Modeling Opportunistic Behavior in Government Energy Concessions: A Real Options Approach

Keywords: Opportunistic Behaviour, Real Options, Energy Concessions.

1. Introduction

As in many countries, the electric energy industry in Brazil is subject to regulation by a government agency which implements policy by determining the rules and standards by which firms in the industry must abide. Government authorities also set targets for installed generation capacity in order to ensure that future supply of electricity covers expected demand. This is achieved by promoting reserve energy purchase auctions three to five years in advance of delivery which grants the winner a long term fixed price energy contract.

By guaranteeing a constant revenue stream for the wining project, the regulator greatly reduces the volatility of returns to investors who would otherwise be subject to the uncertain behavior of energy prices, and ensures that the investors will be able to secure debt financing for the project. Therefore investors will typically perceive this type of project as a low risk fixed income type of investment.

In the 2008-2010 auctions a group of non traditional participants surprised the market by offering energy prices that were significantly lower than expected and which apparently could only be achieved if the project had negative present value. On the other hand, many of these wining projects are now significantly behind schedule, which creates problems for the regulator and may generate potential energy shortages in the future.

In this paper we show that this situation can be explained by an opportunist behavior by a particular group of investors. In the Brazilian electrical energy industry there have been instances where the enforcement of penalties due to contract non performance has been hampered by legal issues and an incomplete regulatory framework. Accordingly, investors who perceive uncertainty over future investments costs may assume some degree of flexibility in the energy generation contract where the regulator did not intent there to be any. This flexibility is a source of additional value in energy generation projects which may allow these investors to bid lower prices in auctions.

We model the strategy of such an investor in a contract for future energy generation under the Real Option approach and investigate whether the perception of uncertainty over capital investments costs and the flexibility of deferring project start or to eventually abandon the project altogether creates an incentive to adopt an opportunistic behavior. We developed a Real Options model that incorporates the value derived from the flexible exercise of investment decisions in the reserve energy auction in Brazil.

The paper is organized as follows: after this introduction we present a review of the literature on opportunistic behavior and project valuation under uncertainty and flexibility. In section three we describe the characteristics of an investment in a reserve energy generation project, and next we develop a real options model that captures the opportunistic behavior of the investor and present our results. Finally, in section five we conclude.

2. Literature Review

Commercial transactions are usually backed by contracts that limit the managerial flexibility available to the parties involved, so that the risk that contractual obligations are not fulfilled or that they are fulfilled with some flexibility is reduced. If one of the parties deviates from agreed upon terms, penalties are applied. On the other hand, if the penalty is low or the party believes that the penalty may be avoided for any reason, and there is a gain to be earned from disregarding a contractual clause, there may be an incentive to adopt and opportunistic behavior.

Contractual penalties may not represent significant losses to the non performing party due to slow implementation of legal resolutions or when their value is low. The possibility of unforeseen gains may lead one of the parties to attempt to modify the original agreement. If the penalties involved are smaller than the expected gains, then as a rational economic agent this party will choose to bear these penalties in order to earn these gains. One might infer that the penalties should be equivalent or superior to the expected value of the loss due the failure to abide by the original agreement, which would cancel any gain the opportunistic party might obtain. But the party subject to the opportunity to deviate might have a different perception or expectation of future uncertainties and flexibilities in the original agreement, and therefore may perceive value where others might not.

Perception of future uncertainty can increase the perceived gain earned from deviating from the pre-agreed arrangement, which can be characterized as flexibilities over the contract clauses. Even though the deviation might not compensate the penalties under a deterministic analysis, when we dynamically consider the uncertainty over the future gains involved, this gain may be significantly enhance. These managerial flexibilities, such as the ability of the firm to adapt to new market conditions, have option like characteristics which can only be analyzed through option pricing methods, such as the Real Options approach.

When quoting prices for the construction of an asset, some bidders might inflate their cost estimates in order to increase their profit, which also has the effect of reducing their competitiveness in the offer (Xu & Tiong, 2001). On the other hand bidders might offer lower prices than other competitors, sacrificing profit margins in order to increase their chances of winning the auction (Mohamed, Khoury, & Hafez, 2011). Crowley & Hancher (1995) show that a low price behavior in acquisitions and can be explained by observing that the bidder seeks to recover the reduction in profit margin, as it believes that changes and claims following the auction may bring excess returns. According to Levin (1998), in very competitive biddings it is common for parties to offer lower prices for a project and then seek to lay claim changes after the auction, citing difficulties in implementation.

