

Demand risk and contractual abandonment: a real options analysis of the BR-381/262/MG/ES highways concession

Risco de demanda e abandono contratual: uma análise por opções reais da concessão da rodovia BR-381/262/MG/ES

Felipe do Amaral Costa¹, Carlos Henrique Rocha²

¹University of Brasília, Brasília – Brazil, felipeamaralcosta@gmail.com

²University of Brasília, Brasília – Brazil, chrocha@unb.br

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ABSTRACT

This article assesses the relationship between demand risk and contractual abandonment of highway concessions according to recent changes in Brazilian regulation. Contractual abandonment is an existent tacit managerial flexibility in contracts of this type and can add value to the project since the concessionaire, according to the law, must be compensated for the investments made, regardless of the termination origin. The real options theory was applied to model the abandonment option of the BR-381-262/MG/ES highway concession. Based on the expected cash flow for the project, currently in the bidding process, and historical data on demand risk for similar projects, the binomial model was applied to price the option. Under those conditions, it was found that the option adds substantial value to the project, about R\$ 2.6 billion. This work contributes to a better understanding of the relationships among uncertainties, the abandonment of the project and the added value. It is important to have prior knowledge on the issue of contractual abandonment in order to define optimal levels of incentives and indemnities for provision purposes.

RESUMO

Este artigo avalia a relação entre risco de demanda e abandono contratual de concessões rodoviárias à luz de recentes alterações na regulamentação brasileira. O abandono contratual é uma flexibilidade gerencial existente em contratos desse tipo e pode agregar valor ao projeto, uma vez que o concessionário deve ser indenizado pelos investimentos realizados, independente da origem da rescisão. A teoria das opções reais foi utilizada para modelagem da opção de abandono da concessão da BR-381-262/MG/ES. A partir do fluxo de caixa esperado para o projeto, ainda em fase de licitação, e dados históricos de outras concessões sobre o risco de demanda, o modelo binomial foi aplicado para precificação da opção. Nessas condições, verificou-se que a opção agrega valor substancial ao projeto, em torno de R\$ 2,6 bilhões. Este trabalho contribui para um melhor entendimento sobre a relação entre as incertezas envolvidas, o abandono do projeto e o valor agregado criado. É importante ter conhecimento prévio sobre a questão do abandono contratual para definições de valores de indenizações para estruturação de provisões.



1. INTRODUCTION

Ever since the mid-1980s there has been a growing worldwide tendency towards less government intervention in the economy and greater dependence on the private sector for the provision of a variety of public services. It has been the way governments have found to reduce

dependency on tax revenues, intensifying its application to services essential for society at large, and also because it is believed to be easier to solve problems of agency in the ambit of private organizations than of public ones (Abdeldayem and Aldulaimi, 2019). It is worth noting, however, that making use of private organizations to provide public services does not eliminate the problem of agency (Abdeldayem and Aldulaimi, 2019) insofar as it inserts another, this time between the government and the service provider.

The central problem is how to create regulations for the performance of private partners that will lead them to act in a manner close to that which the State desires. On the one hand, the government acts to avoid the private partner's exploiting his market powers and on the other, the private partner, well aware of his costs and his demand, tends to take advantage of that power.

Brazil initiated its wave of denationalization/privatization of transportation services in 1992 with the railways (Ribeiro *et al.*, 2018). The country adopted a model based on concessions and since then it has used the same model for railways, highways, ports and airports.

In 2001, to regulate the transportation services concessions, the Federal Government created the National Land Transportation Agency (*Agência Nacional de Transportes Terrestres -ANTT*) and the National Waterways Transportation Agency (*Agência Nacional de Transportes Aquaviários - ANTAQ*) and in 2005 it created the National Civil Aviation Agency (*Agência Nacional de Aviação Civil - ANAC*). Thus the Brazilian State's role changed from proprietor to regulator. The regulatory role is particularly important given the tendency of transportation services providers to become natural monopolies.

Over the years, according to Pereira and Rocha (2019), the regulatory activities of those agencies have evolved, refining the relations between transportation service users and the service providers.

In keeping with their purpose, the transportation services regulatory agencies endeavor to ensure the financial-economic equilibrium of the concessions. In 2017, the Federal Government enacted Law nº 13.448/2017 (Brasil, 2017b), introducing greater flexibility into the hypotheses of consensual devolution of concession contracts supposedly in a situation of insolvency, by means of a retendering process. It is always possible that future market conditions (vehicle traffic intensities) may deteriorate and cause unforeseen reductions in cash flows leading to the venture's perennial financial unbalance.

In cases of early termination of the contract, the central question is for the two parties to arrive at an agreement regarding the just amount that should be paid as financial compensation for the investments already made and determine the onus resulting from the non-payment of the contractual obligations (Xiong *et al.*, 2016; Colín *et al.*, 2016). ANTT Resolution nº 5.860/2019 (ANTT, 2019a) defines the methodology for calculating the value of the indemnity to be paid in cases of the early termination of highway concession contracts.

Contractual abandonment is a tacit option inherent to this type of a rramgement (Igrejas *et al.*, 2017). Option implies a right but not an obligation (Damodaran, 2008; Myers, 1984; Trigeorgis, 1991). It could be said that the 'options revolution' emerged partly in response to the dissatisfaction of strategists, academics and other professionals with the traditional capital budgeting techniques (Myers, 1984; Zeng e Zhang, 2011). The theory of real options is an extension of the theory of financial options applied to real-life assets and projects (Rakic and Radjenovi, 2014).

