods are limited by failing to consider the risk component in the projects, which is an even more important issue given the different risks outlined in a PPP. For the metric "at-Risk", these are the only ones capable of providing the values of NPV, IRR and cash flows from a given scenario for possible levels of significance. Given the SUCT, the risk-return methods seem to indicate internal rate of return identical, to the degree of confidence of 90% and 95%. The NPV-at-Risk, which measures the minimum expected of NPV, to 5% and 10% of significance, seems to denote the viability of SCUT, since the metric is greater than zero. The same analysis applies to the CF-at-Risk, in which the amounts in question relate to the minimum net cash flow expected for each SCUT. In its turn, there are amounts of Value-at-Risk higher compared to other metrics (Table VIII e IX). This is justified by the fact that this method reports for the measurement of maximum exposure to changes in the value of portfolios of SCUT partnerships.

Unlike the case of SCUT, in the new "sub concessions", the methods of risk-return seem to reflect the existence of a partnership at risk of failing financial viability, the granting of "*Transmontanas*" Highways, since the NPV-at-Risk is below zero, with 5% statistical significance. For the other partnerships, they seem to remain financially viable, even after the determination of the minimum amounts expected and for very significant confidence levels.

One possible justification for the viability of concessions may be associated with the differential between payments made by the Portuguese State to the concessionaires and their respective operating and maintenance costs.

The results of Value-at-Risk take into account other risks different of the NPV-at-Risk. While the first metric takes into account essentially the market risk and others (liquidity and credit), the NPV-at-Risk considers other relevant factors, mainly (i) the wide range of results due to the uncertainty and (ii) the specific risks, endogenous and exogenous, to the PPP.

Table VI: Results of risk-return methods applied to SCUT (values in thousands of euros).

	SCUT						
	Algarve	**Beira Interior**	**Beira Literal e Alta**	**Costa da Prata**	**Grande Porto**	**Interior Norte**	**Norte litoral**
Cumulative distribution analysis	Appendix 17 and 18	Appendix 17 and 18	Appendix 17 and 18	Appendix 17 and 18	Appendix 17 and 18	Appendix 17 and 18	Appendix 17 and 18
IRR-at-Risk							
5%	6,354%	12,504%	6,683%	8,999%	5,217%	7,818%	7,740%
10%	6,372%	12,540%	6,752%	9,073%	5,290%	7,890%	7,818%
CF-at-Risk							
5%	19.414 €	46.731 €	105.893 €	25.324 €	30.246 €	54.089 €	25.197 €
10%	22.664 €	60.891 €	112.858 €	31.855 €	36.895 €	64.244 €	30.895 €
NPV-at-Risk							
5%	7.088 €	5.571 €	16.178 €	3.036 €	5.552 €	11.459 €	7.719 €
10%	7.820 €	11.841 €	22.301 €	6.536 €	8.134 €	16.326 €	8.775 €

Table VII: Results of risk-return methods applied to new highways (values in thousands of euros).

	New Highways						
	Pinal Interior	**AE Transmontanas**	**Douro Interior**	**Baixo Alentejo**	**Baixo Tejo**	**Litoral Oeste**	**Algarve Litoral**
Cumulative distribution analysis	Appendix 19 and 20	Appendix 19 and 20	Appendix 19 and 20	Appendix 19 and 20	Appendix 19 and 20	Appendix 19 and 20	Appendix 19 and 20
IRR-at-Risk							
5%	5,37%	6,19%	2,80%	5,16%	14,70%	12,77%	7,59%
10%	5,62%	6,46%	3,07%	5,24%	14,96%	12,96%	7,86%
CF-at-Risk							
5%	80.682,37 €	8.189,63 €	57.112,54 €	37.907,98 €	-9.068,80 €	89.232,65 €	20.779,65 €
10%	96.131,88 €	14.898,17 €	64.607,44 €	40.207,59 €	6.128,77 €	100.009,22 €	24.787,49 €
NPV-at-Risk							
5%	10.818,24 €	-947,60 €	10.629,82 €	11.651,31 €	10.832,44 €	38.612,46 €	9.778,83 €
10%	20.549,27 €	2.169,28 €	16.464,56 €	13.626,31 €	14.991,59 €	45.552,53 €	11.384,88 €

Source: authors.

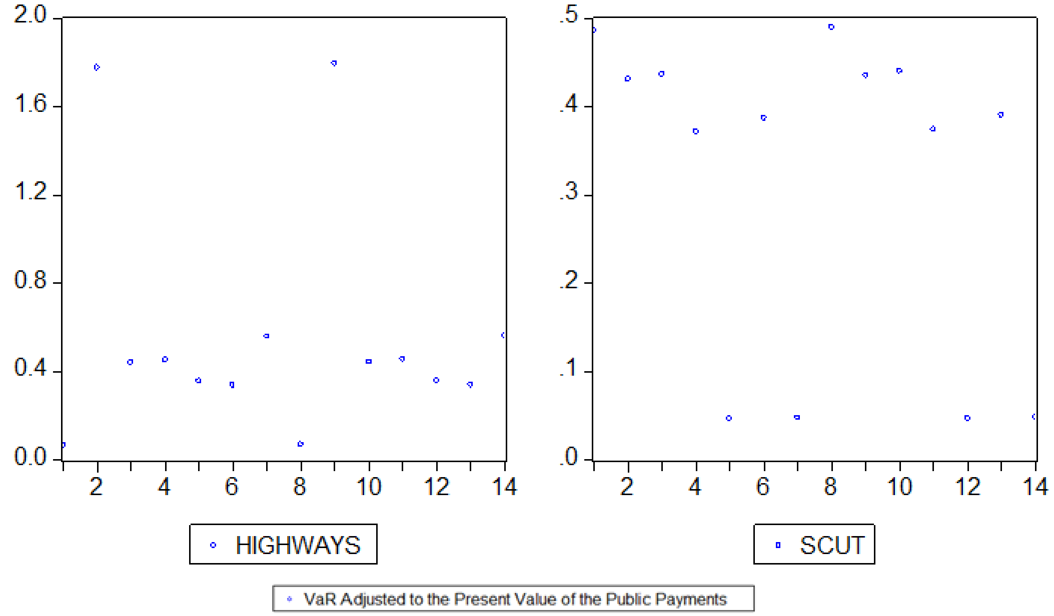
5.3. Risk Exposition

As previously mentioned, the VaR method allows to calculate and quantify the maximum amount exposed to risk. Given a confidence level, VaR summarizes the information in probability distributions of hypothetical changes in value of PPP projects.

The results based on the method of Monte Carlo simulation are summarized in Tables VIII and IX. The VaR method does not allow comparisons between various concessions, because each concession has different dimensions and costs, therefore we adapted the metric with the present value of payments to the concessionaires.

Figure V denotes the ratio of adjusted VaR. Using a scatter graph representation, it is possible to observe a great uniformity around the ratio in the order of 40%. Adjusting the average to the single outlier, the VaR ratio statistical central location stood at 37.36%. The graphical representation of the results confirms that the subconcession Transmontanas Highways has an excessive VaR compared to the central location. Statistically, there appears to be evidence for them to be considered outliers. This is the only PPP project that may not be viable, since it has a negative NPV-at-Risk (significant at the 0.05 level).

Exhibit V: Scatter graph of VaR adjusted to the present value of public payments.

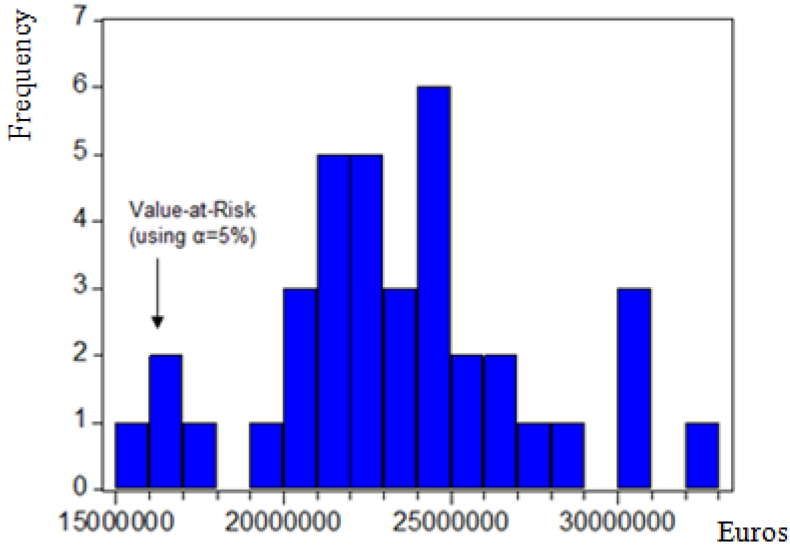


Source: authors.

Alternatively, in terms of Value-at-Risk, we could proceed to the methodology developed by Linsmeier and Pearson (2000), in which the maximum exposure can be analysed based on hypothetical changes in the histogram of an annual PPP.

Although the Value-at-Risk defined has been carried based on the method performed on Monte Carlo simulations, the objectives of this study allowed also the application of another method to determine the Value-at-risk, another words, the Delta-Normal. Briefly, this method has with main objective the determination of the maximum value exposed to market risks, assuming that this risk are underlined to a multivariate normal distribution (Linsmeier and Pearson, 2000). Figure V, placed below, refers to the distribution of hypothetical annual loss of *Douro Interior* concession.

Exhibit VI: Histogram of hipothetical changes and losses in a PPP project.



Source: authors.

Finally, one last note to the fact of the requirements, especially statistical, associated with "at-Risk" metrics. The reasonableness of the statistical distributions assumed is not pinched by the Monte Carlo method because this is a requirement of the same. Throughout the next section, will be presented the main conclusions and limitations of this research opportunity as well as suggestions for future research.

Table VIII: Results of VaR in SCUT projects (values in thousands of euros).

	VaR		VaR Adjusted to the Present Value of the Public Payments	
SCUT	**5%**	**10%**	(using VaR with 5% of significance)	(using VaR with 10% of significance)
Algarve	292.175 €	294.296 €	48,63%	48,99%
Beira Interior	564.035 €	569.523 €	43,13%	43,55%
Beira Literal e Alta	703.538 €	709.511 €	43,71%	44,08%
Costa da Prata	320.024 €	322.672 €	37,18%	37,49%
Grande Porto	386.081 €	388.767 €	46,91%	47,24%
Interior Norte	533.403 €	538.354 €	38,72%	39,08%
Norte litoral	320.496 €	322.867 €	48,05%	48,41%

Table IX: Results of VaR in new highways projects (values in thousands of euros).

	VaR		VaR Adjusted to the Present Value of the Public Payments	
New Highways	**5%**	**10%**	(using VaR with 5% of significance)	(using VaR with 10% of significance)
Pinal Interior	184.574 €	192.479 €	6,75%	7,04%
AE Transmontanas	1.468.475 €	1.483.988 €	177,75%	179,62%
Douro Interior	614.778 €	617.843 €	44,27%	44,49%
Baixo Alentejo	388.495 €	391.327 €	45,45%	45,78%
Baixo Tejo	344.237 €	347.481 €	35,69%	36,02%
Litoral Oeste	408.696 €	413.887 €	33,86%	34,29%
Algarve Litoral	330.194 €	332.800 €	56,09%	56,53%

Source: authors

VI. Conclusions, main limitations and suggestions for future research

6.1. Conclusions

Inevitably, when making a comparison with other investment projects, the PPP are clearly exposed to more risks. This additional or marginal risks exposure requires, invariably, the use of more vigorous and powerful methods for evaluating projects and that can also make a comparison between the returns achieved for the sponsors of the PPP and the risks associated to this type of infrastructural projects. In this research opportunity were addressed the key metrics of international evaluation “at-Risk” for each agent involved in the partnership, but the focus of the study was verified for the sponsors of the PPP.

