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The entrant's dilemma: a dynamic model to derive the optimal corporate entry strategy

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Abstract

Our research provides an in-depth analysis of which factors govern the decision of the optimal mode of entry. Our model considers two scenarios: (i) a firm decides to enter a certain market by merging with the monopolistic incumbent; and (ii) a firm chooses to enter the new market through organic investments, i.e., operating in a newly created duopoly. The choice between both scenarios is modelled as a real options game since this decision is considered to be uncertain, flexible and irreversible. Then, we derive the conditions under which firms find optimal to choose one strategy over the other. Our findings reveal that firms prefer internal investment when the industry exhibits high levels of uncertainty. When we compare both strategies' investment costs, we find that as the merger investment cost becomes increasingly cheaper when compared to the internal investment, both firms will be more prone to merge. When we account for the relative efficiency, we find that a higher efficiency of the entrant firm increases the likelihood of merger deals. Additionally, our model adds value by deriving the optimal investment capacity in the case of the strategy of entering the market through internal investment being optimally followed. Our model predicts that greater uncertainty leads the entrant to adopt larger projects.

Keywords: M&A; Real options; Game Theory; Optimal Capacity
JEL codes: C73; D81; G31; G34

Sumário

A presente dissertação fornece uma análise sobre quais os fatores que regem a decisão sobre qual o modo ótimo de entrada. O nosso modelo considera dois cenários: (i) a empresa decide entrar num determinado mercado através da aquisição do incumbente monopolista; e (ii) a empresa escolhe entrar neste mercado através de investimentos orgânicos, i.e., operando num duopólio. A escolha entre cenários é modelada como um jogo competitivo seguindo a metodologia de opções reais uma vez que esta decisão que tem adjacente características como a incerteza, flexibilidade e irreversibilidade. De seguida, são derivadas as condições em que as empresas escolhem uma estratégica em detrimento da outra. As nossas conclusões revelam que as empresas preferem o investimento interno quando a indústria apresenta elevados níveis de incerteza. Quando comparamos os custos de investimento de ambas as estratégias, verificamos que à medida que o custo de investimento da fusão se torna cada vez mais barato quando comparado com o custo de investimento interno, ambas as empresas serão mais propensas a fundir-se. Quando consideramos a eficiência relativa, verificamos que uma maior eficiência do entrante aumenta a probabilidade de as empresas se fundirem. Além disso, o nosso modelo acrescenta valor à literatura existente ao derivar a capacidade ótima de investimento no caso de a estratégia de entrada no mercado através do investimento interno ser seguida de forma óptima. O nosso modelo prevê que uma maior incerteza leva o entrante a investir em maior escala.

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Chapter 1

Introduction

"Although our intellect always longs for clarity and certainty, our nature often finds uncertainty fascinating."

Karl Von Clausewitz

Undoubtedly, Merger & Acquisitions (M&A) are a vital component of a firm's corporate growth strategy as they allow firms to exploit synergies, respond to economic shocks or access new markets. While a host of theories have been developed about their motives, nature and outcomes, the literature has generally ignored the value of direct entry as an alternative to an M&A attempt. Our research argues that M&A and direct entry[1] should not be considered in isolation, and interesting insights can be retrieved when considering them as alternative strategies when a firm intends to enter a given market.

In our research, we aim to theoretically model how companies choose their entry mode: internally, via organic investments, or externally, via M&A operations. When a firm wants to enter an industry, it is faced with various alternatives. It can independently produce or purchase the assets. It usually includes purchasing land, buildings and machines, training new employees, and building relationships with suppliers and customers. Alternatively, a firm can have access to those assets by buying an established business. Although these two alternatives to enter the market answer the same strategic purpose, there is an important catch. Acquiring a firm to penetrate a new market falls into the action group of entry through M&A. Conversely, firms that may opt to invest organically follow an entry through internal investment strategy. In this dissertation, we aim to model this as a dynamic game

[1]In this dissertation, we use the words *direct entry*, *internal investment* and *greenfield* interchangeably.

and study under which conditions firms find optimal to choose one strategy over the other. We extend the existing literature by incorporating the relative efficiency of the acquirer and the target firm.

Our model considers investment opportunities to be a bundle of corporate real options that are actively managed by the firm and may be affected by competitors' actions and by new technologies. If a firm's investment decisions are sensitive to competitors' moves, a game-theoretic framework is better suited to distill the dynamics of the model. The combined options and games perspective proposed herein is particularly relevant. We derive the terms of the M&A deal endogenously as the outcome of an option exercise game in which each firm determines an exercise strategy while taking into account the other firm's exercise strategy.

Departing from previous literature (Margsiri et al. 2008), we assume that when a firm intends to make an acquisition, it can always choose to invest organically so that the internal investment is a credible outside option for the acquirer. Allowing for different marginal costs of production the acquirer and the target, and different investment costs associated with each alternative entry strategy, we derive analytically the optimal timing to acquire and the optimal sharing-rule.

Additionally, our model adds value to the existing literature by considering the industry structure into the bidding process. We assume that the preexisting industry operates in a monopolistic structure and there is one potential entrant. If the entry occurs via organic investments, the entrant and the incumbent firms play a duopoly game. Alternatively, the entrant firm can acquire the incumbent firm by means of a friendly merger. If the offer is accepted, the entrant and the incumbent merge and a monopoly structure is preserved. If the incumbent rejects the offer, the potential entrant reverts to the moment where it has to decide under which terms an organic type of entry pays off.

We then use this framework to address two sets of points of discussion:
1. Derive the conditions under which managers find optimal to proceed with a direct entry or an entry via merger;
2. Determine the optimal investment capacity in the case of a direct entry strategy being optimally followed.

By addressing these points, our contribution to literature is twofold. First, we provide a methodological contribution. We derive optimal deal contracts for real options games under uncertainty where the terms of the M&A deal are influenced by both parties outside options. Second, our model advances the real options literature on M&A by providing an in-depth analysis of the determinants that drive the choice between entry via internal investment and entry via M&A.

This dissertation is structured as follows. Section 2 contains a literature review of the topic, providing an overview of the main theories, models developed and empirical evidence, as well as a critical analysis of the literature reviewed. Section 3 presents the model derived for two alternative strategies, the internal investment and the merger. Section 4 analyses the determinants that impact the optimal strategy choice and presents numerical results on comparative-static analysis. Section 5 presents the final remarks.