The possibility of abandoning a highway concession contract introduces flexibility in the investment project. Investment projects that present managerial flexibility can be analyzed in the light of real options theory. Unlike the traditional Net Present Value (*NPV*), the *NPV* of a flexible investment project is expressed by the relationship $NPV_{RO} = NPV_T + V_{RO}$, where NPV_{RO} is the net present value of the flexible investment project, NPV_T is the traditional *NPV* and V_{RO} is the value of the real option. The last term enters in the equation because the private partner was given the right to abandon the concession.

According to Martins *et al.* (2015), the models of Black, Scholes (1973) and Merton (1973) (BSM) and the binomial model proposed by Cox, Ross and Rubinstein (1979) are those most used to calculate financial and real options values, although Copeland and Antikarov (2001) and Rakic and Radjenovic (2014) allege that the binomial model is more usually indicated for the real options calculations. The BSM model is suitable for the purchasing option (call) but restricted to the expiry of the option and its application is not recommended when abandonment at any time during the concession's validity period is an option, as is the case in contractual abandonment of concessions.

This article uses the binomial method to model the abandonment option of the BR-381/262/MG/ES highway concession which is still at the bidding stage. The abandonment option is analogous to a sale option at the present value of the project in which the price of abandonment is equal to the value of the indemnity as foreseen in the respective legislation. The Monte Carlo method was used to project the concession's future cash flows. To that end this research used the technical, economic and environmental feasibility study that the ANTT supplied for the tendering process. The volatility of the business, a key consideration in constructing the binomial tree, was derived from the percentage variations in project value from one period to the following one. The main novelties introduced in this article are: an analysis of the new regulatory framework introduced by Resolution nº 5.860/2019 (ANTT, 2019a) and the calculation of the value that managerial flexibility added to the business based on the methodology for quantifying the indemnity defined in the terms of the regulatory instrument.

The rest of the article is organized as follows: section 2 provides a contextualization, a more in-depth discussion of the question of concession contract abandonment and indemnity and an analysis of the respective legal instruments. It also presents an analysis of the literature on the application of real options theory and abandonment of projects. Section 3 presents the main characteristics of the BR-381/262/MG/ES highway concession contract. Section 4 addresses the analysis of the project based on the traditional static cash flow. Section 5 sets out the basic principles underlying the binomial real options analysis model and the methodological procedures adopted. Section 6 discusses the empirical results obtained and Section 7 concludes the article.

2. THE ABANDONMENT OF CONCESSION PROJECTS

According to World Bank data on developing countries, in the period 1984 to 2010, 334 of the 4,874 (6.85%) infrastructure projects in the public-private partnership modality were cancelled before the end-date specified in their contracts. In the case of highway concessions the figure was even higher, 6.76% of the 695 projects financed in that period (Xiong *et al.*, 2016).

The same phenomenon has also affected some of the Brazilian highway concessions. As an example, the BR-153/GO/TO highway concession, granted in 2014 was declared extinct

in 2017 (Brasil, 2017a). More recently the concessionaire responsible for a stretch of the BR-040, highway from Brasília/Federal District to Juiz de Fora/Minas Gerais, also conceded in 2014, declared its interest in terminating the concession on a consensual basis, alleging financial difficulties, a situation foreseen in the terms of Law 13.448/2017 (Via040, 2019).

Early termination of a concession is almost always associated to the materialization of one or more of the risks that in one way or another frustrate the initial expectations of one or both the parties to the contract and lead them to abandon the project. Of all the risks associated to a highway concession project, the demand risk is considered to have the most financially corrosive effect (Flyvbjerg *et al.*, 2005; Lara Galera and Soliño, 2010; Song *et al.*, 2018).

In view of the unforeseeable risks, the public and private sectors often resort to renegotiation of contract terms and endeavor to take steps to solve the problem rather than immediately finalizing the contract. Generally, the premature termination occurs when renegotiation efforts fail and governments find themselves obliged to rescind the contracts by means of a retendering or repurchasing of the project (Song *et al.*, 2017).

In the case of early termination of concessions, determining the suitable indemnity amount is a sensitive issue for both parties (Xiong *et al.*, 2016; Liu *et al.*, 2017; Song *et al.*, 2018). Even when the termination is because the private party is in default, the non-existence of financial compensation for the private entity may unfairly benefit government administration. Thus, the question goes back to determining the fair amount of the indemnity (Colín *et al.*, 2016).

Act nº 8.987/1995 (Brasil, 1995), which sets out provisions regarding the concessions regime, states that the process to be applied in the case of a contract termination due to the concessionaire being in default is by means of the lapse of contract. The law states that generically, the compensation will be the amount of the installments associated to reversible assets in cases of lapse of contract. According to the literature, similar compensation practices are adopted in the legal frameworks of countries with experience in granting public service concessions such as Spain (Vassallo, 2012), Australia and South Korea (Liu *et al.*, 2017). In other countries the procedure is specified directly in the contract terms (Colín *et al.*, 2016).

The respective Brazilian legislation, however, requires the establishment of an administrative process which, more often than not, ends up in long drawn out legal actions with significant losses for both parties.

To address the reality of some Brazilian concessions, especially Third Stage highway concessions including the aforementioned BR-153 and BR-040 highways, Brazil enacted Law nº 13.448/2017 (Brasil, 2017b). Those contracts, auctioned in the period 2013 to 2014, were severely affected by the unfavorable economic conditions stemming from the crisis that began immediately afterwards. The Act in question creates the retendering mechanism and expands the hypotheses for premature termination of the contracts. That was the government's proposal for introducing flexibility and speeding up the process of extinguishing problematic contracts.