Along the application of traditional methods of financial evaluation (which included metrics such as NPV, IRR, Payback period, among others) as well as new methods of risk-return (such as the NPV-at-Risk, CF-at-Risk, Value-at-Risk and IRR-at-Risk), to the Portuguese road sector, the made comparisons allowed to draw some considerations. Hereupon, after the application to the main SCUT released and to the new Portuguese highway, it was verified that the risk-return methods, here developed, provide better strategic decisions for capital investment, given the ability to articulate the components of return and risk. While the metric of the Value-at-Risk has provided an opportunity to quantify the risk exposure of each project, for a given level of statistical significance, the methods of CF-at-Risk, IRR-at-Risk and NPV-at-Risk indicate, for the usual levels of significance, the minimum amounts for net cash flows, IRR and NPV, respectively, of each PPP. Another important conclusion relates to the robustness of the economic and financial viability, mainly achieved with the metric of NPV-at-Risk, which combines in itself three important issues in the financial analysis of projects: (i) includes the value of money in time; (ii) expresses the risk component, by introducing in its determination the values of its central location (median) and dispersion (variance), and finally (iii) the update of the cash flows is performed using the WACC, representing the weighted average cost of capital invested in the project.

Therefore, the scrutiny surrounding the research question, after the application of the methods indicated, allowed to conclude the economic-financial viability for the sponsors of the concessions analyzed. Only one exception is detected, with the metric NPV-at-risk, more specifically against *Transmontanas* highways, since the minimum NPV-at-Risk of this concession, with a 5% level of significance, may be negative. However, the clear viability of the remaining 13 concessions may be justified, with the differential between the payments from State to the utilities concerned, after the process of negotiation and renegotiation, and their respective operational costs.

The combined analysis of the metrics "at-Risk", especially when extended to other perspectives, of government and financing institutions of projects, help, therefore, to an easier and faster negotiation and might lead easily to the desired VfM. Note that these results are aligned with the two most important research in the field, more specifically, with Ye and Tiong (2000) and Ke, Liu and Wang (2008).

6.2. Main limitations

Despite the conclusions outlined above, it will be possible to highlight some issues relating to limitations of the research. Thus, from the viewpoint of those involved in PPP, despite having carried out the use of various models of risk-return for the sponsors of partnerships, it would be possible to extend the analysis methods of interest to governments and funding institutions. For the sample in question, it is noted that the fourteen projects evaluated are clearly superior to the previously discussed studies, however, an even higher sample could lead to more robust results.

The issue of international comparability, given the results, may also be a topic to point as limitation. The national economy, especially when compared with other developed economies, is characterized by a high ratio of spending on PPP on the national Gross Domestic Product. However, the lack of a multi-country analysis will not allow a greater comparability of results. Moreover, by sectors, it is noted that this chance of research only covers the sector of Portuguese road. Although the study covers the vast majority of all the PPP of national road, another limitation relates to the no extension to other sector, equally important, as is the case of PPP in the health sector or in the railway sector. Finally, still need to scrutinize a final limitation pointed out, associated to the methodological issue. Since a mapping of cash flows was performed, it wasn't possible to use only real data, so that these only report to the Portuguese government payments to concessionaires and capex. The other variables, such as operating costs, for examples, result from the application of the conditions listed above.

6.3. Suggestions for future research

For future investigations that occur in this area, of financial evaluation and risk of the PPP, it Is suggested that the analysis of the partnerships in the context of the Portuguese state, using for it the evaluation methods mentioned by Ke, Liu and Wang (2008), more specifically the SLR-at-Risk or the VfM-at-Risk. Since we are in the presence of focused evaluation methods for the participating State, it would be interesting to explore in which measure the extend of the risk component, to the traditional method of VfM, would influence the efficiency and increase the marginal value creation for the public sector. On the other hand, another equally valid suggestion may involve the use of all current methods of evaluation of these projects (SLR-at-Risk, VfM-at-Risk, DSCR-at-Risk, TIE-at-Risk, NPV-at-Risk e IRR-at-Risk) to assess the feasibility of the projects examined in this possibility of investigation, or even extend to other sectors where there is the option for use of the PPP.

Alternatively, given the problem of risk allocation between public and private sector, it is suggested the application of the game theory because of their conflicting objectives. This suggestion would have as main objective to scrutinize the possibility of existence of a certain moral hazard at the level of strategic behaviour of one of the parts when it becomes apparent that the financial guarantees outweigh the hypothetical financial losses.

VII. References

Akintoye, A., Beck, M., Hardcastle, C. *et al.* (2001). *Framework for Risk Assessment and Management of Private Finance Initiative Projects*. Glasgow Caledonian University;

Asenova, D. (2010). Risk Management in Private Finance Initiative Projects: the Role of Financial Services Providers. Lambert Academic Publishing, Saarbrücken. *Accounting Forum*, 29 (2005), 345-348;

Biderman, C. (2008). Sub-national loan authorization in Brazil and politics: is there a room for oportunistic behavior? Revista Dados, 1-1.

Bing, L., Akintoye, A., Edwards, P.J. and Hardcastle, C. (2005). The allocation of risk in PPP/PFI construction projects in the UK. *International Journal of Project Management*, 23, 25–35;

Black, Fischer, (1972). Capital market equilibrium with restricted borrowing, Journal of Finance;

Blanc-Brude, Frederic and Roger Strange, (2007). How banks price loans to public private partnerships: Evidence from the European markets, *Journal of Applied Corporate Finance* 19, 94-106;

Bolton, P., and X. Freixas (2000). Equity, bonds, and bank debt: capital structure and financial market equilibrium under asymmetric information, Journal of Political Economy 108:324−351;

Brealey & Myers, Principles of Corporate Finance (2002). 5 th Edition, McGraw-Hill.

Cartlidge, D. (2006). *Public Private Partnerships in Construction*. Taylor & Francis, England;

Chong, E., Huet, F., Saussier, S. and Steiner, F. 2006. ‘Public–private partnership and prices: evidence from water distribution in France’, *Review of Industrial Organization*, vol. 29, no. 1–2, pp. 146–69;

Comer, B. (1996). *Project Finance teaching note*. The Wharton School;

Comissão Europeia (2004). *Livro verde sobre as PPP e o direito comunitário em matéria de contratos públicos e concessões*. Bruxelas: Comissão Europeia;

Damodaran, Aswath (1997). Corporate finance: theory and practices. New York: Wiley;

Deloitte Research Study (2007). *Closing the infrastructure gap: the role of Public-Private Partnerships*, Reino Unido;

Direcção Geral de Tesouro e Finanças (2011). Relatório de 2011 Parcerias Público Privadas e Concessões. Ministério das Finanças 2011;

Domberger, S. (1998). *The Contracting Organization. A Strategic Guide to Outsourcing*, Oxford University Press, Oxford;

Dos Santos, Tiago. (2006). A transferência de risco em PPP, Universidade Técnica de Lisboa - Instituto Superior de Economia e Gestão;

Dowd, K. (1998). *Beyond Value at Risk, The New Science of Risk Management*. Chichester: Wiley;

Du, Xiaofeng, Li, Amory (2008). Monte Carlo simulation and a value-at-risk of concessionar project: The case study of the Guangshen Freeway in China. Management Research Review. Volume 31, issue 12;

Efficiency Unit, Hong Kong (2003). Serving the Community by Using the Private Sector: An Introductory Guide to Public- Private Partnerships. Hong Kong: Hong Kong SAR Government Publisher,;

Epple, Dennis and Richard Romano. (1998). Competition Behveen Private and Public Schools, Vouchers and Peer Group Effects." *Amnz'ccrn Economic Rmiau.* 88, pp. 33-63;

Esty, B. (2003). *The economic motivations for using Project Finance*. Harvard Business School, Boston;

Esty, B. e Kane, M. (2003). BP Amoco (A): Policy statement on the use of Project Finance. Harvard Business School, Boston. Evaluating alternative approaches and comparing academic and practitioner views";

Fama, Eugene F., and Kenneth R. French, (2004). The capital asset pricing model: Theory and evidence, *Journal of Economic Perspectives* 18:3, 25-46;

Farrell, L. M. (2002). *Principal-agency risk in project finance*. International Journal of Project Management;

Farid, F., Boyer, L. T., and Kangari, R. (1989). Required return on investments in construction. J. Constr. Engrg. And Mgmt., ASCE, 115(1), 109-125;

Fernandez, P., (2009). Market Risk Premium Used in 2008 by Professors: A Survey with 1,400 Answers, Unpublished working paper, University of Navarra;

Fernandez, Pablo, (2009b), The Equity Premium in 150 Textbooks, IESE Business School. working paper;

Fernandez, P. and J. del Campo (2010). Market Risk Premium Used in 2010 by Analysts and Companies: A Survey with 2,400 Answers. University of Navarra - IESE Business School Working Paper;

Fernandez, Pablo, Javier Aguirreamalloa and Luis Corres. (2011). Market Risk Premium used in 56 countries in 2011: a survey with 6,014 answers. Working paper by IESE Business School;

Fishman, G.S. (1995). Monte Carlo: Concepts, Algorithms, and Applications, Springer-Verlag, New York, NY;

Fox, G. (2002). Sources of Finance for PPP/PFI projects: strategically tailoring the model to your project. In: *Financial Modelling Strategies for PFI /PPP Projects*, March 4–5, London. SMI;

Frank, Robert (1994). *Microeconomics and Behavior*. New York: W.W. Norton & Company;

Froud J. (2003).The private finance initiative: risk, uncertainty and the state. Accounting, Organizations and Society 28(6):567–89;

Girmscheid,G.(2006). NPV-Wirtschaftlichkeitsanalysemodell Lebenszyklusbetrachtung von kommunalen Strassenunterhalts-PPP. In: Bauingenieur 81 Nr. 10, S. 455-463;

Girmscheid, G; Fastrich (2007). CIB World Building Congress (2007). Public Private Partnership for maintenance activities – System boundaries for a life cycle oriented economic efficiency analysis. CIB World Building Congress 2007 Edition;

Grimsey, D. and Lewis, M.K. (2004). Discount debates: rates, risk, uncertainty and value for money in PPP. *Public Infrastructure Bulletin*, 3, 4–7;

Grimsey, D., Lewis, M.K (2000). Evaluating the risks of public-private partnerships for infrastructure projects, *International Journal of Project Management* 20 (2002), 107-118;

Grimsey, D., Lewis, M.K (2005). Are Public Private Partnerships Value for Money?;

Grimsey, D., Lewis, M.K (2007). Public Private Partnerships and Public Procurement, Agenda, Volume 14, Number 2, 2007, pages 171-188;

Hainz, Christa and Stefanie Kleimeier, (2006). Project finance: Managing risk in international syndicated lending, working paper, University of Munich;

Handley, M. (2002). Legal implications for the financial model post financial close. In: *Financial Modelling Strategies for PFI/PPP Projects*, March 4–5, London. SMI;

Hardcastle C, eds. Public- Private Partnership: Managing Risks and Opportunities. Blackwell Science, 2003: 1-30.