Ho & Liu (2004) used Game Theory to analyze the relationship between after bid claims and the behavior of bidders in price quotes and found that these might reduce their offered prices if there is the expectation of a return on their claims after the auction. Lo, Lin & Yan (2007) use a dynamic system to develop a pricing model with three dimensions: supplier´s costs, market competition and the reward after the contract, to assess the effects of the different behavior in prices offered in a bid. They conclude that the bidders expect to get rewards after the bidding process or demanding changes to the contract before committing to the start of work. Other studies also use mathematical methods to model auctions, such as Fuzzy Logic (Fayek, 1998), Neural Networks (Li, Shen, & Love, 1999) and Multicriteria Methods such as Analytical Hierarchy Process – AHP (Chua, Li, & Chan, 2001).

Opportunistic behavior in bids and price auctions can be understood as an offer strategy, from the perspective of the uncertainties that influence the decisions. King & Mercer (1985) state that this it is not a matter of the incapacity of suppliers to differentiate themselves in auctions, but due to variations in estimated project costs among bidders. Sudden variations in the margins calculated for bidding strategy, are overcome by changes in estimated project costs. Uncertainty over contract costs create significant risks and opportunities to participants. Quantifying the uncertainty of the cost in terms of a distribution of possible costs is essential if the uncertainty is to be considered (Chapman, Ward, & Bennell, 2000).

Investment decisions are based on the notion that expected returns must exceed the cost of the capital investment. The method traditionally adopted for this is the Discounted Cash Flow method (DCF), where the marginal return on the investment must be greater or equal than the opportunity cost of capital expenditures, or that the present value of the project free cash flows must exceed the investment costs. This approach is based on expected values, which ignores any volatility that may exist in one or more variables that may influence future cash flows. DCF also does note capture the value of the flexibility to optimally alter the project´s operating strategy as uncertainties are resolved over time. In these cases, a project may have a value that is higher than the one determined solely by the DCF method.

The valuation of flexibility was initially disseminated through the theory of financial options with the work of Black & Scholes (1973) and Merton (Merton, 1973). An option is the right, but not the obligation, to make a decision to buy, sell, defer or otherwise dispose of an asset at a predetermined price during a certain time period (Copeland & Antikarov, 2001). Tourinho (1979) was the first to apply options theory to real projects for the exploration of natural resources, in what is now called the Real Options Theory.

Dixit and Pindyck (Dixit & Pindyck, 1994), Brennan and Schwartz (Brennan & Schwartz, 1985), Trigeorgis (Trigeorgis, 1996) and others made significant contributions to the field and helped establish the notion that managerial flexibility may add significant value to a project or a firm. The application of this idea to model opportunistic behavior is discussed in Moel & Tufano (2000), who analyze the case of the bid for the Antamina copper mine in Peru, where the results were totally contrary to the expectation of the Peruvian government due to the significant value of the options embedded in the contract. More recently Fenolio & Minardi (2011) value the postponement option available to investors who already have the granted license for a Small Hydro Power unit with Real Options Theory.