In his comparison of the retendering instrument with the declaration of contract lapse, Oliveira (2018), considered the latter alternative to be a more efficient option for the public authorities. It is in fact an efficient instrument when employed to remedy problematic situations in which the default has arisen from facts beyond the control of the concessionaire that have led it to become incapable of fulfilling its obligations.

From the public authorities' point of view, in turn, it has shown itself to be an efficient instrument when the abnormality that has led to the unviability of the contract created a need

to alter the applicable regulatory premises and guidelines and the modelling of the adjustments needed to result in a new contract.

In the wake of the occurrences, the ANTT, basing itself on Decree nº 9.957/2019 which regulates the retendering process for partnership contracts, published Resolution nº 5.860/2019 (ANTT, 2019a). The resolution established the methodology for calculating the amounts of indemnities for investments associated to undepreciated or unamortized reversible assets in cases of premature termination of federal highway concessions.

The two existing forms for concession extinction foreseen in the Brazilian legislation can be understood as being a real option for abandonment whereby the concessionaire has the right to sell it to the concession granter and be remunerated for part of the investments already made. In the hypothesis of a friendly devolution, there is an established methodology for calculating the amounts of the indemnity for investments associated to reversible assets and it has been used in this paper to quantify the abandonment option.

2.1. The real options approach to contractual abandonment

Tourinho (1979) is considered to be the first to have applied the financial options theory to real assets. According to that author, there are managerial flexibilities in capitals projects such as investing, expanding, exchanging and abandoning, that can be evaluated in a similar way to that used for financial options. However, traditional project analysis methods fail to capture the values of those flexibilities.

Kensinger (1980) was the first to apply the real options approach to the problem of project abandonment. In that author's view, abandonment constitutes a sale option of the American type. Unlike the European options that can only be exercised on their expiry date, the American options can be exercised prior to their expiry. It is a put option because the highway is actually being sold back to the government.

In the case of concessions, the real options naturally derive from the interpretation of the contract clauses which regulate both sides' rights and obligations. The right to abandonment confers flexibility on the concessionaire in order to minimize sunk costs in adverse market conditions (Dixit and Pindyck, 1994).

On the other hand, that right can represent an onus for the government insofar as it requires provision for a budget contingency and may encourage the private partner to arbitrarily fall into arrears with its obligations and jeopardize or suspend the provision of a public service. Quite often, that option is not duly quantified in the financial and economic viability studies using conventional valuation techniques (Igrejas *et al.*, 2017).

In the light of that limitation, Brandão (2002) analyzed the options of abandonment and expansion in a highway concession contract. According to the pre-established premises abandonment could be performed in project years 4, 7 and 10 which would entail an indemnity of 70% of the accounted value of the CAPEX, projected to be R\$ 300 million. In those conditions, the abandonment option enhanced the investment's present value by around 30%. Blank *et al.* (2016) also quantified the value added by the option to abandon the contract. In well-defined conditions and the possibility of opting for abandonment at any time during the project life without indemnity for the sale of the contract, the abandonment option added almost 50% to the value of the project.

Colín *et al* (2016) assessed the possibility of the insolvency of a Spanish highway concession on which the public authorities had conferred the guarantee of abandonment. Those authors considered the indemnity to be the value of the CAPEX, minus the asset depreciation, minus 5% of the original value representing a contractual fine for the devolution of the concession. The execution of that option was defined after project year 3 attributing a value of €58.4 million, equivalent to 17.8% of the initial investment in the project.

3. THE BR-381/262/MG/ES HIGHWAYS CONCESSION

The project selected for an analysis of the abandonment option was the BR-381/262/MG/ES. Highways concession. The project will be one of the first to be put up for public bidding by the government since the new regulations on retendering came into force. The BR-381 highway links the city and municipality of São Mateus in the state of Espírito Santo (ES) to the city of São Paulo in the state of São Paulo (SP). It is an important route for the transportation of industrial production, especially of the automobile sector. The BR-262 highway runs from East to West connecting the states of Espírito Santo and Mato Grosso do Sul and passing through important cities such as Belo Horizonte in Minas Gerais (MG) and São Paulo.

The concession's scope embraces the exploitation of the infrastructure and the provision of service in the form of the recuperation, operation, maintenance, monitoring, conservation, implantation of improvements, capacity expansion and maintenance of the level of service of 692.5 km of the highway system. Figure 1 illustrates the stretches of highways that are the object of the concession.

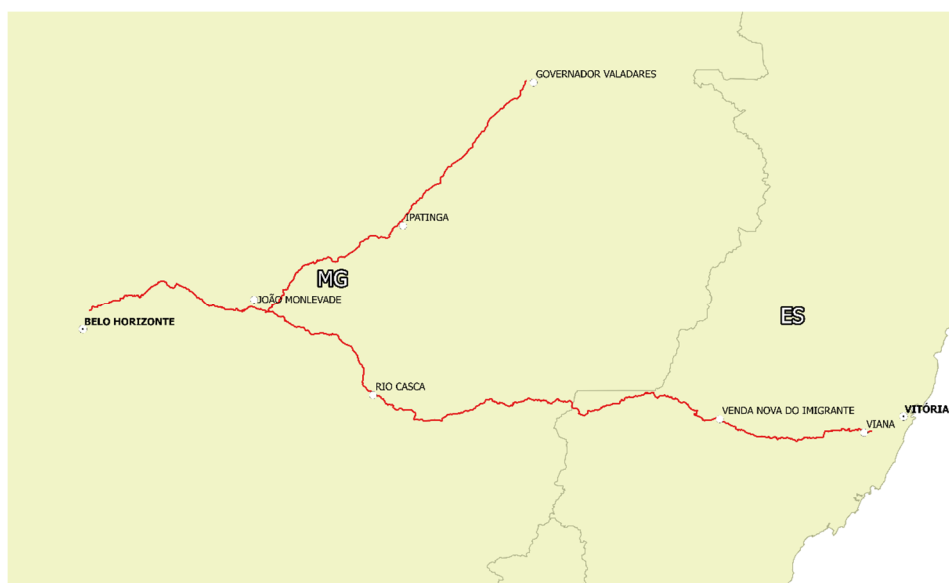


Figure 1. Map of the situation – BR-381/262/MG/ES highways. Source: ANTT (2019b)