Hennessy, J.H. (1986). Handbook of Long-term Financing, 2 edn., Englewood Cliffs, NJ: Prentice-Hall;

Ho S P, Liu L Y. (2002). An option pricing-based model for evaluating the financial viability of privatized infrastructure projects. *Construction Management and Economics*, 20(2): 143-156;

Holmstrom, B. e Milgrom, P. (1991). Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownerships and Job Design, *Journal of Law, Economics & Organization*,7, special issue, 24-52;

Hood, J. e MacGarvey, N. (2002). Managing the Risk of Public-Private Partnerships in Scottish Local Government, *Policy Studies*, 23(1), 21-35;

International Monetary Fund. (2004). Public Private Partnerships. Fiscal Affairs Department;

Isaac, I. (1995). Training in risk management, *International Journal of Project Management*, 13(4), 225-229;

Jeff Youngen, Louis Guth, Michael Tennican and Stephen Usher (2001). A Comparables Approach to Measuring Cash-Flow-at-Risk for Non-Financial Firms. Journal of Applied Corporate Finance 13, 100-11;

Jensen, M., (1972). Capital Markets: Theory and Evidence, Bell Journal of Economics and Management Science ;

Jin, X. H., and Doloi, H. (2008). Interpreting risk allocation mechanism in public-private partnership projects: An empirical study in a transaction cost economics perspective. *Constr. Manage. Econom.*, 26_7_, 707–721;

Jorion, P. (2000). Value at Risk: The New Benchmark for Managing Financial Risk, McGraw-Hill, New York, NY;

JP Morgan/Reuters,., (1996). RiskMetrics-Technical Document, 4th edition. Morgan Guaranty Trust Company and Reuters Ltd., New York;

Justel, A., Pena, D., and Zamar, R. (1997). A multivariate Kolmogorov-Smirnov test of goodness of fit. Statistics and Probability Letters, 35:251-259;

Ke, Y., Liu, I. & Wang, S. (2008). Equitable Financial Evaluation Method for Public-Private Partnership Projects. *Tsinghu Science and Technology, 13*(5), 702-707.

Kleimeier, S. and W.L. Megginson. (2000). Are Project Finance Loans Different from Other Syndicated Credits?. Journal of Applied Corporate Finance, 12., 75-87;

Klein, M (1998). Bidding for Concessions, *The World Bank;*

Knight, Frank H. (1921). Risk, uncertainty, and profit. New York: Hart, Schaffner, and Marx;

Li B, Akintoye A. (2000). An overview of public-private partnership. In: Akintoye A, Beck M;

Lilliefors, H., (1967). On the Kolmogorov – Smirnov test for normality with mean and variance unknown. J. Am. Stat. Assoc. 62, 399 – 402;

Linsmeier, T.J,, and N.D. Pearson. (2000). Value at Risk. Financial Analysts Journal vol. 56, no. 2 (March/Aprii):47-67;

Lintner, John (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets, Review of Economics and Statistics 47, 13—37;

Liu X P (2006). Improvement of financial evaluation methods and quantitative risk analysis for PPP/BOT projects [Dissertation]. Beijing: Tsinghua University;

Mansal, E. (2009). Linking the Concessionaire's Financial Abilities during Different Stages of a BOT Project. Master´s Thesis in Nation Cheng kung University, Taiwan;

Marshall, C. and M. Siegel (1996). Value at Risk: Implementing a Risk Measurement Standard. Working paper;

Matsumura, Toshihiro, (1998). Partial privatization in mixed duopoly. Journal of Public Economics 70, 473–483;

Medda, F. (2004). The Allocation of Political and Regulatory Risks in public Private Partnerships, *University College London*;

Merton, R.C., (1973). An intertemporal capital asset pricing model, Econometrica 41, 867-887;

Morallos, D., Amekudzi, A (2008). The State of the Practice of Value for Money Analyses in comparing Public Private Partnerships to traditional Procurement. *Public Works Management and Policy*, Vol. 13, number 2, 114-125;

NAO, National Audit Office (2003). PFI Construction Performance. London: National Audit Office, HC371;

Ng, S. T., and Wong, Y. M. W. (2006). Adopting non-privately funded public-private partnerships in maintenance projects a case study in Hong Kong. *Eng., Constr., Archit. Manage.*, 13_2_, 186–200;

OECD (2008), Public-Private Partnerships: In Pursuit of Risk Sharing and Value for Money, OECD Publishing, DOI: http://dx.doi.org/10.1787/9789264046733-en.

Price Water House Coopers (2005). *Delivering the PPP promise: A review of PPP issues and activity*. Reino Unido;

Public Private Partnerships (2003). *UK expertise for international markets*. Reino Unido: Londres;

Quiggin, J. (2004). Risk, PPP and the public sector comparator. *Australian Accounting Review*. Vol. 14, no. 2, pp. 51-61;

Ranasinghe M. Private sector participation in infrastructure projects: A methodology to analyse viability of BOT. *Construction Management and Economics*. (1999). 17(5): 613-623;

R. Marques, S. Berg, (2010). Risks, Contracts and Private Sector Participation in Infrastructure;

Romer, Paul, (1990). Endogenous Technological Change, *Journal of Political Economy*, 98(5):71-102;

Sarmento, J. (2010). Do Public-Private Partnerships Create Value for Money for the Public Sector? The Portuguese Experience. OECD Journal on Budgeting, Volume 2010/1, OECD 2010;

Savas, E. S.2000. Privatization and public-private partnerships. Chatham House, NJ: Chatham House;

Shaoul, J. (2005). A critical financial analysis of the Private Finance Initiative: Selecting a financing method or allocating economic wealth? *Critical Perspectives in Accounting*, 16(4),441-471;

Sharpe, W. F. (1964). Capital asset prices: a theory of market equilibrium under conditions of risk**.** The Journal of Finance, v.19, p. 425-442;

Sharpe,W.F. (1970). Portfolio Theory and Capital Market, McGraw-Hill, New York, NY;

Sousa, S. (2009). O uso de PPP em Portugal para a construção de infra-estruturas de distribuição de água e saneamento básico, rodoviárias e de saúde. Instituto Superior de Ciências do Trabalho e da Empresa – ISCTE Business School;

Spackman, M. (2002). Public– Private Partnerships: lessons from the British approach; *Economic Systems*, 26 (2002) 283–301;

Stimpson, D., Ed. (1991). Global Credit Analysis: Moody's Investor’s Service. London, IFR Publishing;

THI Consultants Inc. (2001). Operation manual of feasibility evaluation and planning for private participation in public sector. Taiwan, China;

Tribunal de Contas (2008). *Auditoria à Gestão das Parcerias Público Privadas: Concessões Rodoviárias*. Portugal;

United States Department of Transportation (2008). *Innovation wave: an update on the burgeoning private sector role in U.S. highway and transit infrastructure*. United States of America;

Vega, Arturo Olvera (2011). Risk allocation in infrastructure financing. Journal of Project Finance; Summer97, Vol. 3 Issue 2, p38, 5p;

Wang S Q, Tiong R L K, Ting S K, Ashley D. (2002) Evaluation and management of political risks in China’s BOT projects. *Journal of Construction Engineering and Management*, 126(3): 242-250;

Wong A. (2006). Sustainability appraisal in infrastructure projects (SUSAIP): part 1. Development of indicators and computational methods. *Automation in Construction*, 15(2), 239–251;

Yates, A. e Sashegyi, B. (2001). *Effective risk allocation in major projects: Rhetoric or reality?. A survey on risk allocation in major WA construction projects;*

Ye S D, Tiong R L K. NPV-at-Risk method in infrastructure project investment evaluation (2000). *Journal of Construction Engineering and Management*, 2000, 126(3): 227-233;

Ye, Sudong (2009). Patterns of Financing PPP Projects in Policy, Finance & Management for Public-Private Partnerships, 2009 Blackwell Publishing Ltd;

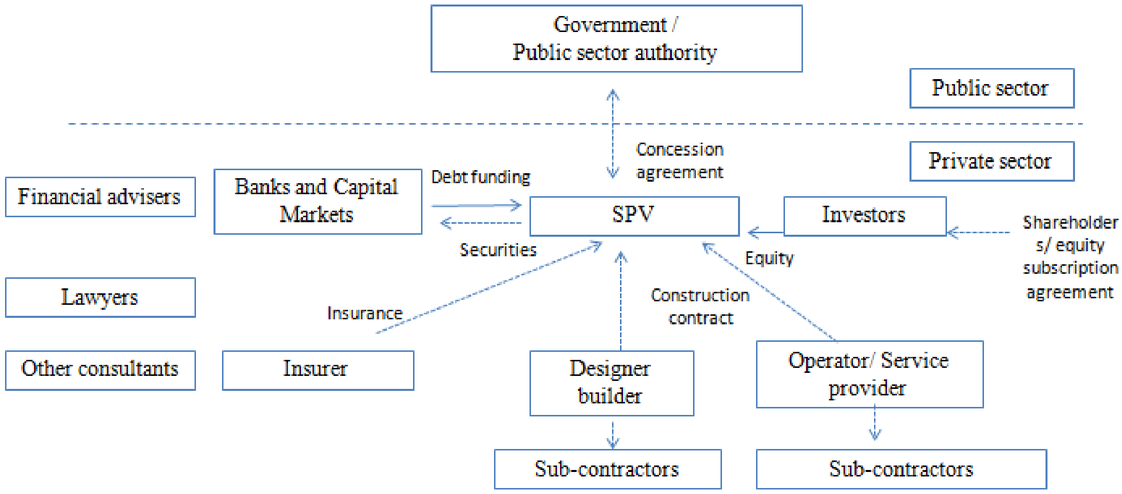
Yescombe, E. R. (2002). *Principles of Project Finance*. Academic Press, Oxford;

Yli-Olly, P. & Virtanen, I. (1989). On the long term stability and cross-country invariance of financial ratio patterns, *European Journal of Operational Research,* vol. 39: 40-53;

Zitron, J. (2006). Public-private partnership projects: Towards a model of contractor bidding decision-making. Journal of Purchasing & Supply Management, Vol. 12, no. 2, pp. 53-62.

Appendices

Appendix I: Relationship between public and private sectors in PPP projects.



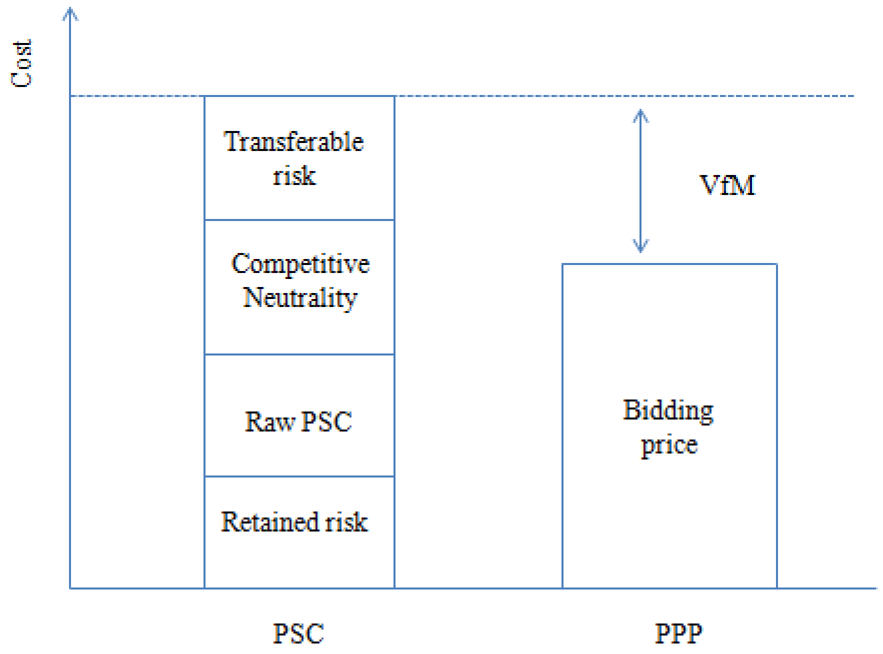
Source: Price Water House Coopers, 2005.

Appendix II: Advantages and disadvantages of project finance.