Chapter 2

Literature Review

The amount of Mergers & Acquisitions (M&A) over time has been somewhat of a puzzle. M&A activity has been racked up over the years in terms of both the number and the value of transactions. In the last 20 years, roughly 800 000 transactions have been announced worldwide with a known value of over 57 trillion USD [1]. For that reason, the topic of M&A has caught the major attention of academics, practitioners and regulators.

Empirical research on M&A has revealed a great consensus about their trends and characteristics over the last century. The two most consistent features of merger activity are 1) M&A have typically followed cyclical patterns - the so-called *waves* - where periods of low takeover activity are followed by periods of high takeover activity, and 2) within a wave, mergers considerably cluster by industry. These features suggest that mergers waves are triggered by unexpected shocks to industry structure (Martynova and Renneboog 2008, Andrade et al. 2001, Rhodes-Kropf and Viswanathan 2004).

But on the issue of why mergers occur, literature has been more diverging. The more prominent theories about why M&A happen are related to synergies. Synergy is the rather simplistic notion that the combination of two businesses creates greater shareholder value than if they operated separately (DePamphilis 2019). The two basic types of synergy are operating and financial. Operating synergy consists of improving efficiency through economies of scale or scope by acquiring a customer, supplier, or competitor. Financial synergy refers to the impact on the cost of capital of the acquiring firm or the newly formed firm. Empirical evidence suggests that operating synergies are among the most important determinants of shareholder wealth creation (Houston et al. 2001, DeLong 2003). Another important theory is related to strategic realignment. M&A are an effective way of acquiring capabilities

[1] Data retrieved from Institute for Mergers, Acquisitions & Alliances.

to adapt more rapidly to environmental changes, such as deregulation and technological innovation, than could be achieved if developed internally (Weston et al. 2004).

Nevertheless, an extensive review of the value-creating performance of mergers and acquisitions reported in numerous studies from the US, the UK and some continental European countries provides clear evidence that shareholders of bidding firms experience wealth losses on average, or at best, break even. Conversely, shareholders of target firms receive large positive gains (Ruback and Jensen 1983, Kaplan and Weisbach 1992, Andrade et al. 2001, Graham et al. 2002). The empirical evidence also shows that there is a sharp deterioration in acquirer performance several years after deal completion. Harford (1999) and Ang and Cheng (2006) find that the stock of acquiring firms performs well in the years before an acquisition. Schwert (2000) and Andrade et al. (2001) find a negative abnormal price reaction to the announcement of a bid. This paradigm leads us to rethink why firms engage in M&A operations from a strategic and financial perspective.

A host of theories have been developed to explain it. Some theories are related to agency costs. The theory of free cash flow (Jensen 1986) argues that low-benefit or even value-destroying mergers are more likely to be conducted by managers of firms with unused borrowing power and large free cash flows. The managerial entrenchment hypothesis (Shleifer and Vishny 1989) claims that managers overinvest in assets that suit their skills to entrench themselves. Another possible explanation relates to market irrationality. Shleifer and Vishny (2003) model mergers and acquisitions based on stock market misvaluations. They argue that mergers occur when managers take advantage of the opportunities created when inefficient financial markets value some firms incorrectly. Other theories are related to human biases. The hubris hypothesis (Roll 1986) argues that managers of bidder firms incorrectly assess the value of the combined firm. Managers are too optimistic about the performance of their acquisitions as they overestimate the benefits of the takeover. This leads to excessively high bids for targets and subsequent ex-post value-destroying mergers. Malmendier and Tate (2005) find that overconfident managers are more likely than rational managers to undertake value-destroying acquisitions as they overvalue the target firm's assets and overestimate the returns from potential synergies.

We aim to bridge the gap between the literature on M&A and the literature on entry and entry deterrence. In one hand, the literature on M&A has generally ignored the value of direct entry as an alternative to a M&A attempt. On the other hand, the literature on entry and entry deterrence has focused on the addition of capital by a new competitor in an industry when an alternative and commonplace

mode of entry is through the acquisition of the assets of existing firms. In our research, we consider internal investment and M&A as alternative strategies when a firm intends to enter a given market.

When a firm intends to enter a given market, it usually includes purchasing land, buildings, and machines, training new employees and building relationships with suppliers and customers. Rather than investing in the assets separately, the firm can acquire a coordinated set of assets in the form of another business. Potential entrants have various motives for choosing the latest alternative as the preferred path to gain a foothold in a new market. The most frequent ones are the exploitation of complementary assets (Teece 1980, Bradley et al. 1983), diversification objectives (Rumelt 1982), capital markets imperfections (Asquith et al. 1983, Ruback 1983) and delay and other barriers associated with new investment (Chatterjee 1990, Scheffman and Spiller 1992).

Although these two alternatives are normally mutually exclusive, they may be seen as interdependent. We assume that when a firm considers to make an acquisition, a firm always has the option to invest internally. Under this framework, internal investment is an outside option that enhances the acquirer firm's position in the negotiations with the seller.

The fundamental trade-off between internal investment and acquisitions has been the subject of some discussion in the literature. Gilbert and Newbery (1992) consider strategic factors affecting the decision of a potential entrant and the resulting market structure. The authors argue that it may be profitable to acquire a firm even if there is no improvement in its profitability. The reason is that it may be more profitable to acquire than to enter *de novo* as the threat of entry may allow the bidding firm to acquire the target at below its previous value. McCardle and Viswanathan (1994) model the optimal mode of entry in a setting with one potential entrant. The entrant can achieve market entry either independently, which increases the number of competitors, or through an acquisition. Raff et al. (2009) expand the analysis to the field of Foreign Direct Invest. They show that the profitability of greenfield investment has a significant indirect effect on the choice of a joint venture or a merger since it determines the outside option of the potential acquisition target or joint venture partner.

Despite these contributions to the decision regarding the optimal mode of entry, it is difficult to use a static approach to explain the dynamics of investments, for at least three reasons: 1) there is uncertainty surrounding the investment decision; 2) the decisions are not now-or-never actions, as managers have the ability to wait, collect information and then make a wiser decision (McDonald and Siegel 1986);

and 3) whenever a manager decides on direct entry or entry via M&A, there is a high level of irreversibility, as the investment cannot be somehow undone and the expenditures recovered if market conditions turn out to be worse than anticipated. Therefore, the decision to enter the market via internal investment or via a M&A deal can be regarded as the problem of exercising a real option.

