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Evaluating Risks in Public-Private Partnerships: The Case of Portuguese Road Sector

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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.

Keywords: 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

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 [1] 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

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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.

Literature Survey

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”* [2]. 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 [3]. Thus PPPs involve several participants in order to obtain a stable relationship between the public and private entity [4,5].

A form of financing, such as the Project Finance, appears to be one of the possibilities to circumvent the problem of the infrastructure gap [6]. 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 [7,8]. 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, whose objective is the generation of cash flows for the project and to the shareholders of the same [9,10]. These future cash flows are the only possible guarantee of funding allocated to lender agents, justifying the concept of non-recourse debt financing [9,11,12]. The Project Finance also presents several advantages, such as tax benefits, the high indebtedness of the Special Purpose Vehicle division and the accounts of the various companies that are shareholders [13]. Esty [14] 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* [15]. 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 [9,16,17]. 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 [18,19]. 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 [20-23].

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 [4,5,24,25]. 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 [26]. 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 [27]. 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 [28,29].

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 erogeneity. 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 [30]. 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 [31]. 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 [21,32,33]. 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* [34]. Despite the subjectivity of some topics in the allocation of risk, in contrast to the importance of the issue to the success of partnerships [35-37], 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 [2,20,38]. 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 [4]. It should therefore optimize the transfer of risk, to the detriment of the possibility of maximizing the risks being transferred. 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 [39]. 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 [40]. Another study suggests that, based on the scenario given above, the performance of the private agent will decline [41].

An analysis of careful risk assessment should witness several steps [42]. 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 [9,42,43]. 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 [44] 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, [45], longed to some alternative methods of return-risk that relate the evaluation of that transfer to the private [46], described in the following sub-chapter.

Financial modelling and current methods of financial evaluation

The process of financing a PPP involves four interdependent aspects: (i) the capital structure; (ii) the organizational structure; (iii) the architecture of the contract structured and (iv) enhancement of credit granted to the project [10]. 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 [47]. 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 [48-51]. 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. 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% [10]. 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 [52] 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, 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 [53,54]. 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 [10]. On the basis of the requirement of current methods to this scenario, Ho and Liu [55] presented a model for evaluating real options. Equally important seems to have been the contribution of Ranasinghe [56], 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 [57], by introducing the concept of NPV-at-Risk, which is a method that in addition 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 [10]. 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 [58] 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 [59] because they are related to the quality of investment and not to the attractiveness of the same [60]. 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 [57].

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 [5] 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 [61]. 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 forces 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 [62,63].

To the sponsors of the partnership, underline the concept of microeconomics that points to the primary objective of private agents: the maximization of profits [64-67]. 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 [5].

Some authors focus that the origin of VaR systems are associated with market risks [68], 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 [5].

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 [5], 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 [57,69]. 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 [5,24,63].

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 has 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 [23]. 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 [70]. 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 [21] 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 [21].

Method and Data

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 [5]. 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 [71,72] 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.

The target variables of the Monte Carlo process are the construction costs and the O&M costs, based on a lognormal (μ, σ2) distribution assumption.

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 [73-75]. 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 [76]. Take c as the confidence level predetermined, so that the Value-at-Risk will correspond to the lower tail of the distribution, 1-c [77]. 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 $\mathrm{F}[\Delta\mathrm{P}(.)]$ is the cumulative density function of revenues, $\mathrm{f}(\mathrm{P}(x))$ 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.

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 [78]. 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. 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.

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 NPVα 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 [57]. 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 cannot 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, 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. 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 1). 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 [57]. 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

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

Equation IV: Determinação das Receitas iniciais da concessionária

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

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

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 [79,80].

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

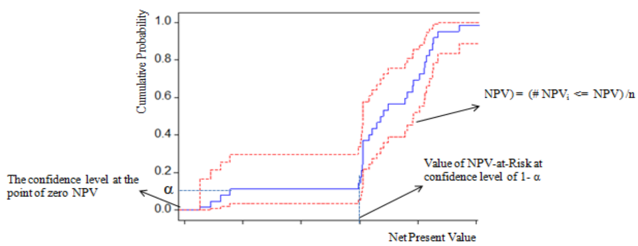

Figure 1: Calculation of NPV-at-Risk and confidence level based on simulation generated distribution.

associated with each road infrastructure, which will culminate in the determination of the IRR-at-Risk with a certain degree of confidence.

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 sub concessions" 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.

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. The graphical representations of the mapping of cash flows, shows 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 2 and 3 are available the main financial information for each SCUT concession and highway.

Analysis and Discussion of results

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 (Table 4). 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 (Table 5). 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.