Advantages of *PROJECT FINANCE*	**Disadvantages of *PROJECT FINANCE***
If risks are appropriately allocated, sponsors may be willing to undertake projects with more risk than they would independently	Project finance can often be complex – particularly as highly specialised (and often unique) SPVs need to be created.
Project sponsor balance sheets are shielded from risk	New structures and arrangements may not be well understood by partners.
High leverage can make it easier to achieve required equity rates of return.	This highly leveraged model can be susceptible to failure.
Investors can hold the debt "off-balance sheet" – increasing their capacity to borrow.	Non-recourse debt is typically expensive (50 – 400 bps higher).
Takes advantage of the relative ease of raising debt compared to equity.	Contracts may require intrusive supervision from investors constrain management actions.

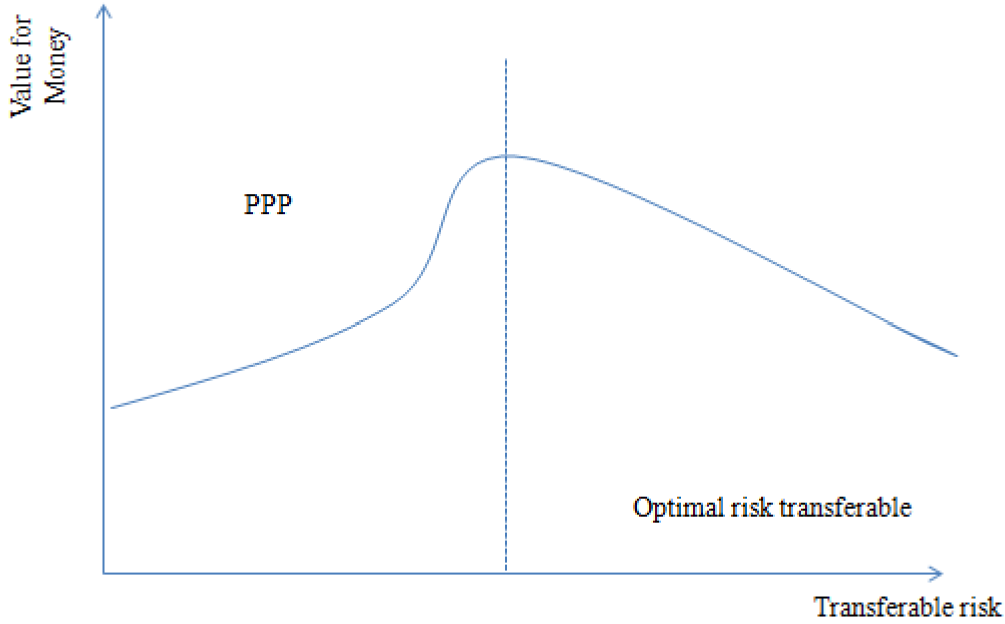
Source: CEPA, Plenary 1: Project Finance

Appendix III: Public Sector Comparative, Value for Money and PPP



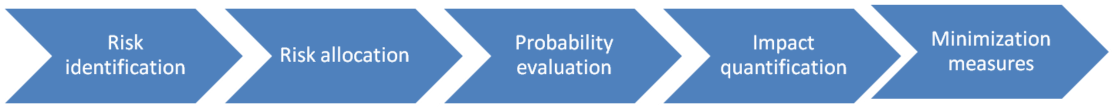
Source: Equitable Financial Evaluation Method for Public-Private Partnership Projects, Ke, Liu e Wang, 2008.

Appendix IV: Allocation of risks and Optimal risk transferable.



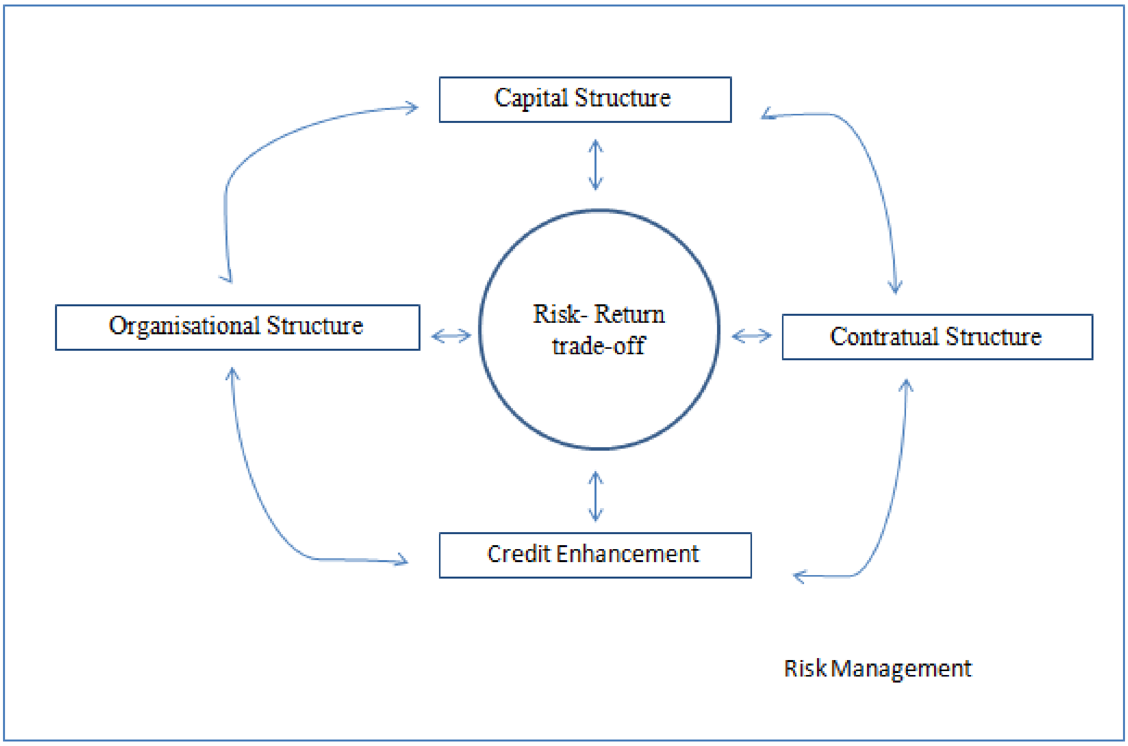
Source: Allocation of risks in PPP, Tiago Alexandre Carvalho dos Santos, 2006.

Appendix V: Stages of analysis and evaluation of risks in PPP.



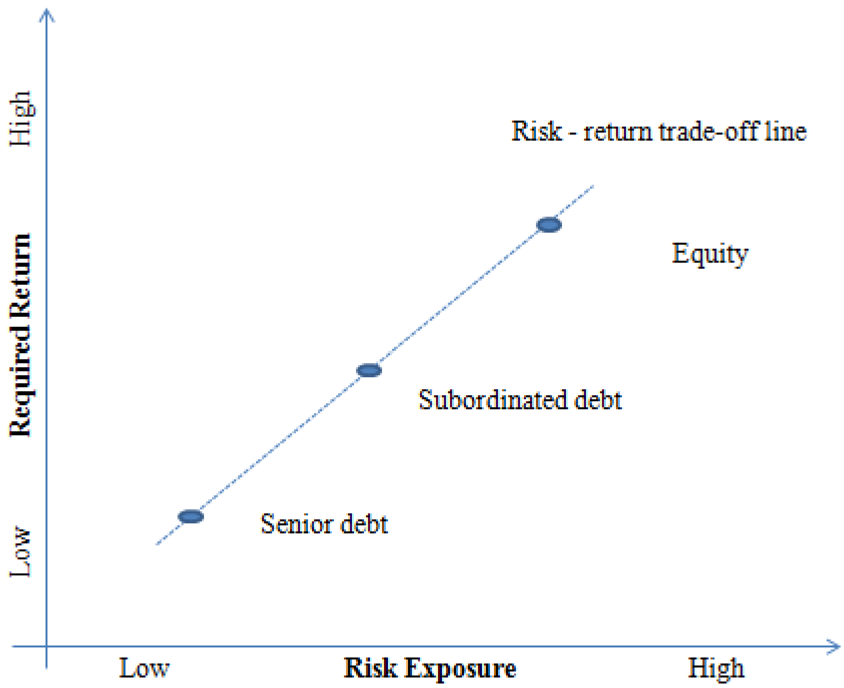
Source: Risks, Contracts and Private Sector Participation in Infrastructure, Marques e Berger, 2010.

Appendix VI: Trade-off between return-risk and risk management in PPP projects.



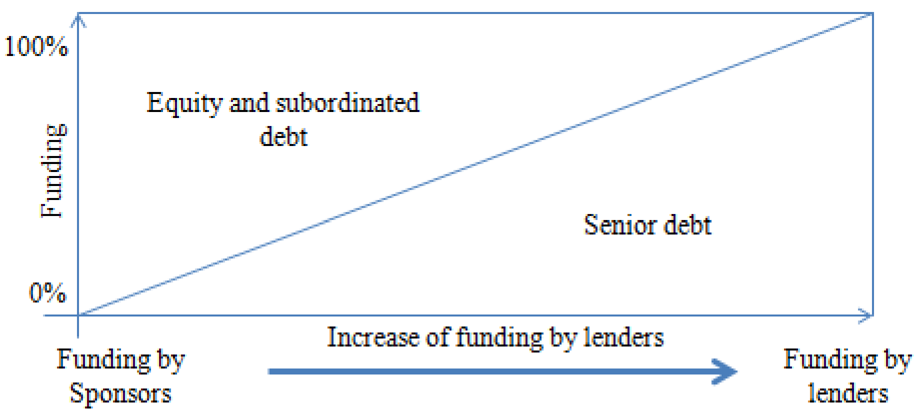
Source: Policy, Finance & Management for Public-Private Partnerships, 2009.

Appendix VII: Trade-off between return and risk of financial instruments.



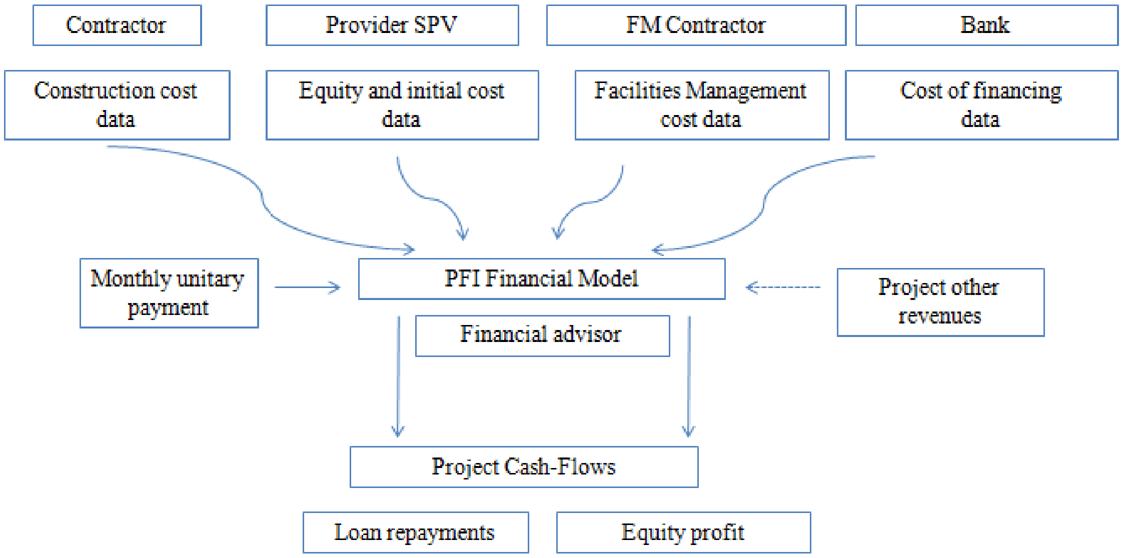
Source: Policy, Finance & Management for Public-Private Partnerships, 2009.