In this dissertation, we extend the standard real options models in which investment strategies are formulated in isolation. It is assumed that agents involved in the investment decisions are perfectly informed and the exercise of one agent's option does not influence the value of other agents' options. Such assumptions are clearly questionable in real-world investment context where it is not reasonable to assume that one is able to formulate an optimal exercise strategy in isolation (Grenadier 2000). In our model, we combine real options and game theory so that the timing and terms of the M&A deal are the outcomes of an option exercise game in which each firm determines an exercise strategy while taking into account the other firm's exercise strategy.

There is a growing literature that studies M&A strategies in a dynamic uncertain context. This stream of real options literature models the M&A decision by acknowledging the potential influence of existing options shared by both firms involved in the deal. These options have an effect on the negotiation terms as they impact the value function of both players. Hackbarth and Morellec (2008) examine the impact of growth options and disinvestment opportunities on the dynamics of M&A. Morellec and Zhdanov (2005) model the timing and the terms of takeovers by solving an option exercise game between the shareholders of the bidder and the target firm. The authors recognize that the participants in the deal are typically presented with an option to exchange one asset (the shares in the initial firm) for another (shares in the new firm or cash). Lukas et al. (2019a) study the option to enter in a given market when different alternative strategies to acquire a prominent incumbent are available to the acquirer. We aim to contribute to the field laid out by this new breed of works as we model the option to invest internally as being an additional factor that impacts the terms of the deal.

Margsiri et al. (2008) is the reference work that ignited our research intents. The authors compare a firm's opportunity to grow internally with the option of expanding via acquisitions. This paper considers internal growth opportunity to act as an outside option in the bargaining game between the firm and the seller. There are two important results from this work: First, when the expenses of integrating the new business entity increase, the acquisition is less profitable which increases the likelihood of internal investment to be the optimal growth strategy. Second, the

positive effect of uncertainty in the value of the internal growth is higher than in the value of the acquisition so that for higher levels of uncertainty internal growth becomes a more attractive strategy.

This dissertation adds to the literature in different ways. First, we acknowledge the existence of a relative efficiency gap between the acquirer and the seller. We assume the acquirer to be more efficient than the seller as it can produce at a lower overall cost. Second, our model extends the line of research of the trade-off between internal investment or M&A by considering that the entrant firm can optimally choose the magnitude of the investment in the case of internal investment strategy being optimally followed.

Deriving the conditions under which managers find optimal to entry in the market via organic investments, our model aims to determine the optimal investment capacity. Dixit (1993) combines investment timing and capacity determination in a single firm case without competition. The paper shows that for higher levels of uncertainty, firms invest later in a larger quantity. Huisman and Kort (2015) generalize this result to a duopoly framework where two firms intend to enter the market. They show that, when the economic environment is more uncertain, both firms invest in larger capacity. Our model aims to complement these results by determining the optimal capacity when a potential entrant intends to share the market in the monopolistic incumbent. Following Huisman and Kort (2015), we consider a homogeneous market where demand is linear and subject to stochastic shocks that admit a geometric Brownian motion process. A duopoly setting is considered since the entrant has the opportunity to enter by investing in a production plant, hence competing in the market with the incumbent firm.

In conclusion, we model the dynamics of choice between internal investment and M&A, in which the timing and terms of both strategies are endogenous and result from value-maximizing decisions. In particular, we aim at contributing to the existing literature by deriving the timing and the terms of the M&A endogenously as the outcome of a threat game, embedding a model of the industry structure into the bidding process. We also extend the existing literature by deriving the optimal capacity in the case of the internal investment being the optimal mode of entry.

Chapter 3

The model

We consider a framework in which the market operates under a monopolistic structure. The active firm – known as the incumbent - in the market is labeled as i. The price at time t in this market is given by:

$$P(t) = X(t)\left(1 - \eta Q_i(t)\right) \tag{3.1}$$

where $Q_i(t)$ is the total market output, $\eta > 0$ is a constant and $X(t)$ is an exogenous shock process.

The inverse demand function as in equation (3.1) is a particular case of Dixit et al. (1994), where the authors assume $P = XD(Q)$ with $D(Q)$ unspecified. Inverse demand being linear in quantity has also been adopted in Pindyck (1988) and Huisman and Kort (2015).

We assume that $X(t)$ follows a Geometric Brownian Motion:

$$dX(t) = \alpha X(t)dt + \sigma X(t)d\omega(t) \tag{3.2}$$

in which α is the instantaneous risk-neutral growth rate (also known as drift rate), σ is the instantaneous standard deviation and $d\omega(t)$ is the increment of a Wiener process. Equation (3.2) reflects the idea that the current value of X is known to the firm, but future values of X are unknown.

We assume that risk neutrality holds with the risk-adjusted required rate of return equal to the risk-free rate denoted by r. We assume $r > \alpha$ as the only credible scenario to be considered. If this inequality does not hold, by postponing the investment, the discounted profit flow would tend towards an infinite value.

Our model setting considers a new firm that intends to enter this market and has identified the existent firm as a potential acquisition target. The entrant firm is labeled as e. To become active in the market, the new entrant must choose

between two mutually exclusive alternatives: (i) it can enter the market through organic investments, i.e., obtaining the set of assets by independently producing or purchasing the assets, or (ii) by assembling the set of required assets through the acquisition of the firm that already operates in the market. In this dissertation, we focus on the particular case where only the new entrant is able to define the optimal strategy and it does not reveal its intention of how to enter the market before implementing its strategy - either directly or by approaching the incumbent in order to start the negotiations.

Our model considers investment decisions within a dynamic uncertain and duopolistic framework. If entry occurs via internal investment, the entrant and the incumbent play a duopoly game. In this case, the investment decision of the entrant comprehends determining both the timing and the capacity level, taking into account the capacity installed by the incumbent. If entry occurs via M&A, the two firms merge and the market remains in a monopolistic structure. Before negotiating the terms of the merger, each of the firms assesses which position they would end up if negotiations break down. This pre-assessment stage is particularly pertinent when the entrant firm can move to direct entry in the case of negotiation failure.

The internal investment opportunity is an outside option that represents the next best alternative if the merger deal proves unsuccessful. For the entrant, it represents the option of entering the market independently. In the case of the incumbent, it stands for the value the incumbent would get in a duopolistic market in which the entrant's intention to join the market comes to fruition. Under our setup, we model this option as being an additional factor that impacts the terms of the negotiations. Both firms play a game in which each company maximizes its position in a cooperative negotiation, which then influences the outcome of the deal in terms of the optimal trigger and the optimal sharing-rule.