The government intends to auction the concession in June 2021. The criteria for determining the winning bid set out in the Invitation to Tender document is the highest offer for the concession combined with the lowest tariff value for highway users. The duration of the concession is set at 30 years from 2021 to 2050 with investments to the order of R\$ 9.1 billion and operational costs of R\$ 5.6 billion.

In the first two years of the concession there will be emergency interventions to eliminate critical points on the highways. In the third to the eighth years the roadway will be recuperated

to regain the project's operational characteristics. During the same period, the first cycle of the roadway duplications will be carried out with the duplication of 202 km of the highway and the construction of the Manhuaçu/MG bypass. Total investments of R\$ 3.03 billion are foreseen for this stage. The second cycle of duplications is scheduled for the period from the 15th to the 20th year of the concession when 394 km of highway will be duplicated involving investments totaling R\$ 2.83 billion.

4. STATIC CASH FLOW ANALYSIS

The references used to construct the project's static cash flow were the premises and values of the financial and economic modelling done by the *Empresa de Planejamento e Logística* (Planning and Logistics Company) which was included in the project's official invitation to tender document (ANTT, 2019b). In keeping with the original document this analysis contemplated a concession timeframe of 30 years. Some premises to simplify the original cash flow were adopted by this study, making it feasible to analyze the project's dynamic cash flows, as will be shown later.

The financial and economic analysis of the venture foresees an increase in the annual equivalent of vehicle numbers from 79,338 thousand in 2019 to 156,701 thousand in 2049. The first simplification carried out was to apply those values in Equation 1 to obtain the annual rate of traffic increase (μ) of 2.29%.

$$V_f = V_i(1 + \mu)^n \quad (1)$$

where V_i is the equivalent volume of vehicles in year 0, V_f is the equivalent volume of vehicles in year 30, n corresponds to the number of periods and μ is the traffic volume growth rate.

The calculation of the annual income from tolls was done by multiplying the toll value for each of the of the planned toll gates by the expected volume of vehicles. An innovative feature of the Invitation to Tender document was the distinction made between single and dual carriageway stretches. According to the document, the ceiling values for the toll charges obtained with the financial and economic modelling are R\$ 8.54/vehicle equivalent and R\$ 11.10/vehicle equivalent for single carriageway stretches and dual carriageway stretches respectively.

The values were applied in accordance with scheduled duplications specified in the tendering document. For the period between the first and second phases of investments, the premise assumed was that the average toll value per vehicle equivalent would be R\$ 9.82.

Income from sources other than toll fees, in alignment with the tendering document specifications, was considered to be 3% of the annual income from toll fees. The tax on services (*Imposto sobre serviços* – ISS) was considered to be 5% of the gross turnover value. The other two taxes, PIS and COFINS are charged cumulatively and their respective rates were 0.65% e 3% of the gross turnover value.

Capital costs associated to investments in the highway system and operational infrastructure are expected to amount to R\$ 9.12 billion altogether. For a question of simplification, the concession's operational expenditures were assumed to have a value proportional to the gross income from toll fees as foreseen in the projects original cash flow forecasts, in this case 25% of that value. That percentage was used unaltered for the calculation of all 30 years of the concession's duration. The intention behind that procedure was to adapt the operational expenditures to the dynamic cash flows in the light of demand uncertainties.

Another premise adopted in this work was that depreciation and amortization were considered according to the recommendations of Resolution nº 5.860/2019 (ANTT, 2019a). According to its Article 11, the depreciation and amortizations rates should be linear, considering the period from the moment the asset was available for use to the end of its useful life. In the case of physical highway infrastructure, the useful life was taken to be up until the end of the period foreseen for the concession, marked by the advent of contract termination.

The Income Tax aliquot was fixed as 15% with an additional 10% on that part of the income in excess of R\$ 240 thousand a year. The Social Contribution on Net profit (*Contribuição Social sobre o Lucro Líquido* - CSLL) was attributed an aliquot of 9% of the concession's real profit.

The project was evaluated accordingly, with the cash flow discounted. The present value of the project (*PV*) was obtained using Equation 2 below:

$$PV = \sum_{t=1}^N \frac{E(FCF_t)}{(1 + WACC)^t} \quad (2)$$

where $E(FCF_t)$ is the Expected Future Cash Flows value based on the last line of cash flow set out in Attachment A; *WACC* corresponds to the Weighted Average Capital Cost which for the purposes of this article is considered to be 9.20%, the value defined by the Brazilian Treasury Department (*Secretaria do Tesouro Nacional*) and adopted by the Environmental, Economic and Technical Viability study (ANTT, 2019b).

5. REAL OPTIONS ANALYSIS

The study adopted the method suggested by Copeland and Antikarov (2001) for pricing the abandonment option. The literature offers various empirical research reports addressing the question of underlying assets subject to risk and with analyses of the distribution of the ratios between the actual numbers of vehicles circulating in the highway and the forecasted numbers in concession projects in the field of transportation (Flyvbjerg *et al.*, 2005; Bain, 2009; Lana, 2014). The studies show that there is a strong divergence between the real traffic figures and those forecast for the first year of the project and indicate, with no surprise, the existence of a bias towards overestimation of the initial traffic volumes in the viability studies.