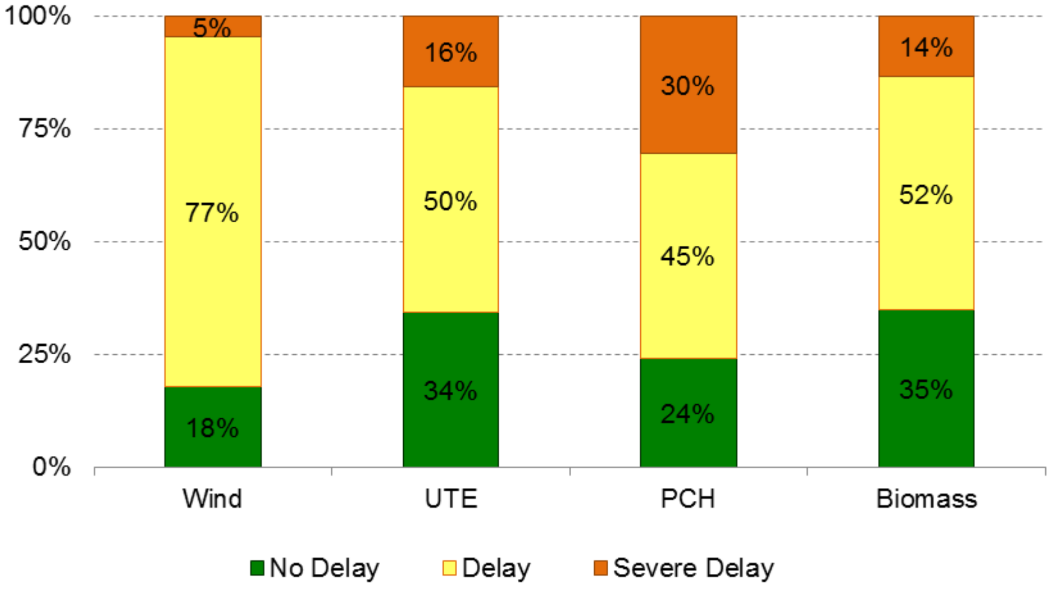
3. Reserve Energy Project

In a reverse auction bid for reserve energy, the winner is the firm who offers the lowest price per MWh. Winners commit to deliver energy for 15 to 30 years beginning 3 to 5 years from the date of the auction, which is the time required to build the new plants, and at the prices fixed at the auction plus inflation. This price is then multiplied by the predetermined energy rating of the plant, which is a fraction of its total capacity and takes into account the plant[s power factor to obtain the constant stream of future revenues the firm will earn during the life of the project.

With this information, the firm may determine the project NPV after consideration of the capital expediture costs (CAPEX), operation costs (OPEX) and the risk adjusted cost of capital. Winning bids are required to post a performance bond to guarantee they will bring the plant on stream in the required time.

The behavior observed in the implementation of winning projects of reserve energy auctions in Brazil suggest that the participating companies may have different perceptions regarding the assessment of project uncertainties and contract enforcement, which would allow for some degree of flexibility in the timing of the project start. This can be observed in Figure 1, which shows that a number of these projects have been delayed, according to consolidated data on the projects planned to be in operation between 2011 and 2019 of ANEEL. Approximately 66% of thermal energy (UTE) projects capacity bid are behind schedule for some reason. In the case of Small Hydro Power (PCH), the percentage is even higher, with 75% of the projects in this category.

Figure 1 - Overview of new energy generation projects status - October 2011



No Delay: Project is on schedule with concession contract signed, environmental license granted and construction in progress with no restriction to operation start:

Delay: Project is behind schedule with no environmental license granted and construction not initiated with some restrictions to operation start:

Severe Delay: Project had no environmental license granted, rescinded contract, legal issues and to operation start severely compromised

Source: Agência Nacional de Energia Elétrica (ANEEL), 2011

Relative to wind energy, almost 77% of the capacity of winning projects face restrictions to become operational, and 5% face severe restrictions, generally related to environmental licenses, contractual restrictions or lawsuits, and only 18% of the projects are on schedule. Thermoelectric projects (UTE) and Biomass projects, the later mostly based on sugarcane bagasse, are the ones with the best status to become operational – in both cases 34% of these should initiate generation between 2011 and 2015.

The status of ongoing projects clearly demonstrates that there are implementation problems and therefore a greater understanding is necessary of the process prior to the auction and on the other of the mechanisms that can be used to mitigate the risks involved.

4. The model

The behavior observed in the performance of project implementation suggests that there are may be different perception among companies relative to the project uncertainties and embedded contractual flexibilities. For simplicity, we assume that companies participating in energy auctions can be divided into two groups, according to their behavior: Conservative (Type I) and Opportunistic firms (Type II).

Type I firms assume that these projects share the investment characteristics of a fixed income financial asset, due to the fact that the future revenue stream is guaranteed. Therefore, project revenues are independent of uncertainties such as rainfall or wind regimes, and future cash flows will have low risk and can the discounted at a risk free rate. Type I companies tend to estimate the NPV of an expected cash flow based of their price bid and assume a fixed capital expenditure (Capex).