Additionally, our model allows for the recognition that each firm has different marginal costs of production and there will be an improvement of the profitability in the case of a merger. The two firms, firm e and firm i, have marginal costs of production c_e and c_i, respectively. We assume the entrant firm is more efficient than the incumbent firm so that $c_e < c_i$. Under this assumption, the incumbent firm is considered to be less efficient than the entrant because of the nature of its assets-in-place. We surmise that the new entrant is the sole owner of a patent for disruptive technological innovation that the incumbent is not able to acquire. If the incumbent firm could acquire the more efficient technology, it could then consider implementing the technology independently and thus having no incentives to accept the merger deal.

In both cases, firms have to incur investment costs. We have defined the investment cost as a function of the capacity installed. Hence, if a unit of capacity costs k, a firm investing in a plant with a capacity of Q incurs investment costs equal to kQ. However, the unitary investment cost k differs in the two alternatives. In the case of the internal investment, the unit of capacity costs k_{GF}, so the entrant firm incurs investment costs equal to $k_{GF}Q_e$. As far as in the M&A deal, the unit of capacity costs k_M. In this case, the investment cost equals to $k_M Q_i$ and it is divided between both firms. We further assume that k_{GF} is greater than k_M ($k_{GF} > k_M$) as the incumbent is modelled as being already endowed with capital stock that will allow the entrant firm to implement the new technology at a lower cost.

Each firm maximizes expected discounted profits. In efficient markets, the expected discounted profit represents the market value of the firm. We also assume that the firm is all-equity financed and that its managers act in the best interest of shareholders who pay for the investment cost in both alternatives. Under these assumptions, no agency conflicts are expected to arise.

In the following sections, we will take a closer look at the new entrant's alternative strategies.

3.1 Internal Investment

Let us start by analyzing the internal investment alternative. Under this setting, an entrant firm can become active in this market by investing in capacity. Since the firm has the opportunity to enter by investing in a key set of assets, it has to determine the optimal time to invest (X^*_{GF}) and the optimal capacity it installs at the time of the investment (Q^*_e). A unit of capacity costs k_{GF}. This implies that a firm investing in this set of assets with capacity Q_e incurs investment costs equal to $k_{GF}Q_e$. We impose that the firm always produces at capacity. If the entry occurs via internal investment, the firm chooses production levels Q_e to maximize profits. Let V_e^D denote the value of the entrant if it enters the market via internal investment.

$$V_e^D(X) = \frac{X\left(1-\eta\left(Q_i+Q_e\right)\right)Q_e - c_e Q_e}{r-\alpha} - k_{GF}Q_e \tag{3.3}$$

where Q_i is the quantity or capacity level installed by the incumbent firm, Q_e is the quantity or capacity level that the entrant firm acquires, c_e is the marginal cost of production of the entrant and k_{GF} is the unitary investment cost.

Then, the investment problem that the firm is facing can be formalized as follows:

$$\max_{Qe} \left[V_e^D (X) \right] \tag{3.4}$$

The optimal investment policy for entry in the market via internal investment can be found in three steps. First, for a given level of the X and a given level of the capacity installed by the incumbent firm, denoted by Q_i, we derive the corresponding optimal value of the capacity level that the entrant acquires as:

$$Q_e (Qi, X) = \frac{X (1 - Q_i \eta) - k_{GF} (r - \alpha) - c_e}{2X\eta} \tag{3.5}$$

Second, the optimal investment threshold (X^*_{GF}) is derived. Let X^*_{GF} be the value of X at which the firm is indifferent between investing and not investing. The corresponding quantity is denoted by Q^*_e. For $X > X^*_{GF}$, we are in the stopping region where it becomes optimal to undertake the investment immediately. For $X < X^*_{GF}$, we are in the continuation region where the firm finds value in deferring the investment decision.

In order to determine the optimal time to invest, we shall now address the valuation of the option to enter the market through internal investment. As in standard in the Real Options literature[1], the value of the option to invest internally $F_e (X)$ must satisfy the following second-order ordinary differential equation (O.D.E):

$$\frac{1}{2}\sigma^2 X^2 \frac{\partial^2 F_e (X)}{\partial X^2} + \alpha X \frac{\partial F_e (X)}{\partial X} - r F_e (X) = 0 \tag{3.6}$$

The solution to the O.D.E takes the general form:

$$F_e (X) = A_1 X^{\beta_1} + A_2 X^{\beta_2} \tag{3.7}$$

where:

$$\beta_1 = \frac{1}{2} - \frac{\alpha}{\sigma^2} + \sqrt{\left(\frac{\alpha}{\sigma^2} - \frac{1}{2} \right)^2 + \frac{2r}{\sigma^2}} > 1 \tag{3.8}$$

$$\beta_2 = \frac{1}{2} - \frac{\alpha}{\sigma^2} - \sqrt{\left(\frac{\alpha}{\sigma^2} - \frac{1}{2} \right)^2 + \frac{2r}{\sigma^2}} < 0 \tag{3.9}$$

Furthermore, the option value for the entrant firm, $F_e (X)$ is subject to the following boundary conditions:

$$\lim_{X \to 0} F_e (X) = 0 \tag{3.10}$$

[1]See Dixit et al. (1994) for details

$$\lim_{X \to X^*_{GF}} F_e(X) = V_e^D(X_{GF}*) \tag{3.11}$$

$$\lim_{X \to X^*_{GF}} \frac{\partial F_e(X)}{\partial X} = \lim_{X \to X^*_{GF}} \frac{\partial V_e^D(X)}{\partial X} \tag{3.12}$$

The first boundary (equation (3.10)) establishes that as X tends to zero, the profit flow of the entrant firm will consequently approach to zero. The second boundary (equation (3.11)), generally called the "value-matching condition", establishes the payoff for the entrant firm when the internal investment project is implemented, so that for the level of X at which is optimal to invest (X^*_{GF}), the value of the option to invest must equal the net present value of the profit flow that the firm receives by undertaking the investment. The third boundary (equation (3.12)), known as the "smooth-pasting condition" or "high-contact condition" ensures that the two value functions $F_e(X)$ and V_e^D meet tangentially when X is equal to X^*_{GF}, i.e., that $F_e(X)$ is continuously differentiable along X.