Appendix VIII: Increase of funding by lenders in PPP projects.



Source: Policy, Finance & Management for Public-Private Partnerships, 2009.

Appendix IX: Unitary payments, project revenues and PPP/PFI financial model.



Source: Policy, Finance & Management for Public-Private Partnerships, 2009.

Appendix X: Participations in the portuguese highways, by Shareholders.

Highways				
Concession	Concessionaire	Kilometers	Shareholders	Participation (%)
Concessão Grande Lisboa	Ascendi Grande Lisboa - Auto Estradas Grande Lisboa, SA	67	Mota-Engil, Engenharia e Construção, S.A.	36,09%
			Odebrecht	14,23%
			OPWAY Engenharia, S.A.	12,38%
			SConcessões, SGPS, S.A	17,50%
			Monte Adriano, SGPS	6,60%
			Hagen Concessões, S.A.	3,30%
			Alberto Martins de Mesquita e Filhos, S.A.	3,30%
			Amândio Carvalho, S.A.	3,30%
			Rosas Construtores, S.A.	3,30%
Sub-Concessão Douro Litoral	AEDL -Auto Estradas Douro Litoral, SA	128,9	Brisa, S.A.	55,00%
			Teixeira Duarte, Engenharia e Construções, S.A.	18,00%
			Alves Ribeiro, S.A.	9,00%
			Construtora do Tâmega, S.A.	9,00%
			Zagope, SGPS, Lda	9,00%
Sub-Concessão AE Transmontanas	Auto - Estradas XXI - subconcessionária Transmontana, SA	186	Soares da Costa, SGPS, S.A.	50,00%
			Caja Madrid	25,00%
			FCC	25,00%
Sub-Concessão Douro Interior	Ascendi Douro - Estradas do Douro, SA	250	Mota-Engil, Engenharia e Construção, S.A.	45,93%
			OPWAY Engenharia, S.A.	14,83%
			SConcessões, SGPS, S.A	19,99%
			Monte Adriano, SGPS	7,70%
			Hagen Concessões, S.A.	3,85%
			Amândio Carvalho, S.A.	3,85%
			Rosas Construtores, S.A.	3,85%
Sub-Concessão Túnel do Marão	Auto-Estradas do Marão, SA	30	Somague Itinere	53,00%
			MSF Concessões, SGPS, S.A.	45,00%
			Itinere Infraestructuras, S.A.	1,00%
			Somague Itinere	1,00%
Sub-Concessão do Baixo Alentejo	SPER - Soc. Port. Construção e Exploração Rodoviária, SA	344	Grupo Edifer	23,00%
			Tecnovia, Sociedade de Empreitadas, S.A.	19,00%
			Iridium Concesiones de infraestruturas, S.A.	15,00%
			Desarollo de Concessiones Viárias Uno, SL	15,00%
			Dragados, S.A.	15,00%
			Conduril, Construtora Duriense, SA	13,00%
Sub-Concessão do Baixo Tejo	VBT - Vias do Baixo Tejo, SA	77	Brisa, S.A.	30,00%
			Transport Infrastructure Investmente Company (SCA) Sicar	25,00%
			Teixeira Duarte, Engenharia e Construções, S.A.	9,00%
			Odebrecht	7,88%
			MSF Concessões, SGPS, S.A.	7,88%
			Zagope, SGPS, Lda	7,88%
			Lena Engenharia e Construções, S.A.	7,88%
			Alves Ribeiro, S.A.	4,50%
Sub-Concessão do Litoral Oeste	AELO - Auto Estradas do Litoral Oeste, SA	109	Lena Engenharia e Construções, S.A.	16,25%
			MSF Concessões, SGPS, S.A.	16,25%
			Novopca - Construtores Associados, S.A.	16,25%
			Somague Itinere	16,25%
			Brisa, S.A.	15,00%
			Transport Infrastructure Investmente Company (SCA) Sicar	20,00%
Sub-Concessão do Algarve Litoral	Rotas do Algarve Litoral, SA	273	Grupo Edifer	23,00%
			Tecnovia, Sociedade de Empreitadas, S.A.	19,00%
			Iridium Concesiones de infraestruturas, S.A.	15,00%
			Desarollo de Concessiones Viárias Uno, SL	15,00%
			Dragados, S.A.	15,00%
			Conduril, Construtora Duriense, SA	13,00%

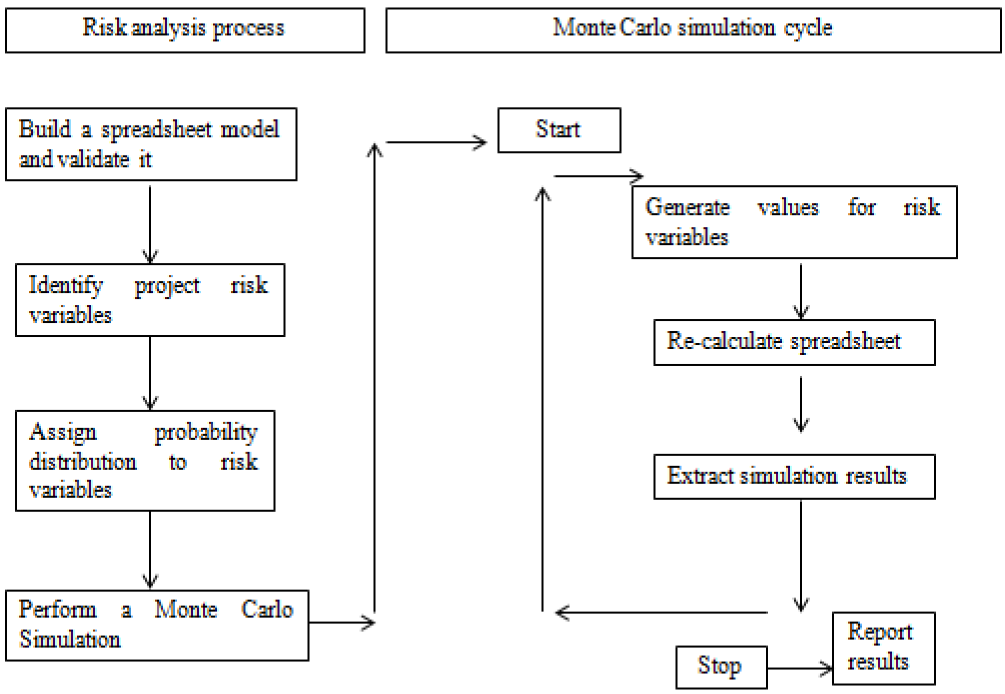
Source: Portuguese Public Road Institute (IEP).

Appendix XI: Participations in the SCUT projects, by Shareholders.

SCUT				
Concession	Concessionaire	Kilometers	Shareholders	Participation (%)
Algarve	EuroScut Algarve,S.A.	129	Cintra Concesiones de Infraestruturas de Transporte, S.A.	77,00%
			Aurélio Martins Sobreiro & Filhos, S.A.	3,50%
			Const. Gabriel AS. Couto, S.A.	3,50%
			Outros	16,00%
Beira Interior	ScutVias, S.A.	178	Soares da Costa, SGPS, S.A.	20,00%
			Teixeira Duarte, Engenharia e Construções, S.A.	20,00%
			Sopol - Sociedade Geral Construções e Obras Públicas, S.A.	13,40%
			Alves Ribeiro, S.A.	13,33%
			Ramalho Rosa Cobetar, S.A.	13,33%
			Outros	19,90%
Beira Literal e Alta, Costa da Prata e Grande Porto	LusoScut, S.A.	353	Mota-Engil, Engenharia e Construção, S.A.	36,09%
			SConcessões, SGPS, S.A	22,38%
			Odebrecht	14,22%
			Millenium Bcp Investimento	7,50%
			Monte Adriano, SGPS	6,60%
			Hagen Concessões, S.A.	3,30%
			Alberto Martins de Mesquita e Filhos, S.A.	3,30%
			Amândio Carvalho, S.A.	3,30%
			Rosas Construtores, S.A.	3,30%
			OPWAY Engenharia, S.A.	0,01%
Interior Norte	NorScut, S.A.	155	Eiffage	45,00%
			Contacto - Sociedade Construções, S.A.	25,00%
			C.D.C.IXIS	15,00%
			Egis Projects	10,00%
			SEOP - Sociedade de Empreendimentos de Obras Públicas, S.A.	4,00%
			Solucel	1,00%
Norte litoral	EuroScut Norte, S.A.	115	Cintra Concesiones de Infraestruturas de Transporte, S.A.	75,53%
			Aurélio Martins Sobreiro & Filhos, S.A.	13,50%
			Ferrovial Agroman, S.A.	8,51%
			Outros	2,50%

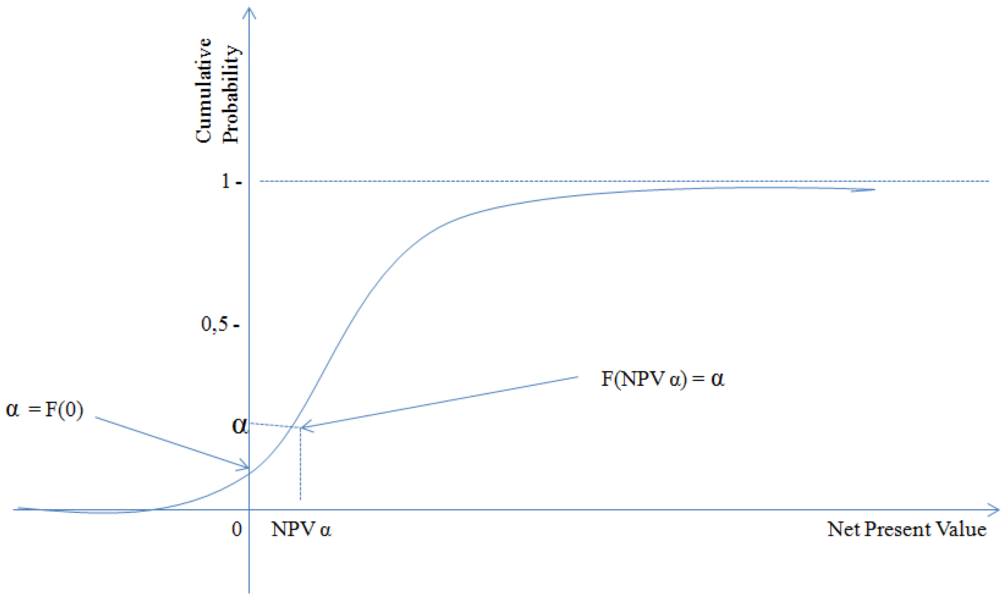
Source: Portuguese Public Road Institute (IEP).

Appendix XII: Risk management and Monte Carlo simulation.



