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Interfaces with Other Disciplines

Mature or emerging markets: Competitive duopoly investment decisions

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ABSTRACT

We develop a competitive investment model wherein two competing firms consider investing into two projects targeting, separately, a mature and an emerging market. The returns firms obtain from investments into these markets are assumed to follow an S-shaped curve and depend on both firms' actions. Considering symmetric environments (in terms of investment opportunities), we find that different forms of interactions may arise (e.g., Prisoner's Dilemma and Game of Chicken) and outline corresponding strategies that offer higher returns by exploiting first-mover advantages, cooperation opportunities and aggressive choices. We also discuss the market conditions that can lead to these outcomes. Finally, considering non-symmetric environments, we show that a firm may be better off when its competitor's budget increases.

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1. Introduction

Allocating scarce resources over a range of project alternatives is an essential decision commonly faced by firms. The decision that firms face is not *whether* to engage in project portfolio management but *how* to engage in it. Approaches to the resource allocation problem vary significantly, ranging from ad hoc resource allocation decisions by senior managers to formal processes that have been entrenched throughout all hierarchies of the firm. Although the success of project portfolio management implementations has been mixed, any type of formal process is better than ad hoc decision-making (Cooper et al., 2004).

Allocating resources across hundreds of possible projects is clearly difficult, but even deciding between two seemingly unrelated projects can be quite challenging. The complexity of allocating resources between multiple projects has been addressed in the literature, yet a fundamental complexity that has largely been ignored in this context is the effect of competition. When a firm makes resource allocation decisions, its competitor may be contemplating its own portfolio of projects. In such a situation, the portfolio decisions made by the two firms can influence the outcome and returns of each other. For example, a simultaneous change in packaging by two competing firms is unlikely to attract the same consumer attention compared to packaging change by only one of the firms, thus leading to less than expected returns. Conversely, joint entry into a new market may create market hype and increase returns for competing firms from this emerging sector. Each firm's respective share of the market could decrease by joint entry with two competing products but the increase in the overall size of the market may outweigh that effect. Although this example and the prediction of the outcomes are pure speculation, it is clear that firms that compete in the same markets will influence each other's returns with their portfolio decisions.

Firms routinely face these types of decisions, as illustrated in the example of the major rivalry between the giants of the comic book industry, Marvel Comics and DC Comics, who have been competing with each other since the 1960s. In recent years, both firms were also highly successful in licensing some of their comic characters to the big movie studios, such as 'X-Men' (Marvel Comics) and 'Batman Begins' (DC Comics). After this success, Marvel Comics and DC Comics now faced an important investment decision: should they invest their budget into the mature comic book market or instead focus on the emerging comic-based movie market? While the comic book market was showing quickly diminishing returns in past years, the comic-based movie market was expected to provide significant returns, even for very large investments. In this particular instance, the two firms invested in different markets. DC Comics invested all of its resources into the comic book business by launching 52 new comic lines (Guzman, 2011), while Marvel Comics created Marvel Studios and produced its first movie, 'Iron Man', in 2008 (Kell and Barris, 2008). In this work, we want to explore these types of investment decisions. Under what conditions would it have been optimal for both Marvel Comics and DC Comics to invest in the comic book market or the comic-based movie market? When is asymmetric investment optimal, where one firm invests in the comic book market while the other invests in the comic-based movie market? How important is it for these firms to consider each other's investment decisions?

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Though we are interested in competitive project portfolio management decisions broadly, we limit our attention to a duopoly in which firms consider project investment opportunities into two markets. Firms are constrained to invest in only one of the two markets. In other words, our focus is on a two-market binary investment choice in a competitive setting. Accounting for symmetric investment scenarios, we find that various types of interactions may occur between the two firms (such as the Prisoner's Dilemma and the Game of Chicken) and that, given our assumptions, a pure strategy exists for all possible interactions. We further characterize the market parameters and investment opportunities that lead to particular strategic interactions between the two firms. To gain insights in the more general asymmetric investment scenarios, we conduct numerical analyses which reveal that a firm may be better off when its competitor's budget increases.

This paper is organized as follows. In the next section, we review the literature on the resource allocation problem and show how our work fits into current research streams. In Section 3, we develop a competitive project portfolio management model for the symmetric case where firms have equally sized project opportunities. Using this model, we outline the optimal investment decisions in Section 4, discuss our findings under a range of market dynamics in Section 5, and describe other possible market states in Section 6. In Section 7, we provide some numerical results from a competitive project portfolio management model where firms have asymmetric project opportunities and in Section 8 we conclude.