Applying the first boundary (equation (3.10)) to the general equation for the value of the option (equation (3.7)), we get that $\lim_{X \to 0} A_2 X^{\beta_2} = -\infty$ (note that $\beta_2 < 0$), which violates the first boundary condition. Consequently, to ensure that the first boundary condition is respected, A_2 must be set equal to zero. Therefore, the term $A_2 X^{\beta_2}$ is dropped from the value of the option and we can rewrite the general solution as:

$$F_e(X) = A_1 X^{\beta_1} \tag{3.13}$$

Hereinafter, we designate A_1 as A and β_1 as β as they are the only relevant parameters for our analysis. To determine the optimal timing for the internal investment for a given level of the capacity installed by the incumbent firm, denoted by Q_i, we employ the value-matching and smooth-pasting conditions. Solving this system, we can show the optimal timing for the internal investment X^*_{GF} for a given level of the capacity installed by the incumbent firm, is given by:

$$X^*_{GF}(Q_i) = \frac{(c_e + k_{GF}(r - \alpha))(\beta + 1)}{(\beta - 1)(1 - Q_i \eta)} \tag{3.14}$$

Then, on the third step we derive the optimal capacity of the entrant firm in function of the capacity installed by the incumbent firm, $Q_e(Q_i)$, assuming an optimal investment timing strategy ($X = X^*_{GF}$) as the entrant firm follows equation (3.14):

$$Q_e\left(Q_i\right) = \frac{1 - Q_i\eta}{\left(\beta + 1\right)\eta} \tag{3.15}$$

Both the optimal investing trigger and the corresponding optimal capacity level are a function of the capacity of the incumbent firm in the pre-existing market structure. We assume that the incumbent firm has chosen its optimal capacity following the same procedure as in equation (3.15). This derivation follows the same rationale as in Huisman and Kort (2015), which allows us to retrieve Q_i^* as:

$$Q_i^* = \frac{1}{\left(\beta + 1\right)\eta} \tag{3.16}$$

We can then retrieve the optimal investment threshold (X_{GF}^*) and the optimal capacity level of the entrant (Q_e^*), both assuming an optimal investment timing strategy and an optimal capacity installed by the incumbent. The next proposition summarises the results of these three steps.

Proposition 1. *The optimal investment trigger X_{GF}^* and the corresponding optimal capacity level Q_e^* are given by:*

$$X_{GF}^* = \frac{\left(c_e + k_{GF}\left(r - \alpha\right)\right)\left(\beta + 1\right)^2}{\beta\left(\beta - 1\right)} \tag{3.17}$$

$$Q_e^* = \frac{\beta}{\left(\beta + 1\right)^2\eta} \tag{3.18}$$

Notice that $Q_e^* = \frac{\beta}{\beta + 1}Q_i^*$. As β is greater than 1, we conclude that the optimal capacity level that the entrant acquires is always lower than the optimal capacity of the incumbent ($Q_e^* < Q_i^*$).

Next, we carry out some comparative statics analysis in order to understand the impact of the key variables in both the optimal trigger for the internal investment and the optimal capacity acquired by the entrant firm. Table (3.2) gives us the analytical solutions for the relevant derivatives.

$\frac{\partial X^*_{GF}}{\partial \beta} = -\frac{(c_e + k_{GF}(r-\alpha))(\beta+1)(3\beta-1)}{\beta^2(\beta-1)^2} < 0$
$\frac{\partial X^*_{GF}}{\partial k_{GF}} = \frac{(r-\alpha)(\beta+1)^2}{\beta(\beta-1)} > 0$
$\frac{\partial X^*_{GF}}{\partial c_e} = \frac{(\beta+1)^2}{\beta(\beta-1)} > 0$
$\frac{\partial Q^*_e}{\partial \beta} = -\frac{\beta-1}{(\beta+1)^3\eta} < 0$

Table 3.1: Partial Derivatives on the optimal trigger for internal investment and the corresponding optimal capacity (X^*_{GF}; Q^*_e)

We conclude that the optimal timing for internal investment X^*_{GF} is negatively related to β. A well-known result of real options is that β is negatively related with σ - which captures uncertainty -, so we conclude that the optimal timing for internal investment is positively related with uncertainty. Increased uncertainty raises the threshold and thus delays the investment decision. Additionally, the optimal timing is positively impacted by the investment cost. A higher investment cost in the case of internal investment (k_{GF}) implies that the firm will invest later in the same capacity. Finally, we analyze the effect of the marginal cost of production of the entrant (c_e). The optimal timing is positively related to the marginal cost of production of the entrant, hence as the entrant is more efficient (lower c_e), the firm will invest sooner.

As for the entrant's quantity, we can also find a positive relationship with uncertainty. This result confirms Dixit (1993) and Huisman and Kort (2015) who conclude that higher levels of volatility lead to the adoption of larger projects.

Following the standard procedures and using standard calculus, the solution for the value of the option to enter the market via internal investment, denoted by F_e, incorporating the optimal value for $Q^*_e = \frac{\beta}{(\beta+1)^2\eta}$ and $Q^*_i = \frac{1}{(\beta+1)\eta}$ is:

$$F_e(X) = \begin{cases} \dfrac{(c_e + k_{GF}(r-\alpha))\beta}{(r-\alpha)(\beta-1)(\beta+1)^2\eta}\left(\dfrac{X}{X^*_{GF}}\right)^\beta & if X < X^*_{GF} \\ \dfrac{(c_e + k_{GF}(r-\alpha))\beta}{(r-\alpha)(\beta-1)(\beta+1)^2\eta} & if X \geq X^*_{GF} \end{cases} \tag{3.19}$$

When $X < X^*_{GF}$, the entrant has the option to enter the market but has not yet exercised it. When $X \geq X^*_{GF}$, the entrant gets the net present value of the profit flow as in this branch, the firm has already decided to undertake the investment.

Let us now move to the value function of the incumbent firm. As the incumbent firm is already in the market, the incumbent's value function, denoted by F_i, has

two parts: (i) corresponding to the period while it remains alone the market (the monopolistic period) and (ii) after the entrance of the new firm. Accordingly,

$$F_i(X) = \begin{cases} \dfrac{X\beta - c_i(\beta+1)}{(r-\alpha)(\beta+1)^2\eta} - \dfrac{c_e + k_{GF}(r-\alpha)}{(r-\alpha)(\beta^2-1)\eta}\left(\dfrac{X}{X^*_{GF}}\right)^{\beta} & if X < X^*_{GF} \\ \dfrac{X\beta^2 - c_i(\beta+1)^2}{(r-\alpha)(\beta+1)^3\eta} & if X \geq X^*_{GF} \end{cases} \tag{3.20}$$

When $X < X^*_{GF}$, the incumbent firm has its monopoly value and the short position in the option of the entrant to enter the market through organic investments. This second term of the equation captures the always-on threat of the direct entry captured by the uncertain loss of value between the monopolistic and the duopolistic market structure. When $X \geq X^*_{GF}$, the incumbent shares the market with the newly entrant firm and thus getting the corresponding duopoly value.