According to the three studies referenced above, the ratio between effective and expected traffic follows a normal distribution. The mean and the standard deviation established in the study that Lana (2014) conducted were 0.709 and 0.262 respectively. That author constructed a structured database with the data gathered from 41 Brazilian federal and state highway concessions. To simplify procedures those values have been adopted in the present study.

The literature (Brandão and Saraiva, 2007; Lara Galera, 2006; Martins, 2013) commonly assumes that the traffic demand in the years subsequent to the first year obeys a Geometric Brownian Motion expressed by:

$$dS = \mu \cdot S \cdot dt + \sigma \cdot S \cdot dz \quad (3)$$

where dS : the incremental variation in traffic in the time interval Δt
 μ : the traffic growth rate (calculated as 2.29% per annum)
 dz : Standard Wiener increment $\varepsilon \cdot \sqrt{dt}$, $\varepsilon \sim N[0,1]$
 σ : traffic volatility

The solution of the equation for annual time intervals used for the stochastic modelling of the traffic is given by Equation 4, as follows:

$$S_{t+1} = S_t \cdot e^{\left(\mu - \frac{\sigma^2}{2}\right)\Delta t + \sigma \cdot \varepsilon \cdot \Delta t} \tag{4}$$

Given the unavailability of a historical series of traffic data for the highway under analysis which could serve as the base for projections and analyses, the study had recourse to indirect inferences regarding the traffic. Traffic volatility was estimated based on the index recommended by the Brazilian Highways Concessionaires Association (*Associação Brasileira de Concessionárias Rodoviárias - ABCR*, 2019). According to Lara Galera (2006) the volatility is expressed as the standard deviation of the logarithm of the traffic returns (growth). For the years 1999 to 2019, traffic volatility was found to be 2.93%.

In this study project volatility was defined as the standard deviation in the percentage variations in the project value from one period to the following one: $z = \ln(PV_1/PV_0)$. That value was calculated using Monte Carlo simulation of the cash flow subject to risk. 10,000 interactions were run using @Risk software.

The binomial tree method proposed by Cox, Ross and Rubinstein (1979) was used to model the uncertainty of the Future Project Value as a function of the stochastic demand process. According to that model, the binomial tree has binary probabilities p and $(1-p)$, for the occurrence of upward (u) and downward (d) movements. Figure 2 illustrates the binomial tree for a given asset with a value V .

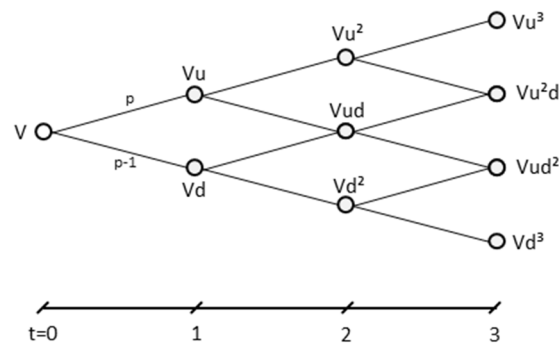


Figure 2. Binomial tree model. Source: adapted from Copeland and Antikarov (2001)

The relations that convert the upward (u) and downward (d) movements and the neutral probability in relation to risk (p) into a binomial grid are expressed by equations 5, 6 and 7 below:

$$u = e^{\sigma\sqrt{T/n}} \tag{5}$$

$$d = e^{-\sigma\sqrt{T/n}} \tag{6}$$

$$p = \frac{(1+r_f)-d}{u-d} \tag{7}$$

- where
- r_f : risk free rate of returns
 - n : number of upward movements
 - T : total number of periods;
 - σ : standard deviation of the returns from the underlying asset subject to risk

In the following stage, the conditions for project abandonment were defined for each node in the events tree to transform it into a decision-making tree. In the latter, the returns of the optimal decisions were represented regardless of whether they were associated to exercising the abandonment option or not.

The risk-free rate of returns (r_f) was based on the historical record of the nominal returns of US Treasury 10-year Bonds over the last ten years for which the average rate of return was found to be 2.58% (Damodaran, 2020). That rate was incorporated to the country risk rate and the average value of the EMBI+ over the last 10 years, estimated as 2.59% (IPEA, 2020) was added to it. The inflation rate for the period, 1.56% (Damodaran, 2020), was subtracted from the risk-free returns rate resulting in $r_f=3.61\%$; the calculations were done using the equation proposed by (Dornbusch *et al.*, 2013).

The indemnity values regarding investments associated to reversible assets for each period t were calculated based on the project’s available cash flow data (Attachment A). According to Article 6 of ANTT Resolution nº 5.860 (ANTT, 2019a) the indemnity values for reversible assets should be based on the historical costs, less the taxes recovered, financial costs, depreciation and amortization. In other word for the purposes of the present work, the amount of the indemnity was taken to be the difference between the accumulated value of the investments flow and the depreciation/amortization.

In Figure 3 the blue bars represent the intended investments for each concession year in alignment with the investment schedule punished in the official document and the red bars correspond to the depreciation/amortization for each year. The purple line and the blue line represent the accumulated values of the investments and the depreciation/amortization respectively and the green line represents the difference between those accumulated values which is the indemnity to be paid in the time t according to the criteria explained above.