2. Relevant literature

Project portfolio management was first addressed by Lorie and Savage (1955) under the context of a capital budgeting problem in which firms choose between a selection of projects with different costs and returns, subject to a budget constraint. They acknowledged the complexity of the problem and used a trial-and-error method to derive solutions. Over the years, many additional features have been incorporated into resource allocation models, such as project uncertainty (Solak et al., 2010), project interdependencies (Liesio et al., 2008), and the degree to which projects fit the overall strategy of the firm (Loch and Tapper, 2002). There are also many behavioral issues that affect project portfolio decisions since the outcomes can heavily influence the careers of decision-makers (Sanwal, 2007). In spite of the many advances in the project portfolio management literature and the recognition that competitive effects are important in a resource allocation setting (Bower and Gilbert, 2005; Hauser et al., 2006), the effect of competition has not been considered deeply, with a few exceptions, which are described below.

Gibson et al. (2009) used a multidimensional knapsack model to explicitly consider competitive actions and sequential decisions on what set of indivisible items to acquire. The authors simulated the actions of competitors and then applied an efficient search heuristic to find good solutions. Although this problem is closely related to the project portfolio management problem, it differs in that as soon as one decision-maker selects a particular item (or project), that item is no longer available to the competitors. One could argue that the first-mover advantage in certain product categories would have a similar effect by removing the incentive of the other firm to pursue the same project; however, Gibson et al.'s framework is generally more suitable to their own example, namely a sports draft, where teams have a certain budget to spend on new players of various costs and as soon as one team chooses a player, that player is off the market.

Zhu and Weyant (2003) model competitive forces within a real options framework. In their model, each firm's profit depends on the actions of the competitor: if both firms invest without observing each other's decisions, a Nash-Cournot equilibrium is reached; if one firm invests first, a Stackelberg leader–follower equilibrium is reached; if a firm invests solely in a market, it acquires a monopoly position. Zhu and Weyant develop decision trees to predict the outcomes of these games. Furthermore, they show that although firms that act first experience a first-mover advantage, they also reveal private information when doing so, which is advantageous to their competitors. Thus, the strategic implications of timing decisions should be considered when making investment decisions on new technologies or products. Although this problem framework is directly embedded in resource allocations towards new products, the decision includes only a single project within a single market. In contrast, we are interested in models where firms are considering how to allocate resources between multiple projects across different markets.

Another approach to solving the resource allocation problem while considering competition comes from the field of innovation contests (Terwiesch and Xu, 2008), all-pay auctions (Baye et al., 1996) and R&D races (Grossman and Shapiro, 1987). In innovation contests, firms engage in R&D 'experiments' and the firm with the best resulting product wins a prize. Similar to the project portfolio management problem, firms decide how many resources to invest in these projects. In a more abstract sense, innovation contests can be seen as all-pay auctions where all players place a certain bid and the highest bidder wins, but all bidders must pay their bid. Finally, R&D races are similar to innovation contests and all-pay auctions except that players are racing to secure a patent. Because there can only be one patent holder, models of R&D races assume a "winner takes all" framework. The exception in this research stream is the paper by Ali et al. (1993) who consider a project portfolio management framework. In their model, project choices consist of a pioneering and a modification product, both targeting the same market. Depending on the investment decisions and timing, firms derive monopolistic or duopolistic returns. While unable to express the Nash equilibrium in closed form, Ali et al. used numerical analysis to derive insights. Similarly, Zschocke et al. (2012) study a competitive project portfolio setting where firms face two R&D investment choices: a radical project targeting an emerging market and an incremental project targeting a mature market. As firms invest their entire budgets into these two projects, the net effect of competition is incrementalism—as more firms enter these two markets, they divert more of their budget from the emerging into the mature market. Adding the timing of the investment as a decision variable to this problem, Zschocke et al. (2013) show that competition may drive firms to delay their investment even in the absence of demand uncertainty, but that high diffusion effects coupled with low demand uncertainty in the emerging market can drive firms to invest early – even if higher returns are attainable to both firms if they delay their investment. The frameworks established by Ali et al. and Zschocke et al. are closest to our model.

Although some of the aforementioned studies have addressed the resource allocation decision with competition, we are interested in exploring some of the understudied aspects: first of all, firms often compete in more than one market and consequently have a portfolio of projects that includes projects that target different markets. Ali et al. did consider two project types, but both project types target the same market. Most of the other papers assume the even more restrictive case of only one project in the portfolio. Second, with only a few exceptions (e.g., Savin and Terwiesch, 2005), most studies assume that returns always decline through joint investment into the same market. However, this is not necessarily true. For example, Carpenter and Nakamoto (1989) showed that competition can increase category credibility, thereby aiding market penetration of a new product and ultimately leading to higher returns for all firms. Third, for tractability, many approaches

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