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Real Options Approach: Investment Projects in Eucalyptus Planted Forests

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Abstract: Economic analyses of forest investment projects through the application of the Real Options Approach (ROA) allow the weighting of market uncertainties, furthermore, it attributes value to these projects by incorporating managerial flexibilities. Thus, we evaluated whether investment projects in *Eucalyptus* planted forests are economically viable, through the pricing of multiplicative binomial options in discrete time. Investment projects in *Eucalyptus* planted forests located in the State of São Paulo in Brazil were evaluated. Therefore, we considered the possibility of the forest producer acquiring the land or leasing it, considering two silvicultural regimes, i.e., forest conduction and forest area reform. Consequently, cash flows were elaborated based on technical-economic coefficients for a projected horizon for 14 years as a result of clear-cutting of the forests. Dynamic binomial trees were built in order to incorporate managerial flexibilities. In analyzing the investment project based on land acquisition, economic viability was proven for both silvicultural regimes, with 100% probability of deferral after the second year of implementation, and 99% of abandonment in the seventh year, with an expanded net present value of USD 7,171,265 and USD 25,970,288, respectively. As for the investment project under land lease regime, the project proved to be economically unviable. The ROA applied to the forest investment projects, provided added value and allowed inferring that, under the conditions of the study, the investment projects for reforming and conduction *Eucalyptus* planted forests are viable from the acquisition of land.

Keywords: Binomial tree. Biological assets. Discreet time. Forestry Economics. Managerial flexibility.

1. Introduction

The development of forests planted with *Eucalyptus* demands silvicultural treatments that aim at increasing the quality and productivity, therefore requiring significant financial contributions from forest-based companies. Thus, the economic analysis of investments in biological assets enables the implementation of mitigation actions and provides subsidies for decision making by forest managers.

However, the way in which cash flows are received is beyond the control of the party responsible for executing the project, which leads to the need to analyze the effect of managerial flexibility (LEYMAN; VANHOUCKE, 2016). From this perspective, we have the Real Option Approach (ROA), which allows estimating the additional value of flexibility in an investment project (BORISON, 2005; COLLAN, 2011; TRIGEORGIS; SCHWARTZ, 2001).

Thus, managerial flexibility determined by absorbing ROA, initiates by capturing the volatility present in the investment. In the forestry sector, for example, volatility can be perceived in the demand for wood, because prices tend to fluctuate from year to year (BRAZEE; MENDELSOHN, 1988).

It is noteworthy that ignoring these market fluctuations in forestry could make decision making biased (SHOGREN, 2007), justifying the ROA. In this context, we evaluated whether investment projects in *Eucalyptus* planted forests are economically viable, through the pricing of multiplicative binomial options in discrete time.

2. Methods

The study was based on *Eucalyptus* planted forests located in the Midwest of the state of São Paulo, Brazil. That said, four investment projects in biological assets were considered, characterized as:

Conducting planted forests in own areas (CPFOA): conducting planted forests with *Eucalyptus*, clonal, in spacing of 3 m x 2 m, in an area of 3,615.85 hectares belonging to the company and average individual tree volume of 0.22 m³.

Reform of planted forests in own areas (RPFOA): implementation of forests planted with *Eucalyptus*, clonal, in 3 m x 2.5 m spacing, in an area of 11,677.09 hectares belonging to the company and mean individual tree volume of 0.28 m³.

Conducting planted forests in leased areas (CPFLA): conducting of forests planted with *Eucalyptus*, clonal, in 3 m x 2 m spacing, in an area of 1,811.10 hectares leased by the company and average individual tree volume of 0.22 m³.

Reform of planted forests in leased areas (RPFLA): implementation of forests planted with *Eucalyptus*, clonal, in 3 m x 2.5 m spacing, in an area of 3,192.85 hectares leased by the company and average individual tree volume of 0.28 m³.

2.1. Cash flows from investment projects in biological assets

Cash flows were projected over a fourteen-year horizon when clear-cutting of the forests. In view of this, all expendable expenses from silvicultural treatments were considered. Consequently, due to the forest-based company having third party capital participation in its

capital structure, the discount rate of the investment projects in biological assets was obtained by weighting the average cost of capital according to Magni (2015).

2.2. Biological asset modeling

The main source of uncertainty of the investment projects in biological assets was the wood price, which has associated uncertainties that culminate in price oscillations due to the volatility of wood demand in the forest sector. Thus, the estimation of the future volatility of the value of the investment projects was done through the Monte Carlo simulation method, with the help of the software @Risk Copyright © 2020 Palisade Corporation (PALISADE, 2020), according to Brandão et al. (2005).

Then, the biological asset was modeled following a binomial model of binomial tree developed by Cox et al. (1979), using dynamic programming software Decision Programming Language (DPL), Copyright © 2020 Syncopation Software (SYNCOPATION, 2020). It should be noted that American call options (deferral and expansion) and put option (abandon) were incorporated into the decision tree. Therefore, the expansion percentage considered was 25% at the end of the seventh year.

The deferral option was incorporated into the biological asset investment project values in the second year. Finally, the American put option was incorporated at the end of the seventh year. Thus, the premium of the options, which were inserted concurrently into the binomial deterministic present value analysis, resulted from the difference between the expanded present value and the present value without flexibility (TRIGEORGIS, 1996).

3. Results

The real options of an investment project are part of a dynamic framework with stochastic evolution, in which both the optimal timing of investments and capacity choices are explicitly considered (HUBERTS et al., 2019). From this perspective, Table 1 shows the probability values for the deferral, expansion, and abandonment options. Furthermore, the deterministic and expanded net present value (NPV) information for the investment projects in biological assets were inserted.

Table 1 – Deterministic and expanded net present value of biological asset investment projects and probability of real options occurring.

Investment Project	NPV deterministic (USD)	NPV expanded (USD)	Probability deferral (%)	Probability Abandon (%)	Probability Expansion (%)
CPFOA	-13,855,319	7,171,265	100.0	99.0	1.0
RPFOA	-43,489,792	25,970,288	100.0	99.0	1.0
CPFLA	-6,163,648	-6,163,648	0.0	0.0	0.0
RPFLA	-10,809,103	-10,809,103	0.0	0.0	0.0

The options exercised concomitantly attributed value to the biological asset investment projects CPFOA and RPFOA, resulting in positive NPV with flexibility, proving their economic viability, as opposed to the traditional valuation method. However, the NPV of the CPFLA and RPFLA biological asset investment projects were equal to the present value with flexibility, since the related options were not sufficient to create value, and therefore make them feasible.

Therefore, real options do not always attribute value, but they do alert one to the need to rethink the investment project in view of declining capital. According to Belderbos et al. (2019), the value of the real option in the investment is determined by the interaction between market uncertainty and the investment strategy.

Hence, the forest manager must align the firm's investment strategy with the market context to which it is inserted, therefore, culminating in the creation of value of the related real options. After all, according to Grover et al. (2018), the economic success of any investment project lies in realizing the strategic value of the business, which gives companies, especially forestry companies, competitive advantages.

4. Conclusions

The volatility of biological assets, for investment projects in owned areas, influences economic profitability in comparison to investment projects developed in leased areas.

Investment projects in biological assets for conducting and reforming forests planted with *Eucalyptus* prove to be economically viable, under the condition of land acquisition, with expanded NPV of USD 7,171,265 and USD 25,970,288, respectively.

Investment projects in biological assets under land leases are economically unviable, even after incorporating real options.

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