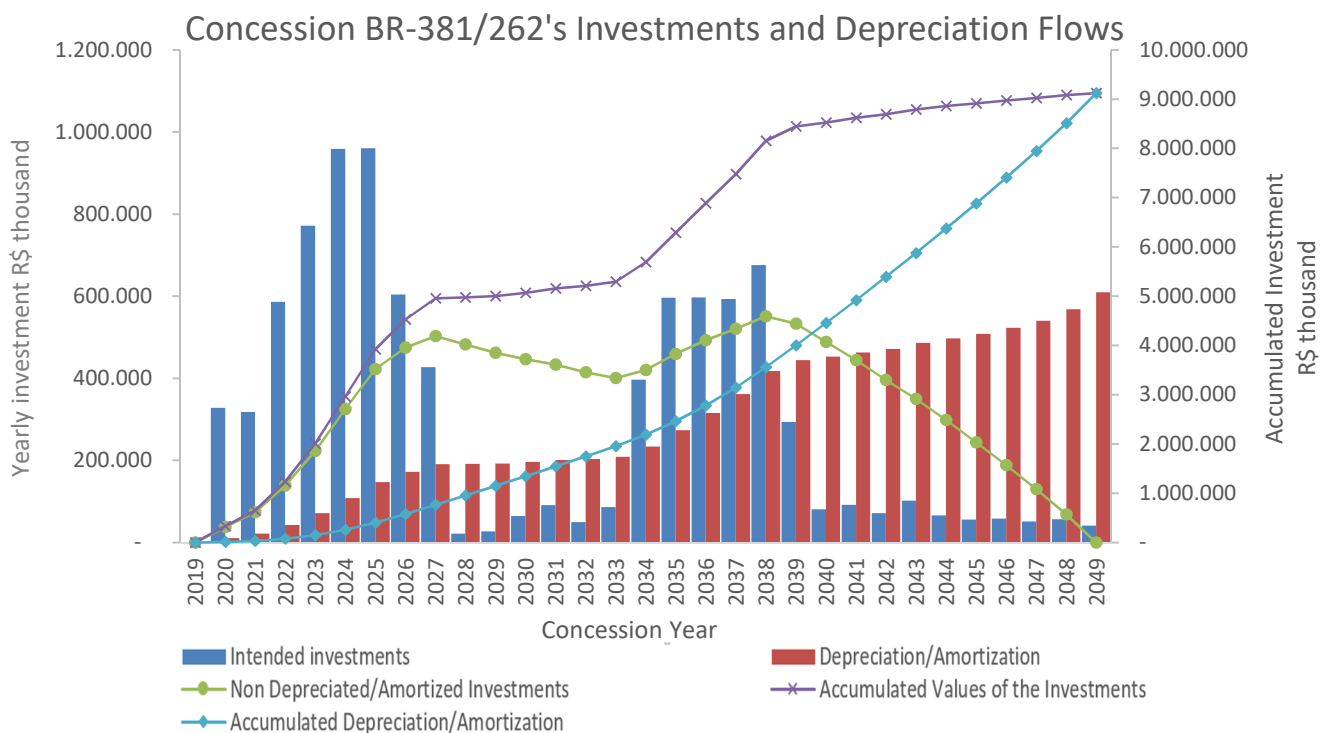


Figure 3. Investment and depreciation flows

A discount of 10% was applied to the indemnity value to cover expenses with the retendering process, eventual contract fines or sanctions, and other related costs and that discount was subsequently the object of a sensitivity analysis to assess the influence of that variable on the option value. The values for that discount reported in the literature range from 0 to 30% (Brandão, 2002; Blank *et al.*, 2016; Colín *et al.*, 2016). For study purposes the period for the exercise of the abandonment option was taken to be from year 9 to year 29 of the concession. The initial period of investments in increasing highway capacity was rejected for study purposes as abandonment during that period would result in very high indemnity values to be paid by the public authority.

Lastly, the optimal returns from the decision tree were calculated using an *MS-Excel*[®] spreadsheet. The value of the abandonment option (P_0) is given by and energy consumption.

$$P_0 = \frac{\left\{ \sum_{n=0}^T \frac{T!}{(T-n)!n!} p^n (1-p)^{T-n} \text{MAX}[0, X - u^n d^{T-n} V_0] \right\}}{(1+r_f)^T} \quad (8)$$

where

- p : the probability of occurrence of an upward movement
- r_f : the risk free rate of returns
- n : the number of upward movements
- T : the total number of periods
- X : the price of exercising the option
- V_0 : the price of the underlying asset

6. RESULTS AND DISCUSSION

As discussed in section 4 the project's static cash flow analysis indicates that its present value (PV), in this case without managerial flexibility, was R\$ 61.52 million. It should be noted that this figure is very close to the cash flow PV presented in the financial and economic modelling set out in the Invitation to Tender document for that highway. With the incorporation of the abandonment option, the project's present value went up to R\$ 2.64 billion. Therefore, the value of the abandonment option is R\$ 2.58 billion. That is a considerable increase of more than 4,000% over the original value of the project and it corresponds to around 28% of the expected investment.

That high value of the abandonment option is associated to the relation between the low value of the underlying asset and the criterion defined for the sale of the concession. In most cases the value of the indemnity surpasses the upward and downward movements in the project's events tree.

In the first year when the option can be exercised, year 9, the indemnity value is R\$ 3.62 billion, and it reaches its maximum of R\$ 4.13 billion in the 19th year. Only from that year on does the indemnity value start to drop, reaching its minimum of R\$ 511.41 million in the penultimate year of the concession.

To exemplify the situation in the ninth year of the project, the first year for which abandonment was considered, the accumulated investment is expected to be R\$ 4.97 billion. For that period, the indemnity surpasses the value of R\$ 3.5 billion, while among the movements of the binomial tree only three out of the ten movements foreseen do not consider exercising the option.