We assume that Type II firms, on the other hand, view an energy generation project as having embedded managerial flexibilities, such as the option to temporarily defer or even permanently abandon the investment. This behavior is characteristic of an opportunistic risk seeking participant who will accept a higher level of uncertainty as long as there is a higher expected return on the invested capital. This is due to the fact that despite the assured future cash flows, there may still be uncertainty over the cost of the capital investment or environmental permits. Thus, these firms would exercise their investment flexibly as uncertainty over future cost are resolved, therefore capturing the value of this flexibility for the investors.

The reason for the increasing number of Type II companies in the auctions appears to be linked to low entry barriers to in auctions and the low penalty for non performance. These conditions allow for the participation of a larger number of firms, which increases the competition and further depresses the prices. This has the effect of making the project unattractive to Type I firms.

It must be noted that Type II firms may choose to exercise the option to defer the investment by resorting to legal maneuvers in order to avoid characterizing an open breach of contract, in a behavior that increases the value of the project to the firm. Even though this behavior cannot be characterized as a default on the contract, it nonetheless has a negative effect on the guarantee of future supply of energy, as the mere delay in the implementation of generation projects which have a significant time to build compromises the schedule of installed generation capacity set by the regulator.

Type II companies still perceive other flexibilities in the implementation of projects won in auctions such as: wind site change, synergies with other players with cost sharing for interconnection, possibility of selling the project even before the start of construction, etc. It is worth mentioning that even if these flexibilities or options do not represent a direct risk for tariff stability therefore not affecting the interest of the regulator, they often involve delay in the project schedule. The current barriers to entry in the energy auctions, the bid-bonds and performance-bonds, appear to be insufficient to limit the entry of a larger number of competitors, which on one hand, stimulate competition, but on the other introduces a risk to future supply of energy that ultimately generate a risk for triggering the tariff of thermal power plants operating costs higher.

We model the dynamics of a firm who enters a reserve energy auction in order to build a electricity generation power plant and sell a fixed amount of energy at a fixed price, where the Regulator assumes that the winning firm will make the capital investment immediately. We model a typical wind power generation plant which has present value V of R$ 300 million, a required capital investment C of R$ 275 million, which generates a deterministic NPV of R$25 million. We assume a weighted average cost of capital (WACC) of 8% per year in real terms and a risk-free rate r of 5% per year.

On the other hand, the combination of an increased worldwide equipment production capacity and lower demand due to the economic downturn that has affected Europe and the United States since 2009, has negatively affected prices for generation equipment. Due to this, capital investment costs for recent wind energy projects have been significantly lower than originally planned. Also, in Brazil a favorable exchange rate has lowered the cost of capital goods. Therefore, while one can safely assume the project value V as deterministic, the capital investment C on the other hand will present an uncertain behavior over time due to fluctuations in demand and local exchange rate.

If the Type II investor bid such a low price that the project NPV is negative, we assume that this investor will defer his decision until such time when the NPV becomes positive due to lower Capex costs or at least less than any penalty cost that may be incurred due to contract non compliance, such as the performance bond. Therefore at any time in future, the decision to implement the project can be modeled by equation (1).

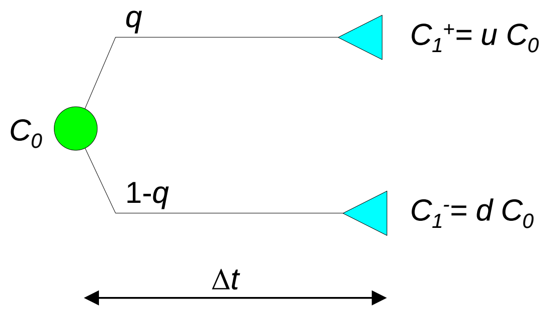
$$V_t = \max(VP - C_t; - \delta) \tag{1}$$

where V_t is the expected value of the project at time t, C_t is the uncertain (stochastic) value of the investment cost in t, and δ is the value of the performance bond, or the cost associated with the decision to defer the project start. We also assume that C_t is a stochastic variable following a Geometric Brownian Motion (GBM) diffusion process described by equation (2).

$$dC = \alpha\, C\, dt + \sigma\, C\, dz \tag{2}$$

where α is the drift rate of C which we assume as zero in order to model a neutral expectation regarding the future prices of the equipment, σ is the volatility parameter of C which we assume is 35% per year and dz is the standard Weiner process. The period of deferment for the investment is assumed to be 6 months or 0.5 years initially. This simple investment deferral option which is subject to the uncertainty of C for a period of Δt = 0.5 year, can be modeled using the binomial lattice of Cox, Ross & Rubinstein (1979), as shown in Figure 2.