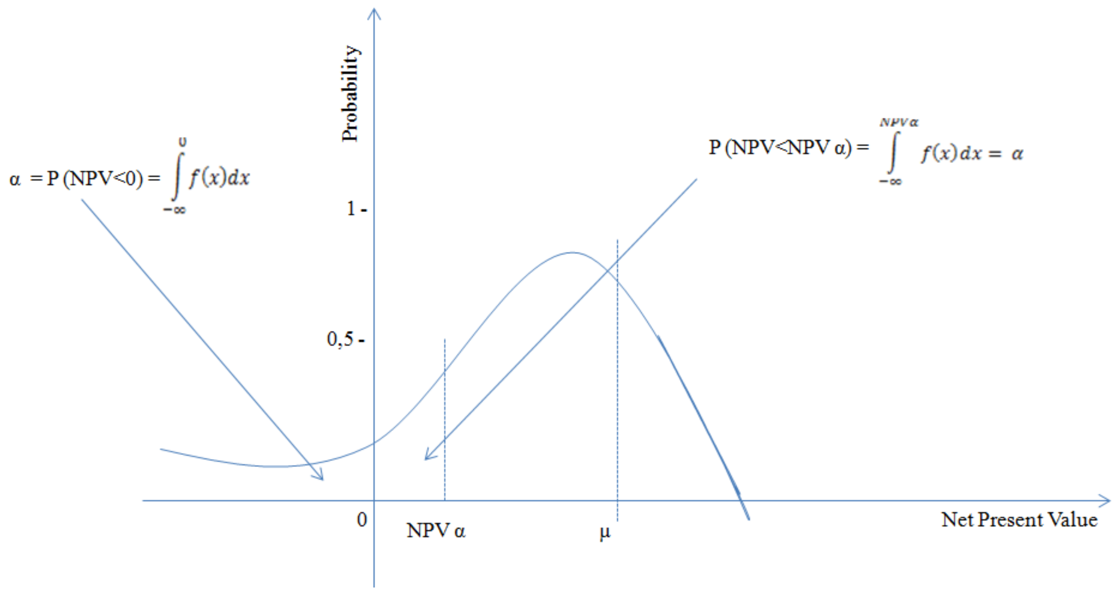
Source: Du e Li, Monte Carlo simulation and a value-at-risk of concessionar project: The case study of the Guangshen Freeway in China, 2008.

Appendix XIII: Calculation of NPV-at-Risk and confidence level based on cumulative distribution function.



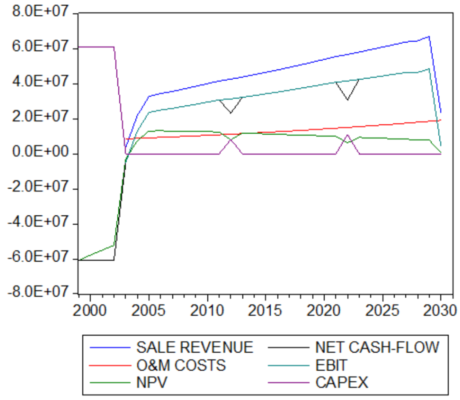
Source: Ye e Tiong, 2000.

Appendix XIV: Calculation of NPV-at-Risk and confidence level based on probability distribution function.

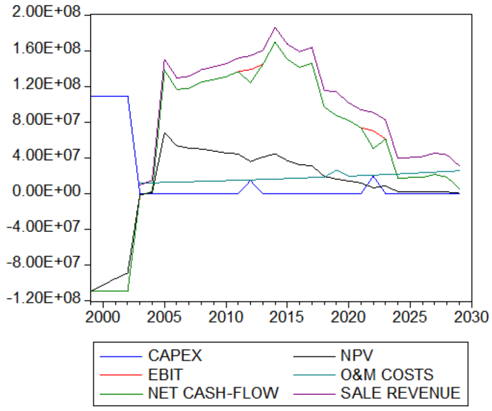


Source: Ye e Tiong, 2000.

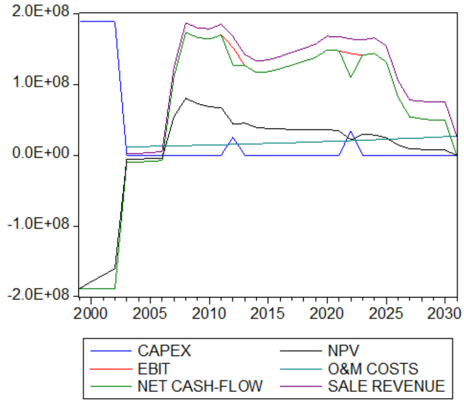
Appendix XV: Evolution of cash-flows in SCUT projects.



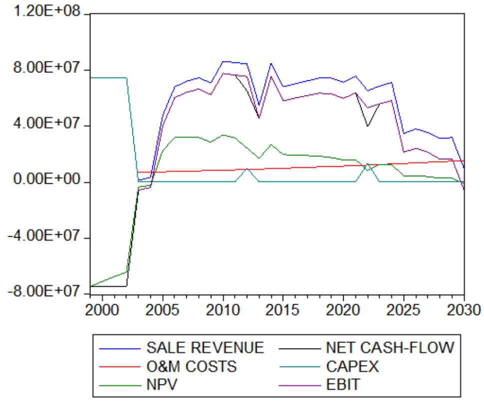
(a) *Algarve*



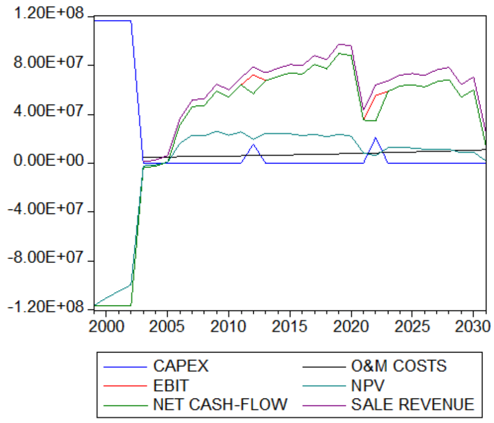
(b) *Beira Interior*



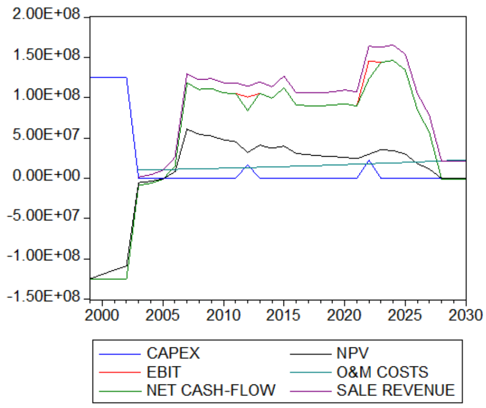
(c) *Beira Litoral Alta*



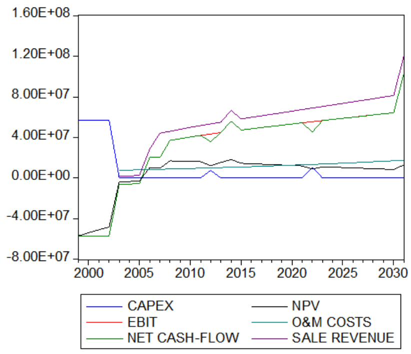
(d) *Costa da Prata*



(e) *Grande Porto*



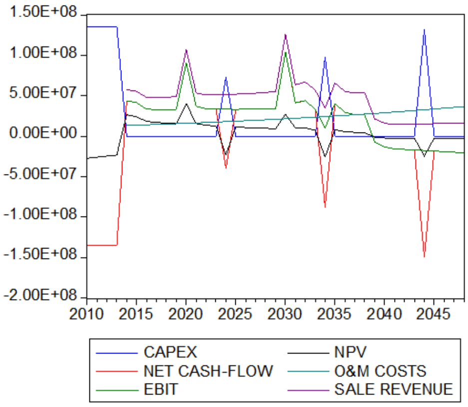
(f) *Interior Norte*



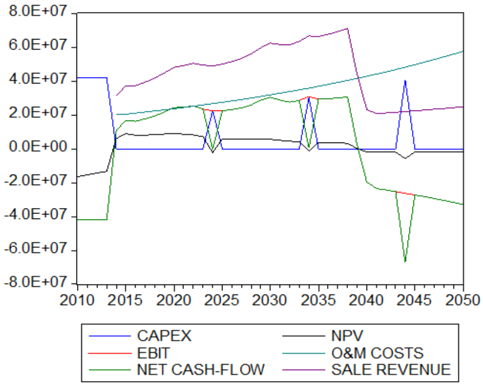
(g) *Norte Litoral*

Source: authors.

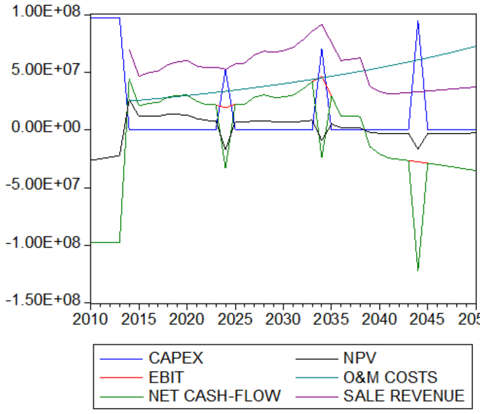
Appendix XVI: Evolution of cash-flows in new highways.



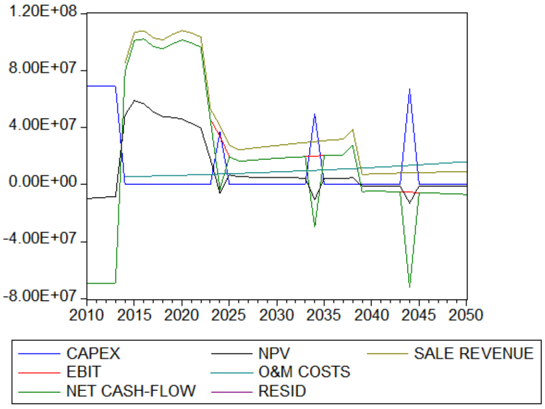
(a) *Auto-estradas transmontanas*



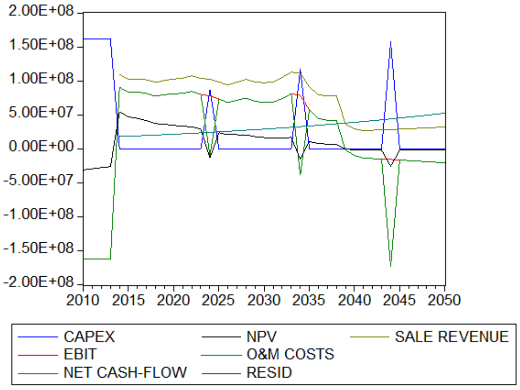
(b) *Algarve litoral*



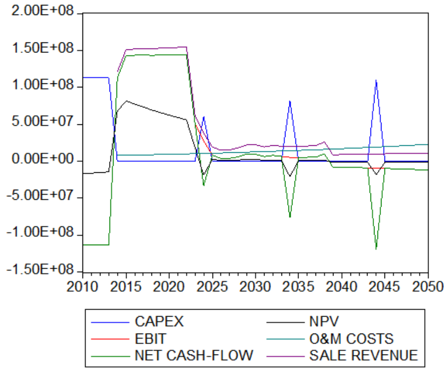
(c) *Baixo Alentejo*



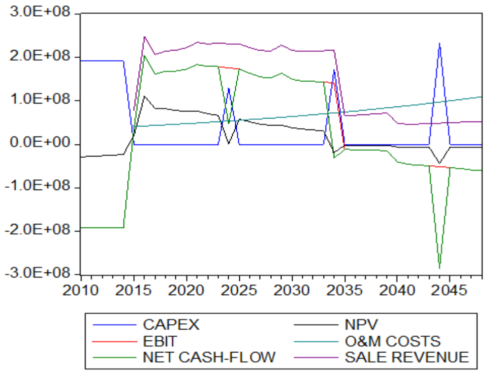
(d) *Baixo Tejo*



(e) *Douro Interior*



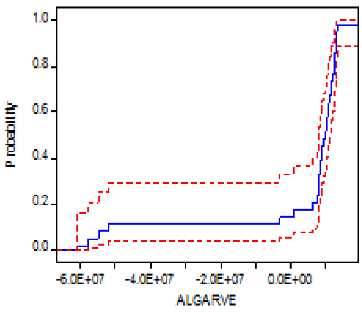
(f) *Litoral Oeste*



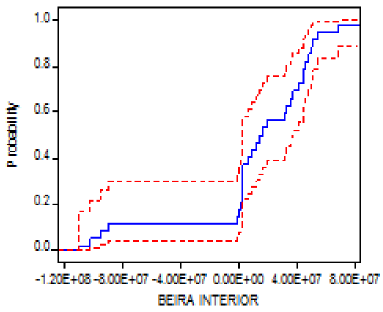
(g) *Pinhal Interior*

Source: authors.