3.2 Merger

Let us now consider the scenario in which the acquisition alternative is the selected strategy for the market entrance. Under this hypothesis, an alternative to direct entry means the potential entrant choosing to merge with the incumbent firm.

We consider the acquisition to be a cooperative game, i.e., the entrant opts for a friendly merger negotiation. Many arguments may justify this strategy. First, the entrant prefers to gain fast entry into the new market. Undertaking the non-cooperative takeover would lead to timing inefficiencies and unnecessarily delays in the acquisition of the target. Second, the source of inefficiency that may justify the merger may be related to the assets-in-place deployment and not any form of management-specific issues. Under this assumption, it would be reasonable to assume that the incumbent's board and management would be receptive to the negotiations as there is no threat of being replaced.

To derive the solutions under this alternative, we follow Alvarez and Stenbacka (2006) and Thijssen (2008a) and we assume that a friendly merger is modelled as a cooperative game between two firms which jointly decide on the timing of the merger and the sharing rule of the surplus. We assume that after the merger, each firm holds an equity stake in the new firm, γ for the entrant firm and $1-\gamma$ for the incumbent firm. In that case, they use the Nash bargaining solution to determine how the merger surplus is divided.

In our model, we follow Thijssen (2008b) and assume that transaction costs are

zero. Under this assumption, the optimal investment trigger for the merger will always occur sooner than the optimal investment trigger for internal investment. Hence, for computing the payoff of the merger for the entrant and the incumbent, we are in the first branch of the equations (3.19) and (3.20), respectively.

Once the merger is completed, a newly created monopoly, now dominated by a post-merger firm, will represent the structure of the market. The value function representing the new post-merger firm under this new market setting is shown below:

$$V_{ie}^{M} = \frac{X\beta - c_e\left(\beta + 1\right)}{\left(r - \alpha\right)\left(\beta + 1\right)^2 \eta} - k_M \frac{1}{\left(\beta + 1\right)\eta} \tag{3.21}$$

Note that the entrant firm will endow the post-merger firm with new technology that will improve the profitability so that its marginal cost of production will equal the cost of the entrant firm when entering directly in the market (c_e). For this technology to be implemented, the post-merger firm will have to incur in investments costs of $k_M \frac{1}{(\beta+1)\eta}$.

3.2.1 Incumbent's perspective

There are three effects on the value retrieved by the incumbent firm from this market change. By dividing the market with the entrant company through the newly created firm, the incumbent will hold a portion of its market value given by $1 - \gamma$. This dynamic accounts for the positive effect of the M&A deal on the incumbent's overall value. However, this move carries two negative side-effects. For the deal to go forward, the incumbent will have to give ups its full monopoly stand-alone value in a situation without any potential entrant in sight, as this pre-existing market structure no longer holds. We denote the incumbent's full monopoly stand-alone value as V_i^M and it can be expressed as:

$$V_{i}^{M} = \frac{X\beta - c_i\left(\beta + 1\right)}{\left(r - \alpha\right)\left(\beta + 1\right)^2 \eta} \tag{3.22}$$

Simultaneously, an additional scenario is now considered unfeasible. The incumbent also loses the value of being a firm operating in a monopolistic market with a threat of entry offered by a potential raider. This is considered to be the incumbent's outside option if the deal falls through. This incumbent's outside option is represented by F_i as in the first branch of equation (3.20).

Both lost scenarios add up to form the opportunity cost for the incumbent firm to merge with the entrant. Hence, the incumbent's net gain (π_i) becomes:

$$\pi_i = (1-\gamma)\, V_{ie}^M - V_i^M - F_i \tag{3.23}$$

Equation (3.23) represents the net gain of firm i if it accepts the merger deal. The first two terms of the equation represent the payoff of the M&A and it translates the idea that in the case of a merger firm i receives a stake in the new firm but it gives up its full monopoly stand-alone value. The third term F_i reflects the negative impact of losing its outside option.

3.2.2 Entrant's perspective

If the entrant firm and the incumbent do not reach an agreement, the entrant firm has the opportunity to assemble the assets required to enter the market through individual investments. This opportunity is itself an option, assuming the entrant has the flexibility to decide if and when to invest. Thus, the value of the option to invest internally and enter directly in the market represents the entrant's outside option at the time of negotiations. Once the merger is set, this option becomes worthless, thus it is considered as having a negative effect on the entrant's total value after the market change. However, in the case of the merger, the entrant firm will be entitled to a stake of γ in the new market. Thus, the entrant's net gain (π_e) becomes:

$$\pi_e = \gamma V_{ie}^M - F_e \tag{3.24}$$

Equation (3.24) represents the net gain of firm e in the case of the merger. The first term of the equation (γV_{ie}^M) represents the payoff of the M&A deal and it reflects the stake of γ owned by firm e in the merged firm. The second term of the equation (F_e) captures the negative effect associated with the loss of the option to enter the market via organic investment as the internal investment and the merger are mutually exclusive projects.

3.2.3 Optimal timing to acquire and optimal sharing-rule

Let us consider a friendly merger between firm e and firm i. In particular, let us assume that after the merger, firm e holds an equity stake of γ and firm i holds an equity stake of $1-\gamma$ in the new firm. Each firm's net gain in the case of a merger is explained in the previous subsections. Then, the optimal share each firm has in the new venture solves the following optimization problem:

$$\max_{\gamma} \left[\left((1-\gamma) V_{ie}^{M} - V_{i}^{M} - F_i \right) \left(\gamma V_{ie}^{M} - F_e \right) \right] \tag{3.25}$$

Since we are focusing on a cooperative game, the optimal investment trigger for the merger deal (X_M^*) equals the central planner's optimal investment threshold. The central planner's trigger reflects both firm's aggregate positions and comes from the solution of the standard smooth-pasting condition at $X = X_M^*$. Consequently, solving the cooperative game by means of the Nash-bargaining solution leads to the following proposition:

Proposition 2. *Both firms will agree to merge if X hits the optimal timing threshold X_M^*:*

$$X_M^* = \frac{(c_e + k_M (r - \alpha))(\beta + 1)}{\beta - 1} \tag{3.26}$$

Now, we analyze how the optimal timing of the entrant firm relates to its explanatory variables.