Risk-Return methods

However, given the limitations of traditional methods mentioned above, it was preceded to the use of more vigorous 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 (Table 6 and 7) 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 8 and 9). 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

Table 1: 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

Table 2: Main information's 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 3: Main information's 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).

Table 4: Results of traditional methods applied to SCUT (values in thousands of euros).

SCUT							
	Algarve	**Beira Interior**	**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	919.99 €	2.356.450 €	2.923.335 €	1.328.508 €	1.593.425 €	2.224.108 €	1.325.323 €
Net Cash-Flow	657.86 €	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)	229.06 €	634.01 €	794.19 €	429.51 €	419.53 €	727.84 €	264.18 €
NPV (legal discount rate)	196.34 €	731.94 €	720.54 €	372.73 €	370.27 €	591.82 €	246.24 €
NPV (subjective discount rate)	238.98 €	841.46 €	859.85 €	435.04 €	445.31 €	698.75 €	309.02 €

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.

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 8 and 9. 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 2 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 sub concession, 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).

Alternatively, in terms of Value-at-Risk, we could proceed to the methodology developed by Linsmeier and Pearson [75], 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 [75]. Figure 3, placed below, refers to the distribution of hypothetical annual loss of *Douro Interior* concession.

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.

Conclusions, Main Limitations and Suggestions for Future Research

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 concluding 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 [51] and Ke, Liu and Wang [5].

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

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%
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 €

Table 5: Results of traditional methods applied to new highways (values in thousands of euros).

SCUT							
	Algarve	**Beira Interior**	**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 6: Results of risk-return methods applied to SCUT (values in thousands of euros).

New Highways							
	Pinhal 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 €

Table 7: Results of risk-return methods applied to new highways (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	292.18 €	294.30 €	48,63%	48,99%
Beira Interior	564.04 €	569.52 €	43,13%	43,55%
Beira Literal e Alta	703.54 €	709.51 €	43,71%	44,08%
Costa da Prata	320.02 €	322.67 €	37,18%	37,49%
Grande Porto	386.08 €	388.77 €	46,91%	47,24%
Interior Norte	533.40 €	538.35 €	38,72%	39,08%
Norte litoral	320.50 €	322.87 €	48,05%	48,41%

Table 8: Results of VaR in SCUT projects (values in thousands of euros).

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 GDP. 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.

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 [5], 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 of 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)

	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	184.57 €	192.48 €	6,75%	7,04%
AE Transmontanas	1.468.475 €	1.483.988 €	177,75%	179,62%
Douro Interior	614.78 €	617.84 €	44,27%	44,49%
Baixo Alentejo	388.50 €	391.33 €	45,45%	45,78%
Baixo Tejo	344.24 €	347.48 €	35,69%	36,02%
Litoral Oeste	408.70 €	413.89 €	33,86%	34,29%
Algarve Litoral	330.19 €	332.80 €	56,09%	56,53%

Table 9: Results of VaR in new highways projects (values in thousands of euros).

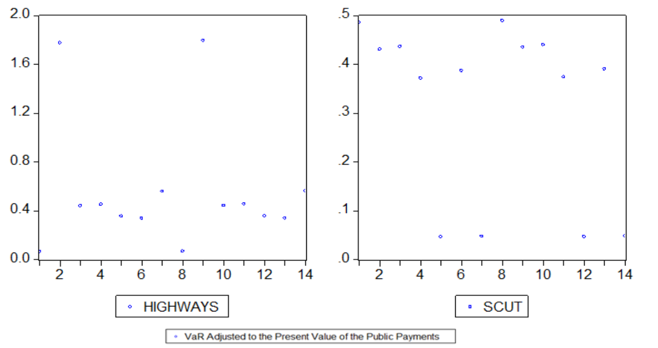

Figure 2: Scatter graph of VaR adjusted to the present value of public payments.

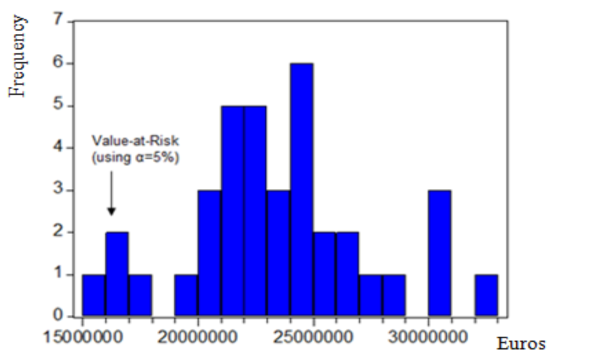

Figure 3: Histogram of hipothetical changes and losses in a PPP project.

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.

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