Figure 2 – One step binomial lattice



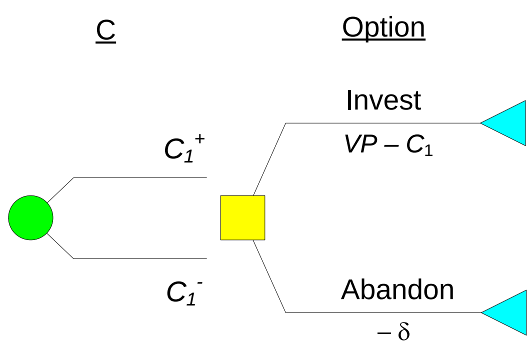
where $u = e^{\sigma\sqrt{\Delta t}}$, $d = \mathrm{e}^{-\sigma\sqrt{\Delta t}}$ and $q = \dfrac{1+\alpha-d}{u-d}$. The parameters u and d, are respectively the up and down movement multipliers, q is the risk adjusted probability of an upward move and Δt is the time interval, which in our case is 6 months or 0.5 years.

In each period Δt of the lattice we determine $V = VP - C_1$. These values are then discounted at the risk free rate r under the risk neutral measure. With the base case parameters of u = 1.2808, d = 0.7808 and risk neutral probability p = 0.43395, we obtain a value for the upward move of C_1^+ = R$ 352.22 million and V_1^+ = -R$ 52.22 million. For the case of the downward move, V_1^- = *R$* 85.29 million. The expected project value V at time 0 is V_0 = R$ 25.00 million, which is the same as the deterministic case.

We now incorporate an option to defer the investment for six months, or until Δt = 0.5 years, and calculate the values for V in period 1 using equation (1). In our single period model the firm must either invest by the end of period 1 or abandon the project altogether. The flexibility to defer has the characteristics of a Call option, while the option to abandon is modeled as a put option with maturity at Δt = 0.5 years.

We also assume that the performance bond, which is effectively the exercise cost of the abandonment option, amounts to 10% of the value of the planned investment C_0, or R$ 27.5 million. Therefore the values for V at the end of period 1 will be V_1^+= -R$ 27.5 million and V_1^- = R$ 5.291million. Weighting these values with p and (1-p) and discounting at the risk free rate, yields a NPV in time 0 of V_0 = R$ 35.47 million, a value R$ 10.47 million greater than the original project value of R$ 25 million. Figure 3 shows the single period model with options, where the circle represents the uncertainty of C and the square represents the option the firm has to optimally choose between investing or abandoning the project by forfeiting the performance bond.

Figure 3 – Single Period Model



By solving this model we observe that under these parameters, the probability of abandoning the project at Δt=0.5 years is 49.4%, which shows that the firm only has sufficient incentive to undertake the project in approximately 50% of the cases.

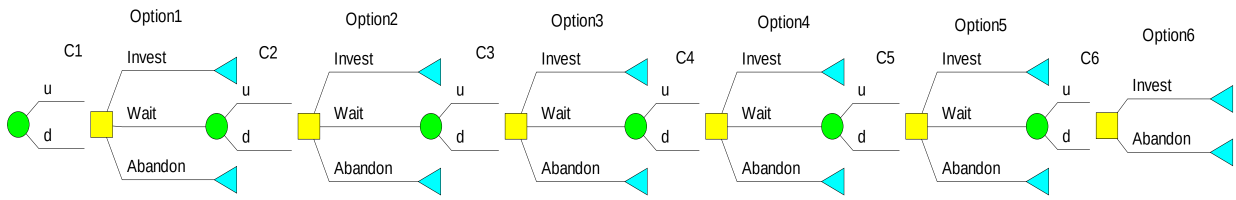
We now extend this model to a more realistic case, where the firm has up to three years to observe the behavior of the capital costs *C* before it commits to a final investment decision. The three year limit was chosen because we assumed the project is a result of an A-3 auction, where it should be producing power three years from the auction date. We also assume that if the project is not started within the three year time period, the Regulator will cancel the building permit and penalize the firm. In the periods between 0.5 and 2.5 years, aside from these two alternatives, the investor can choose to defer the decision to a future date.