$\frac{\partial X_M^*}{\partial \beta} = -\frac{2(c_e + k_M (r-\alpha))}{(\beta-1)^2} < 0$	
$\frac{\partial X_M^*}{\partial k_M} = \frac{(r-\alpha)(\beta+1)}{\beta-1} > 0$	
$\frac{\partial X_M^*}{\partial c_e} = \frac{\beta+1}{\beta-1} > 0$	

Table 3.2: Partial Derivatives on the optimal trigger (X_M^*)

The optimal timing of the merger is negatively (positively) related to β (uncertainty), in line with the literature that uncertainty leads to postponing the deal. The positive derivative of the optimal trigger in order to the level of investment (k_{GF}) and the marginal cost of production of the entrant firm (c_e) is in line with the economic intuition as higher levels of investment leads to a higher investment trigger and the improvement in efficiency, captured by the imposed lower cost of the entrant *versus* the cost of the incumbent, leads to a lower threshold that determines the likelihood of the deal to happen.

Substituting X_M^* for X in the general solution of γ leads to the following proposition:

Proposition 3. *Firm's e optimal stake γ^* in the merger amounts to:*

$$\gamma^* = \frac{\beta \left(\frac{(c_e + k_M (r-\alpha))\beta}{(c_e + k_{GF}(r-\alpha))(\beta+1)} \right)^{\beta-1} (2\beta+1)}{2(\beta+1)^2} + \frac{2c_i(\beta-1) - c_e(2\beta-1) - k_M(r-\alpha)(2\beta-1)}{2(c_e + k_M(r-\alpha))} \tag{3.27}$$

Chapter 4

The choice of the optimal strategy

In this chapter, we use a numerical comparative statics to study which factors govern the decision of the optimal mode of entry. In particular, we aim to understand how uncertainty (measured by the parameter σ), the unitary investment cost associated to entry strategy through M&A (k_M) and the marginal cost of production of the entrant firm (c_e) may play a role in defining the optimal strategy. Therefore, this analysis has two main goals: (i) understand how the variables impact the value of internal investment opportunity and the merger deal; (ii) analyze how different levels of these variables may drive the choice of how to enter a given market.

As explained in the previous chapter, we assume that the merger deal has no transaction costs. Consequently, the optimal timing to the merger will always occur sooner than the optimal timing to enter the market through organic investments. In our model setting, in the optimal timing to merge (when $X = X_M^*$) the entrant firm has to decide between two alternatives: (i) go further with the negotiations with the incumbent in order to create a newly merged firm, receiving γ^* of the new firm; and (ii) keep the option to enter the market via internal investments alive, i.e., not approach the incumbent in order to start the negotiations and wait until the optimal internal investment trigger is reached. At the same time, the incumbent firm has to decide between: (i) accepting the merger deal, giving up its stand-alone value and receiving a stake of $(1 - \gamma^*)$ in the merged firm; and (ii) rejecting the merger deal, thus preferring to share the market with the new entrant.

We assume that internal investment and the merger are mutually exclusive strategies, so we do not consider the scenario under which the entrant firm starts to invest internally and later merge with the incumbent, and vice versa. For defining the strategy to follow, the entrant firm should compare the value of the option to invest internally ($F_e(X_M^*)$) and the payoff of the merger in the optimal timing to merge, choosing the alternative with the highest value. If $F_e(X_M^*)$ is the most valuable, the

firm should keep the option to invest internally alive, if not, the firm should propose the merger deal.

Simultaneously, the incumbent's firm should compare the value of $F_i(X_M^*)$ and the payoff of the merger in the optimal timing to merge, choosing the alternative with the highest value. If $F_i(X_M^*)$ is the most valuable, the firm should not accept to merge with the entrant firm, if not, the firm should accept the merger deal.

To do so, let us showcase the model dynamics with a numerical example. Consider the basic parameters as shown in Table 4.1.

Parameter	**Value**	**Description**
k_M	30	Unitary investment cost in the case of merger
k_{GF}	100	Unitary investment cost in the case of internal investment
ce	1	Marginal cost of production for the entrant firm
ci	3	Marginal cost of production for the incumbent firm
σ	0.2	Volatility
η	0.1	Constant
r	0.05	Risk-free rate
α	0.02	Risk neutral growth rate

Table 4.1: The base case parameters

Note that each entry strategy is associated with a specific unitary investment cost. We acknowledge that it is more expensive to enter the market via internal investment rather than enter via a merger. Hence, the unitary cost of investment in the internal investment strategy is always higher than the unitary cost of investment in the merging strategy ($k_{GF} > k_M$).

We also take into account that the entrant firm is more efficient than the incumbent firm. In our model, the entrant firm is the owner of a technological innovation that either allows the entrant firm to enter the market with a lower cost or an improvement in profitability if the entrant and the incumbent merge, i.e., the newly merged firm will produce at a cost of c_e. Under this assumption, the marginal cost of production of the entrant will always be lower than the marginal cost of production of the incumbent ($c_e < c_i$).

4.1 The effect of uncertainty

We first aim to discuss the impact of volatility in the optimal entry strategy. With this analysis, our goal is to distill the effect of uncertainty on the optimal decision. Namely, our objective is to numerically show how the parameter σ - measuring the uncertainty of the profit flow - impacts the value of the two alternatives: invest via

M&A or in an organic fashion. To further investigate how uncertainty affects the choice of the mode of entry, Figure 4.1 and Figure 4.2 shows the value of the two different strategies as a function of uncertainty for the entrant and the incumbent, respectively.

Let us start by analyzing the entrant's perspective. From Figure 4.1, we find that the lower the level of volatility, the higher the likelihood that the value of the merger will be higher than the value of direct entry, *ceteris paribus*. Under this scenario, lower uncertainty regarding the profit flow of the investment project increases the probability that the entrant will find optimal to enter the market via merger. Conversely, for higher levels of volatility, the value of direct entry will tend to be higher than the value for the acquisition, *ceteris paribus*. In this case, higher levels of uncertainty act as a tailwind effect on the likelihood that an internal investment will be the optimal strategy for the entrant. In a nutshell, higher levels of uncertainty have a positive impact on the value of the internal investment project and a negative impact on the merger deal. Hence, the more uncertain an investment project is, the more likely it will be that the entrant will favor an independent type of strategy.

In the case of the incumbent, higher levels of uncertainty increase the value of the merger deal. Nevertheless, the positive effect on the value of internal investment is more pronounced, i.e., higher uncertainty tends to impact the incumbent's value position so that it prefers not to accept the deal and wait for the entrant to decide when it will be optimal to invest and create a duopolistic market, *ceteris paribus*. This differential is captured by the steeper slope of the value of the internal investment curve in relation to different levels of volatility. This dynamic is shown in Figure 4.2.

