EVALUATION OF INVESTMENTS IN AN ETHANOL PLANT BY MONTE CARLO SIMULATION

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Overview

In Brazil, sugar and ethanol plants produce both sugar and ethanol from the same energy input, sugar cane. In this way, it is possible to decide which fraction of the sugar cane harvest will be destined for each final product, respecting the technical limits of production. Between the 2011/2012 and 2014/2015 harvests, for example, sugar cane mills opted for the majority, while between 2015/2016 and 2017/2018 there was a greater commitment to the production of ethanol. In general, such a decision is made according to the prices of each product and its substitutes in the market.

Besides this flexibility of choice of production, there are also other flexibilities in the plants, for example: (i) the possibility of increasing (or decreasing) production; (ii) the possibility of anticipating (or delaying) the harvest; (iii) the possibility of altering the production mix between sugar and ethanol, among other aspects. Therefore, it is to be expected that these aspects can significantly alter investment decisions, as well as their returns.

As a result of these flexibilities, many studies were developed with the purpose of determining an optimal planning for a sugar cane plant (GONÇALVES et al., 2006; PENEDO, 2008; BASTIAN-PINTO et al., 2009; PEDERSON; ZOU, 2004, DIAS et al., 2011, IGREJAS SILVA, 2012, DE OLIVEIRA et al., 2014). These studies take into account (1) the competitive environment of ethanol and sugar, (2) flexibility in the choice of production between sugar and ethanol, market uncertainties, such as price and demand for these products, (3) possible physical, environmental, managerial, legal, etc. restrictions, and also (4) the evaluation of cogeneration investments of electric energy. Thus, one way to achieve such an objective is through the real options analysis.

The theory of real options can model all these flexibilities, which would have been ignored by other techniques of management and economic-financial evaluation, such as discounted cash flow. Therefore, real options analysis add value to projects in decision making (KULATILAKA, 1993). In this context, the main objective of this article will be to evaluate the decision-making of the proportion of production between ethanol and sugar in sugar cane plants, using the real options analysis methodology in comparison to discounted cash flow methods.

Methods

The real options methodology emerged as a complement to the theory of valuation of investments by discounted cash flow. In this second technique it is only taken the decision to invest or not in a project. Therefore, any flexibility to change the investment momentum, ie any opportunity to make changes in the investments during the project, is ignored and, moreover, the uncertainties are not adequately quantified (DIXIT, PINDYCK, 1994; TRIGEORGIS, 1996; DIAS, 2014).

The reason flexibility does not exist in the discounted cash flow, as this methodology works with expected cash flow and assumes a passive and static role of the decision maker (TRIGEORGIS, 1996). Thus, according to Dixit and Pindyck (1994), the opportunity cost of any investment decision change over time in projects is ignored, leading to wrong decisions. Dias (2014) adds that real options analysis "emphasize the value of the decision-maker's flexibility in changing the course of a project or the operation of a real asset, especially under conditions of uncertainty". Therefore, the risks are explicitly modeled in the real options analysis, differentiating the possible scenarios clearly, unlike the discounted cash flow (HO et al., 2004). In this way, any flexibility and change in investments can not be measured by the discounted cash flow.

In this article the real options analysis will be quantified by Monte Carlo Simulation. This method solves the problem by direct simulation of the physical process, so that it is possible to include the various sources of uncertainties as well as the constraints. Thus, in the model – in a finite horizon of 50 weeks – will be tested for each week which is the optimal decision, that is, the proportion that should be destined for sugar and ethanol production. In addition, flexibilities were also included, such as temporary shutdown and plant closure. Thus, the model receives the European option sequence treatment, since it chooses the maximum payoff on each operational decision date.

Results

With the quantification of the flexibilities inside sugar and ethanol plant, it was possible to obtain return of 19% higher, when compared to a strategy of static production, without any flexibility.

Conclusions

With this research, it was possible to indicate which flexibilities (for example, changes in the production mix between ethanol and sugar, as well as anticipations or deferrals of production and harvest, among others) that add more value to the sugar-ethanol plant. In addition, it was also possible to provide a more robust decision-making tool for sector managers. Thus, it is expected that such results lead to better strategies in the conduct of the sugar-energy business and may also indicate ways to be followed by sectoral public policies.

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