As before, the decision to abandon is modeled as a put option with an exercise price equal to the cost of the performance bond, while the decision to invest in period *t* is modeled as a call option on the value of the project with an exercise price of C_t. Both options can be exercised at any time during the three year time frame and therefore are modeled as American type options, but there is now a third option, which is to defer the decision to the next period. Accordingly, equation (1) is only used in the last period of the model, while the earlier periods must now be modeled by the Bellman equation as show in (3).

$$V_t = \max\left(\underbrace{VP - \widetilde{C}_t}_{Invest} \; ; \; \underbrace{-\delta}_{Abandon} \; ; \underbrace{E\left(\tilde{V}_{t+1}\right) / (1+r)}_{Wait} \right) \tag{3}$$

The last part of equation (3) represents the continuity value in *t*+1 which characterizes the American option and allows the recursive backwards calculation of Bellman´s equation to always estimate the possibility of later exercise maximize the value of the timing of option exercise. This problem can be modeled with an expanded binomial tree as shown in Figure 4.

Figure 4 – Six Period (Three years) Model



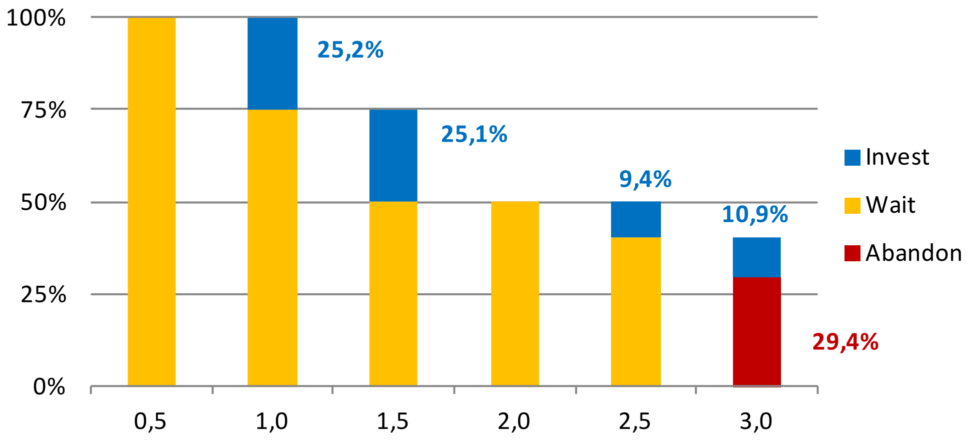
Under the six period model, the embedded options increase the value of the project to R$ 68.83 million, up from R$ 34.98 for the single period model and R$ 25 million for the project without any flexibility. The option value for the six period model is R$ 43.83 million (R$ 68.83 million - R$ 25.00 million). The results for models from one to six periods is shown in Table 1.

Table 1 - Option values as function of maximum deferral time

Maximum deferral time (years)	0.5	1.0	1.5	2.0	2.5	3.0
Option value (R$ millions)	9.97	22.57	26.24	35.15	37.50	43.83