To analyze the performance of the abandonment option value, sensitivity analyses were conducted for the model’s most important variables. The first variable tested was the value of the fine to be discounted from the total value of the indemnity. The results, displayed in Figure 4, show that the value of the option is sensitively affected by that percentage. In an extreme situation, the value falls to R\$ 264 million if the fine is set at 90%.

Another aspect tested for sensitivity was the volatility of project returns. It is a direct measure of the uncertainty associated to traffic levels. The stochastic analysis indicated that given the conditions defined in the preceding section, project volatility is 0.66. The option value was tested for the interval with the lowest volume of traffic and a volatility equal to 0.2 up to the condition with the greatest uncertainty with a volatility of 1.4. The results showed that this variable has little impact on the option value. The increase in volatility from 0.2 to 1.4 was mirrored by a mere 2.14% increase in the option value.

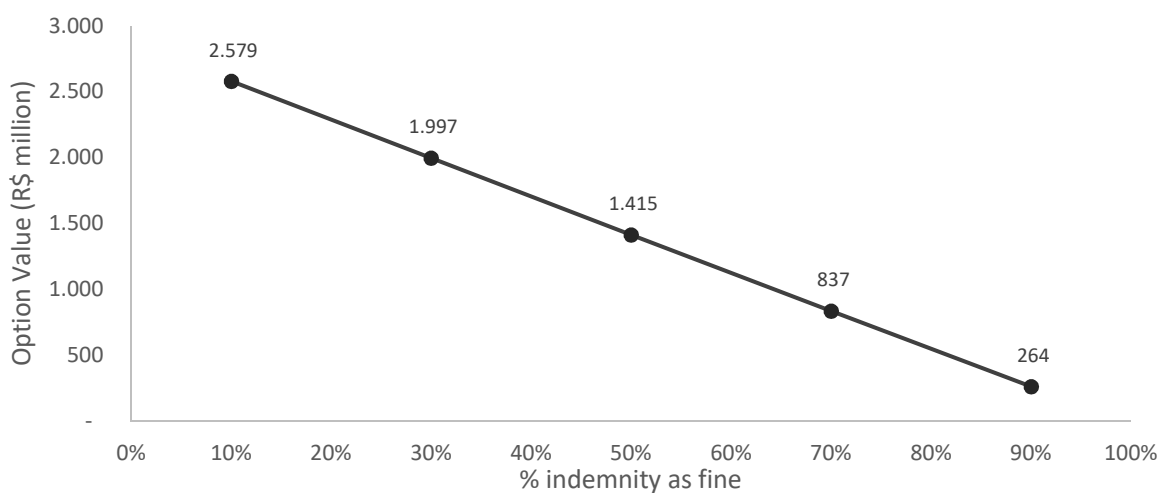


Figure 4. Sensitivity analysis of the option value - Fine % of indemnity

It must be pointed out, however, that the respective behavior is directly affected by the low value of the underlying asset compared to the indemnity values. In the conditions defined here, the abandonment option is preferred in most of the events in the binomial tree and that limits the influence of volatility in the model.

Figure 5 shows the behavior of volatility in regard to the project value. In the volatility interval from 0.2 to 0.4, the variation in volatility shows almost no influence at all. In the volatility variation interval from 0.4 to 1.2 the project value shows itself to be more sensitive and above volatility 1.4, it tends to stabilize.

Another variable tested was the underlying asset value. Simulations were made of the option value in situations of different project values ranging from R\$ 200 million to R\$ 1.80 billion as illustrated in Figure 6. As was to be expected, the option value went down as the project value increased but it did so at a low rate. An increase of 800% in the *PV* only reduced the option value by 13.90%. It was found that the sensitivity of this variable is affected by project volatility.

Given the demand uncertainties referred to in the preceding section, a Monte Carlo simulation was performed and obtained a volatility value of 66%. If, for example, that were to be reduced to 20% in the light of a more optimistic perspective in regard to demand risk, then the same 800% increase in project value would mean a 55.22% reduction in the option value.

