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"Valuación de Inversiones en Infraestructura Eléctrica y Comportamiento Estratégico"

ANEXO 21
PGT 6.1 – Integración y Comparación de modelos de Opciones Reales (OR) y Teoría de Juegos (TJ), ABM y Dinámica de Sistemas (DS) – Informe

Option Games applied for investment in power generation capacity

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***Abstract*—Due to significant economies of scale, the capital-intensive involved and government regulations that still don't rule a perfect competition environment, the power generation industry is usually organized as a market with oligopolistic competition. In this type of market structure, participating agents implement different strategies or games to exercise market power in order to increase their profits above competitive levels or prevent the entry of new agents to the market. This kind of problem is usually described by a Game Theory (GT) approach. Furthermore, the investor must evaluate the investment alternatives taking into account the flexibility of the investment options, in order to face unfavorable market scenarios, including the strategic movements of its competitors. This kind of problem is usually described by a Real Option (RO) approach. Therefore, it has been highlighted the necessity of developing a hybrid tool that combines the methods of GT and RO in order to fully face those inconveniences in the power generation problem mentioned. This evaluation tool, called Options Games has been developed recently. Despite its enormous potential, this new methodology has not yet received significant attention in the field of power generation. This paper presents an application of the Options Games approach in order to describe the challenge of investment in power generation capacity in a duopoly market.**

***Index Terms*— Flexibility, Irreversibility, Risk, Uncertainty.**

I. INTRODUCTION

In recent decades, the power generation industry in many countries has been restructured, moving from vertically integrated and centrally management monopolies to electricity markets with mechanisms of competition in the generation sector.

Due to economies of scale, the market concentration [1], the increasing ability of companies to withstand risks through diversification, to the structural characteristics of the electricity networks [2] and so on, the power generation industry is often organized as an oligopoly market, with some agents taking dominant positions. These dominant positions are achieved through the exercise of market power [3], resulting in increased profits above competitive levels; or by increasing barriers to entry (preventive/dissuasive investments), in order to limit or prevent new participants from entering the market. To this end, the participating agents implement different strategies or games, making modeling of the behavior of oligopolistic markets much more complex to describe and anticipate.

In power markets characterized by high volatility, generation companies are looking for investment alternatives that maximize (or at least maintain) profit levels and limit risks. In this context, the generating agents operate in an environment subject to large variability that are difficult to predict accurately. Among the existing uncertainties, we can mention the evolution of demand, fuel prices, the introduction of new technologies, the evolution of macroeconomic variables, which has been considered in [4]-[5], as well as the entry and exit of competitors in the market. In addition, the expected returns of the generating agents depend upon their positioning in the market in relation to their competitors. Therefore, in this environment, appropriate management of the uncertainties and risks associated with key factors such as the irreversibility [6] (sunk economic value) has to be taken into account in order to determine the survival opportunities of electricity producers in the long-term.

From the above, it can be concluded that there is the need of having flexible projects in order to deal with unfavorable market scenarios. Therefore, investment options must be carefully identified and evaluated before decisions are made.

Traditionally, investments are evaluated through the Net Present Value (NPV) approach, but the NPV does not consider the options that can be included in the project, that is, contingent actions in response to changing conditions or the arrival of new information throughout the investment horizon, nor does it assess the flexibility of these options; nor does it consider the additional investments that the agent or its competitors can make. The uncertainties associated with long-term investments

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