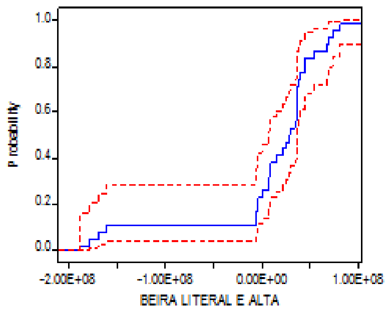
Appendix XVII: Cumulative density functions of SCUT projects.



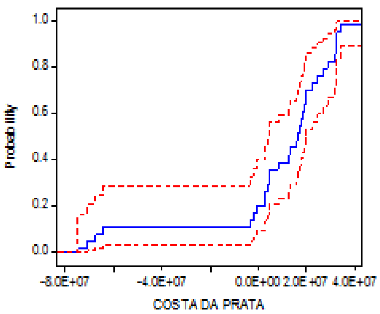
(a) *Algarve*



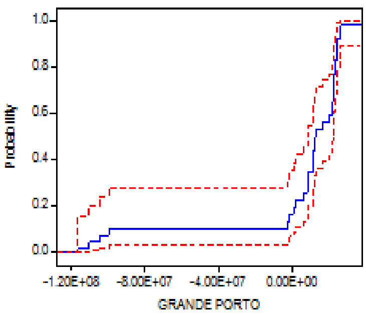
(b) *Beira Interior*



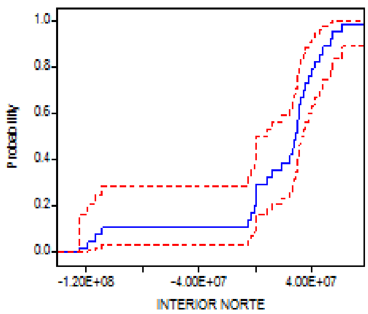
(c) *Beira Litoral e Alta*



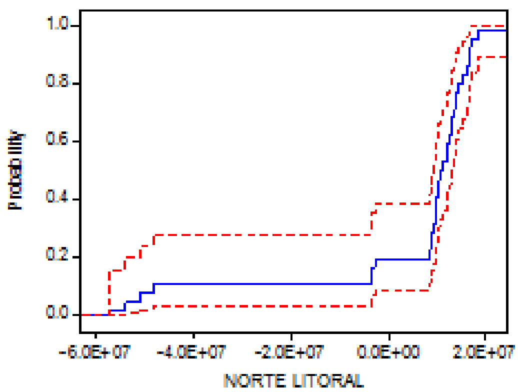
(d) *Costa da Prata*



(e) *Grande Porto*



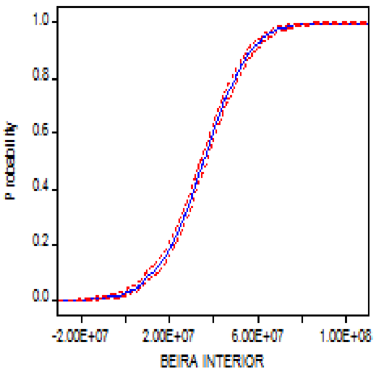
(f) *Interior Norte*



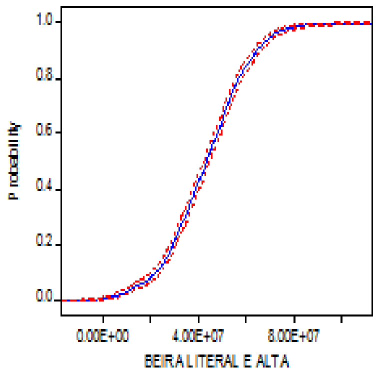
(g) *Norte Litoral*

Source: authors.

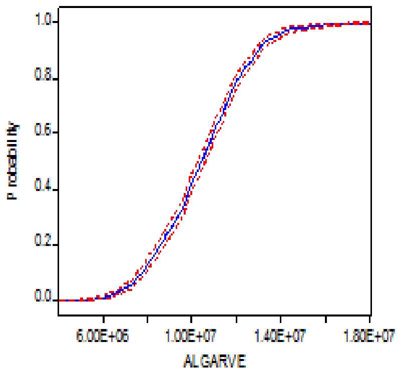
Appendix XVIII: Cumulative density functions of SCUT projects based in Monte Carlo simulation.



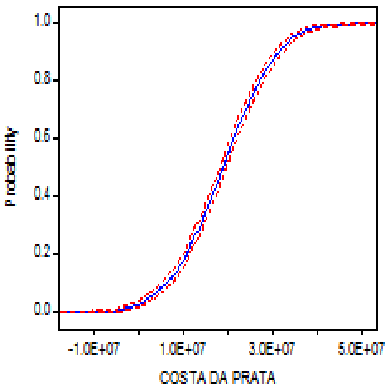
(a) *Beira Interior*



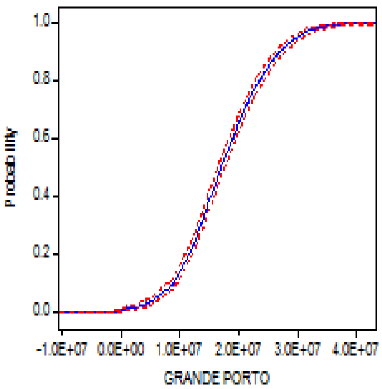
(b) *Beira Litoral e Alta*



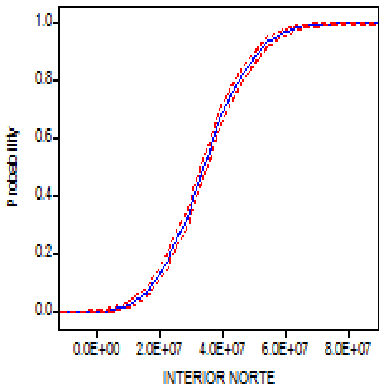
(c) *Algarve*



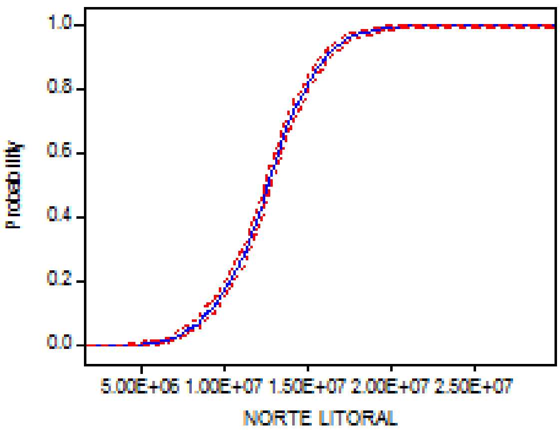
(d) *Costa da Prata*



(e) *Grande Porto*



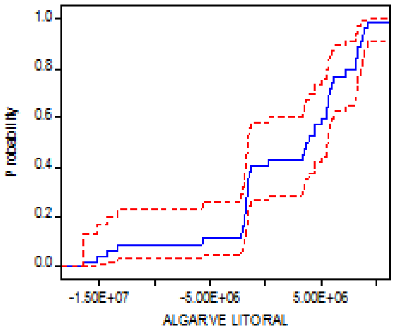
(f) *Interior Norte*



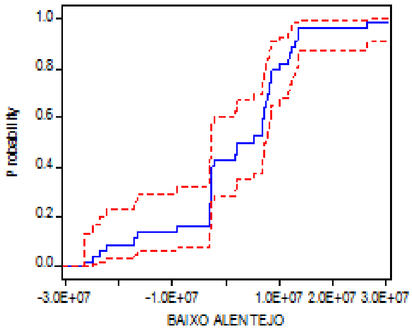
(g) *Norte Litoral*

Source: authors.

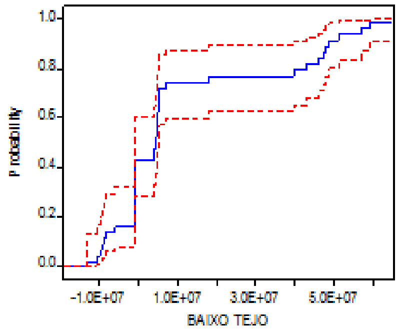
Appendix XIX: Cumulative density functions of new highways.



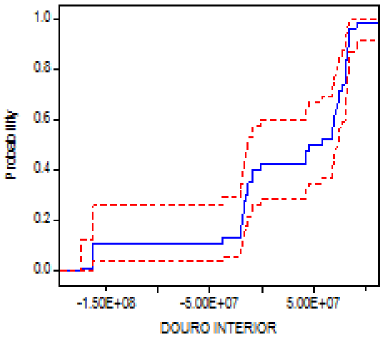
(a) *Algarve Litoral*



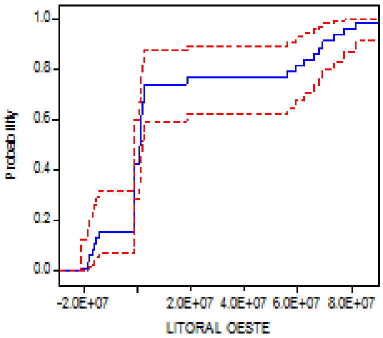
(b) *Baixo Alentejo*



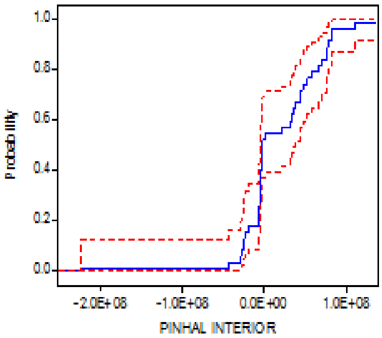
(c) *Baixo Tejo*



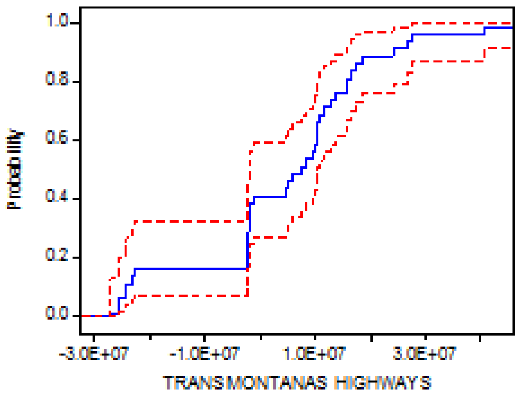
(d*) Douro Interior*



(e) *Litoral Oeste*



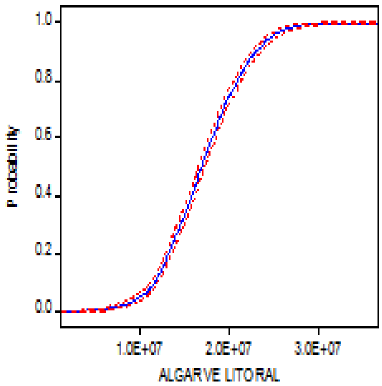
(f) *Pinhal Interior*



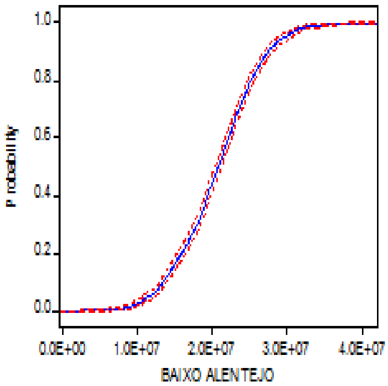
(g) *Auto-Estradas Transmontanas*

Source: authors.