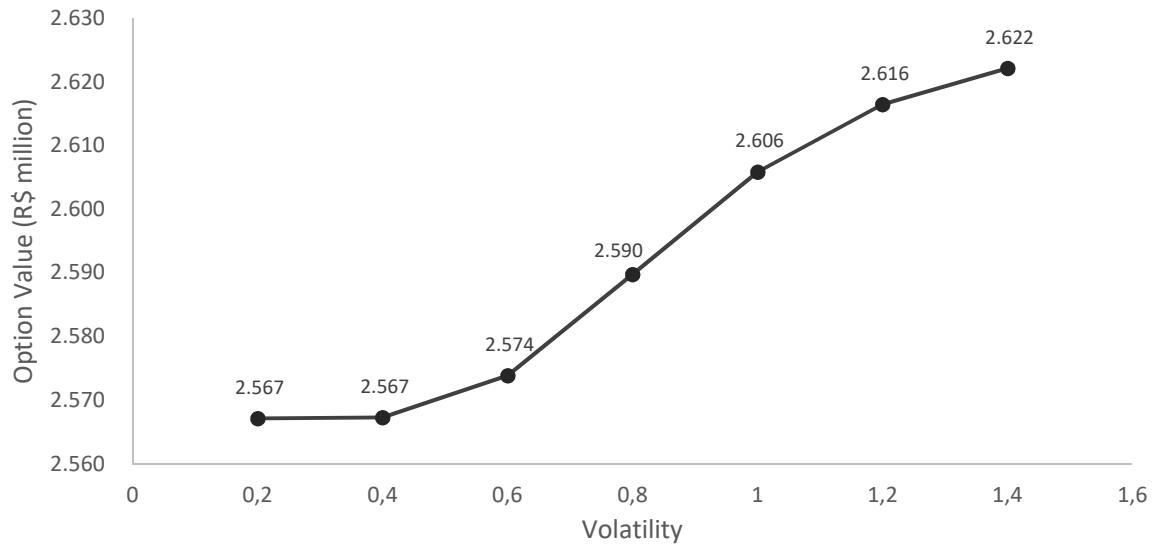


Figure 5. Analysis of option value sensitivity to project volatility

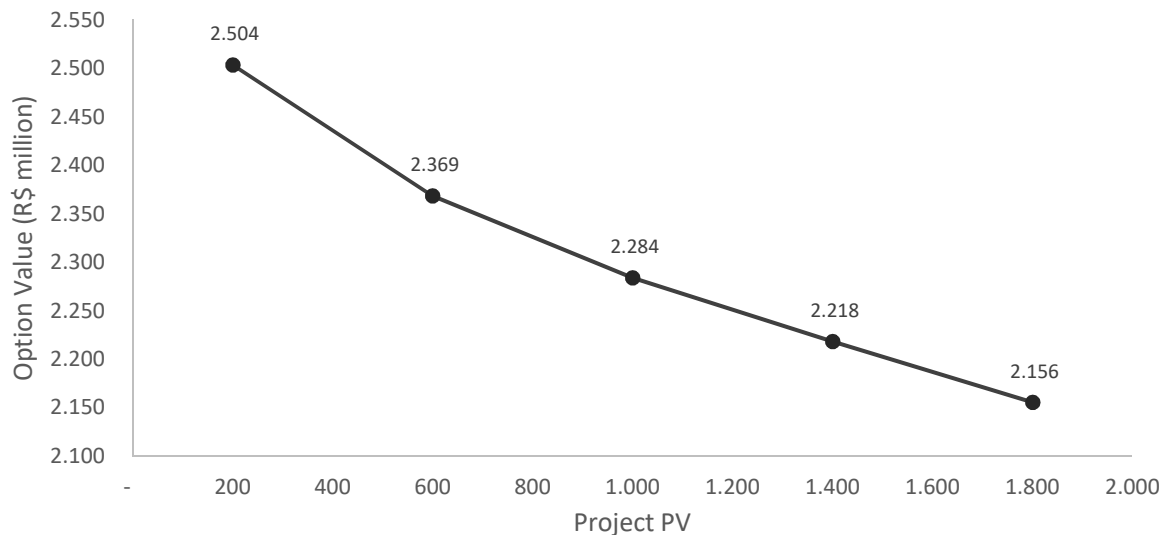


Figure 6. Analysis of option value sensitivity to underlying asset value

7. FINAL CONSIDERATIONS

This article has analyzed the case of the termination of the BR-381-262/MG/ES highway concession contract in the light of the recent framework concerning consensual devolution of concession projects in situations of insolvency. Based on those condition and taking into account the project demand risk, the real options theory was applied to calculate the value of the abandonment option.

Considering the expected cash flows set out in the official Invitation to Tender document, the results suggest that the abandonment option adds the considerable sum of R\$2.58 billion to the project. Obviously, the results of this kind of analysis will vary according to the peculiarities of each project.

For example, the project schedule for this particular concession foresees two distinct stages of investment (in highway duplication) up until the twentieth year. That feature means that any

eventual indemnity due remains at a high level for years due to the staging of the amortization and depreciation of the investment. Added to that is the fact that the present value of the underlying asset is relatively low compared to the indemnity values, which shows that there is a preference for the exercise of the abandonment option in most of the decision-making tree nodes and that considerably increases the value of the option.

The sensitivity analyses showed that the value of the option is considerably affected by the discount applied to undepreciated and unamortized part of the investment. The reference value used in this study was 10%. However, it is difficult to anticipate future conditions regarding contractual administration and expenses associated to the retendering process. Another situation that the sensitivity analyses revealed was the value of the abandonment option goes down when the value of the underlying assets increases and the option becomes unattractive.

Although it exists as a means of preventing undue gains on the part of the public authorities in the case of contractual extinction, in the case analyzed by this study, the indemnity revealed itself to be a significant guarantee that the government administration confers on the private partner. It is, however, important that the onus and the gains of both parties should be balanced. Three factors should be taken into account to define those optimum levels: 1) the concession must be attractive for private investment; 2) the attractiveness of eventual contractual default must be limited; and 3) the government must minimize its budget commitments.

In that regard, this article has contributed towards gaining a better understanding of the relationship between the uncertainties involved in the concessions and the new conditions favored by the Brazilian legislation. It is important to have prior knowledge of the value that a retendering process aggregates to projects so that future concession contracts can be modelled more efficiently, taking into account the above three points.

The main limitation of this work is related to the interest rate adopted by the ANTT and the cash flows calculated in the Invitation to Tender document. The rate (9.20%) does not reflect the market expectation for the venture. The project's internal return rate was fixed at that value in order to define the maximum tariff to be considered in the tendering process. With that the regulatory agency presents the market a project with a present value that is null.

Again in regard to the cash flows, the interested organizations insert their market expectations and operational costs in order to define their strategies in regard to the competition. For that reason, it would be interesting for them to apply the methodology presented in this article to the business plan of the winning bidder. In that way the real value of the abandonment option could be obtained because under the conditions presented in the document, the abandonment option will always have an unduly high value.

The recommendation for future work is to incorporate additional uncertainties to the project such as timeframes for the respective works, and costs. Another important factor to incorporate in the analysis is the question of contractual negotiations that antecede contract rescission, and which could have an impact on the real value of the abandonment option.

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