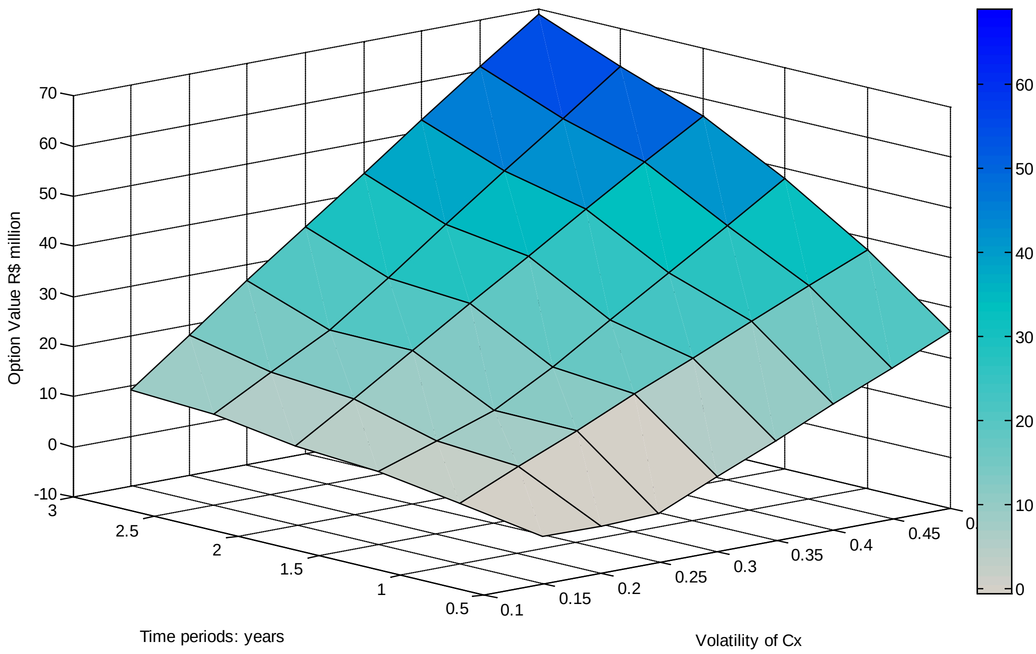
The results show that these options add significant value to the project and that this value increase over time. The probabilities associated with the exercise of each of the options, calculated using the objective, rather than the risk free probabilities, are shown in Figure 5, where it is clear that the probability of abandoning the project by forfeiting the performance bond diminishes over time.

Figure 5 – Probability of Option Exercise



Given that there is no market data or historical series available, the volatility of the capital investment cost C is a subjective estimate of the firm. The sensitivity analysis of this parameter shows that, as expected, the option value is positively correlated and varies significantly with volatility and deferral time. This implies that higher levels of uncertainty in the projects act as additional incentive for opportunistic behavior by the participating firms. This can also be seen in Figure 6.

Figure 6 – Option Value (R$ million) x Volatility of *C*.



As can be observed, for low values of volatility and few possible deferral periods, the options value is low. This is consistent with the behavior of Type I firms who do not consider a high volatility of CAPEX and/or the possibility of voluntarily deferring implementation of projects obtained in energy auctions. These firms only perceived the value determined through traditional NPV analysis. On the other hand, the creation of value by deferring project start, abandoning the project or otherwise actively managing the project in order to optimally exercise these embedded options constitutes an opportunistic behavior which is typical of Type II firms.

5. Conclusions and suggestions for further research

We investigate the reasons behind the significant price discounts that have occurred in recent reserve energy auctions in Brazil and analyze if there may be any additional motivation beyond simple price competition between participating firms. We divide the participants into two types of firms, each with different expectations of project risk and contract flexibility and model their behavior under the Real Options approach.

The significant discounts that have been observed in these auctions should translate into lower electricity tariffs in the future, therefore achieving one of the regulator´s objectives. Also the aggressiveness of opportunistic Type II firms expands the number of players in the electricity industry, increasing competition that under normal conditions would to be dictated by the Type I conservative firms which invest only in low risk or fixed income type investments. On the other hand the entry of Type II firms into the field, which are more prone to delay scheduled investment in the project due to opportunist behavior, also introduces an additional risk to the regulatory agency, which may compromise the certainty of future low tariffs. This is because in the event of delays in future energy projects the system operation may be forced to fire thermal units at a higher cost.

We conclude that despite the high discounts achieved in the energy auctions, the present status of projects for power generation represents a risk to the regulator of achieving its projected energy capacity objectives. The model developed in this paper shows that the perception of volatility by firms associated with the flexibility to defer the investment is the main source of value of real options that explains the opportunistic behavior of such firms. The significant delay in implementation of projects that has been occurring can be explained as the exercise of the deferral options by Type II firms.

The implications for public policy are twofold. First, opportunistic behavior such as observed in recent wind energy auctions in Brazil can hamper the regulatory agency´s efforts to secure a satisfactory level of energy supply at all times for the system. Second, in order to minimize this risk, the regulatory agency must reduce the perceived value of the embedded options in the project by Type II firms. This can be achieved by increasing the cost of option exercise through greater penalties for breach of contract, such as a higher performance bond and the cancelation of the license in the case of investment delays. While care must be taken in order not to excessively restrict competition, such actions would send a clear signal to the market that would limit any perceived contractual flexibility on the part of bidding firms.

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