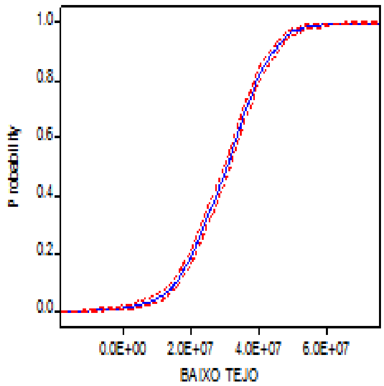
Appendix XX: Cumulative density functions of new highways based in Monte Carlo simulation.



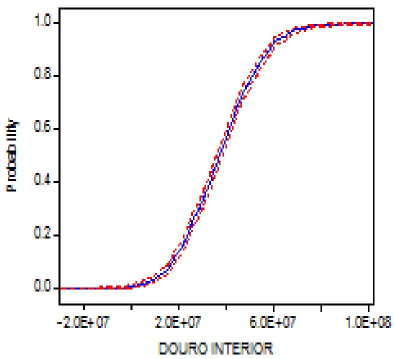
(a) *Algarve Litoral*



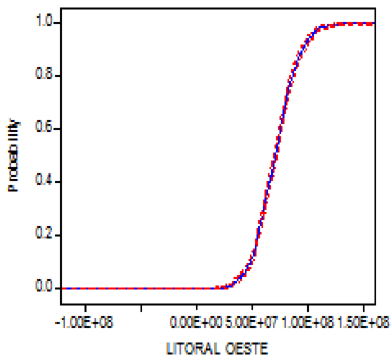
(b) *Baixo Alentejo*



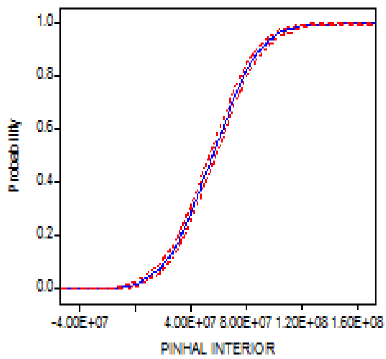
(c) *Baixo Tejo*



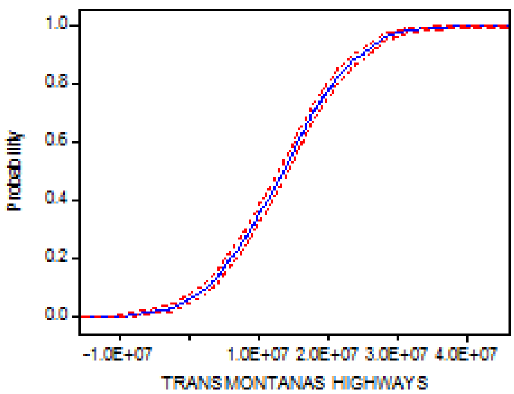
(d) *Douro Interior*



(e) *Litoral Oeste*



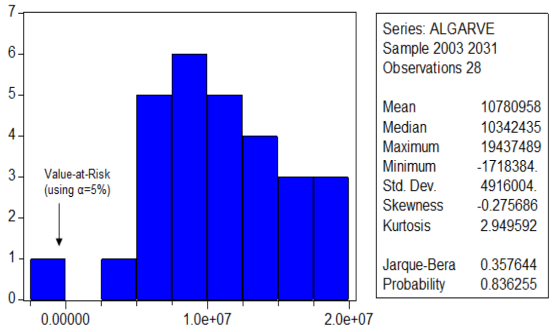
(f) *Pinhal Interior*



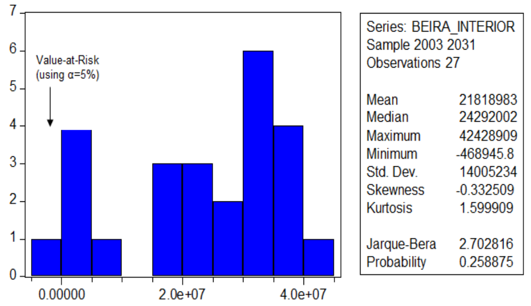
(g) *Auto-Estradas Transmontanas*

Source: authors.

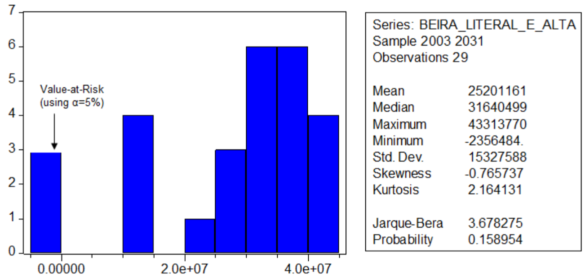
Appendix XXI: Histogram of hipothetical changes in SCUT projects.



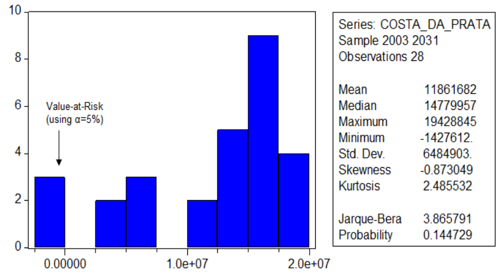
(a) *Algarve*



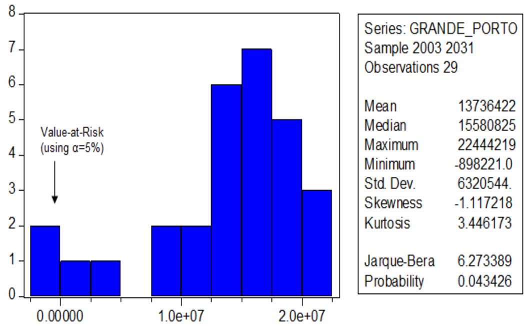
(b) *Beira Interior*



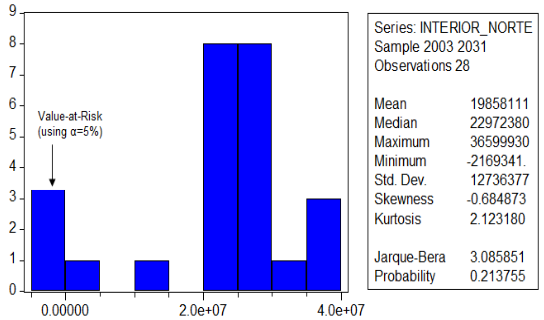
(c) *Beira Litoral e Alta*



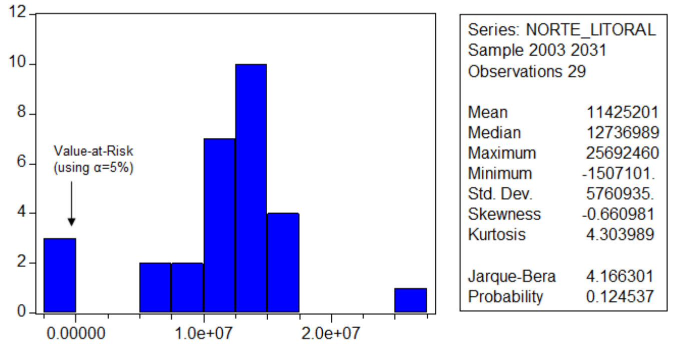
(d) *Costa da Prata*



(e) *Grande Porto*



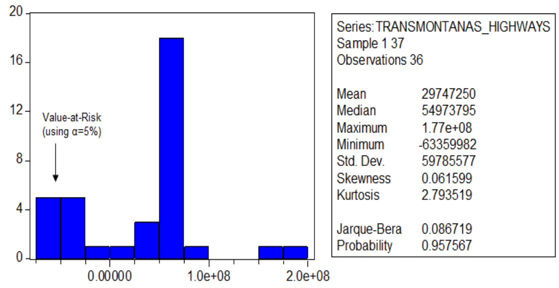
(f) *Interior Norte*



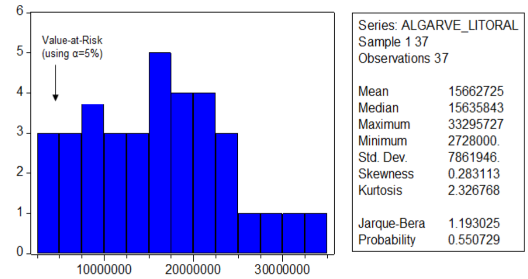
(g) *Norte Litoral*

Source: authors.

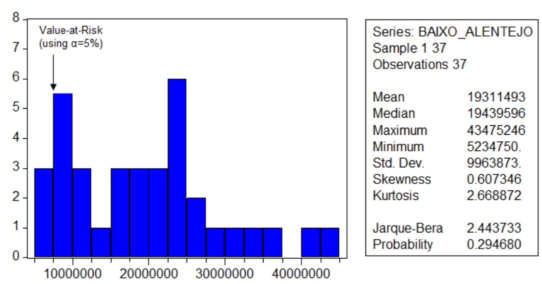
Appendix XXII: Histogram of hipothetical changes in new highways.



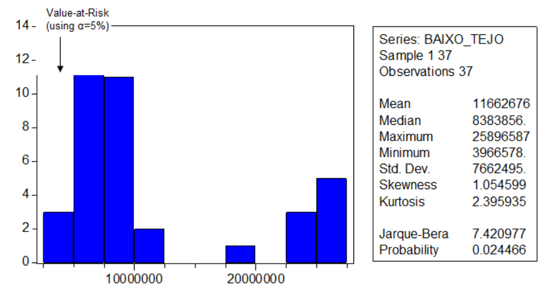
(a) *Auto-Estradas Transmontanas*



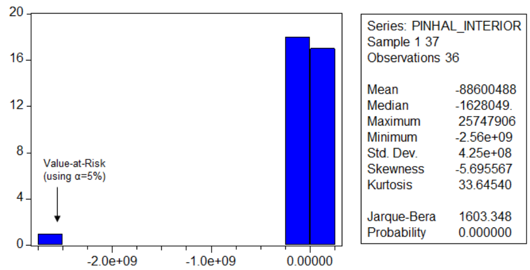
(b) *Algarve Litoral*



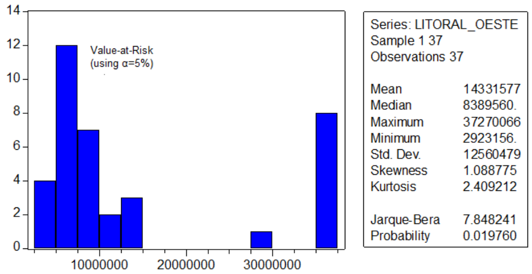
(c) *Baixo Alentejo*



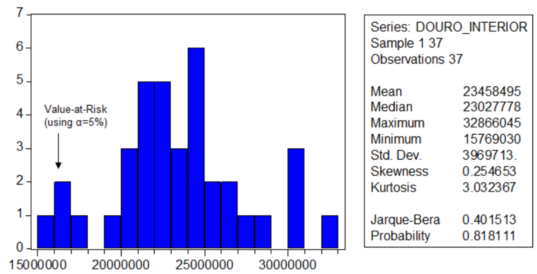
(d) *Baixo Tejo*



(e) *Pinhal Interior*



(f) *Litoral Oeste*



(g) *Douro Interior*

Source: authors.