The intersection of the value functions in each graph represents the level of volatility in which both the entrant and the incumbent are indifferent between both strategies. For our base case parameters, the indifference point is reached at $\sigma = 0.14$. That means that for levels of volatility lower than 0.14, the firms optimally choose to merge. For levels of volatility higher than 0.14, the internal investment is more valuable than the merger solution.

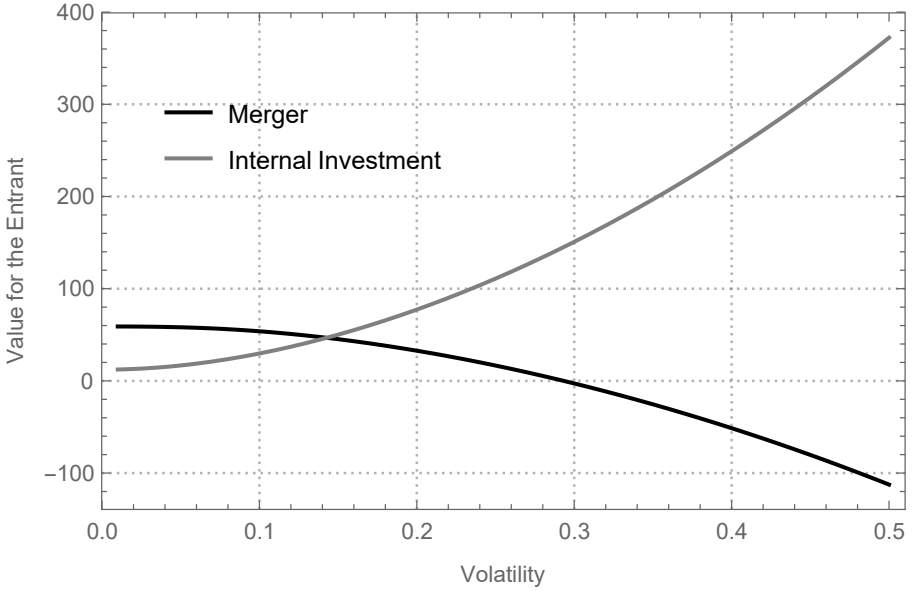

Figure 4.1: The effect of volatility (σ) on entrant's optimal decision. The black line represents the value range of the payoff of the merger deal for the entrant. The grey line represents the value range of the option to invest internally. The computation is based on the parameters shown in Table 4.1.

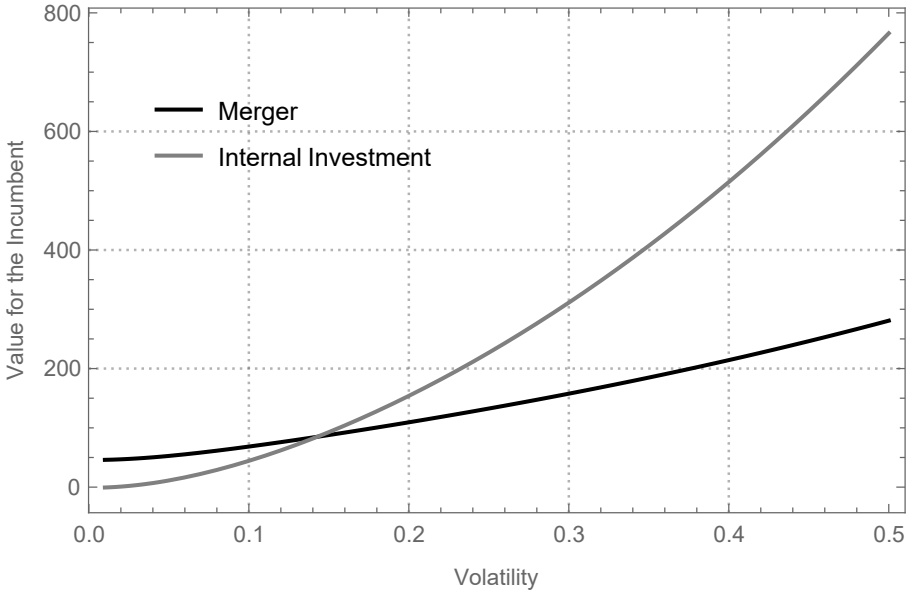

Figure 4.2: The effect of volatility (σ) on incumbent's optimal decision. The black line represents the value range of the payoff of the merger deal for the incumbent. The grey line represents the value range of the value function of the incumbent in the case of internal investment being optimally chosen by the entrant. The computation is based on the parameters shown in Table 4.1.

Our finding that higher levels of uncertainty have a negative impact on the value of the merger deal for the entrant firm goes against standard real options literature. To better understand this result, we decouple the effect of uncertainty on the stake owned in the newly merged firm (γ) and on the value of the newly merged firm (V_{ie}^{M}). Even though uncertainty has a positive effect on the value of the newly merged firm, a negative effect on the entrant's share in this new firm offsets the value-boosting effect. As uncertainty goes higher, the entrant captures a lower stake up to the point it has to pay to the incumbent to accept the merger deal.

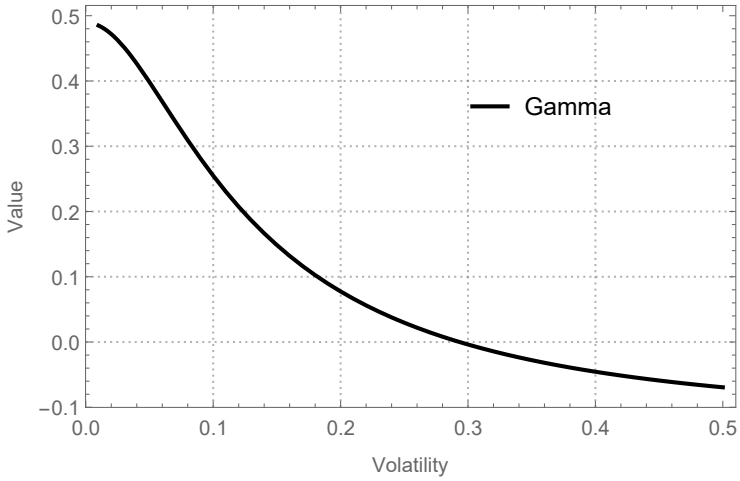

Figure 4.3: The effect of volatility (σ) on the stake owned by the entrant firm in the newly merged firm (γ). The computation is based on the parameters shown in Table 4.1.

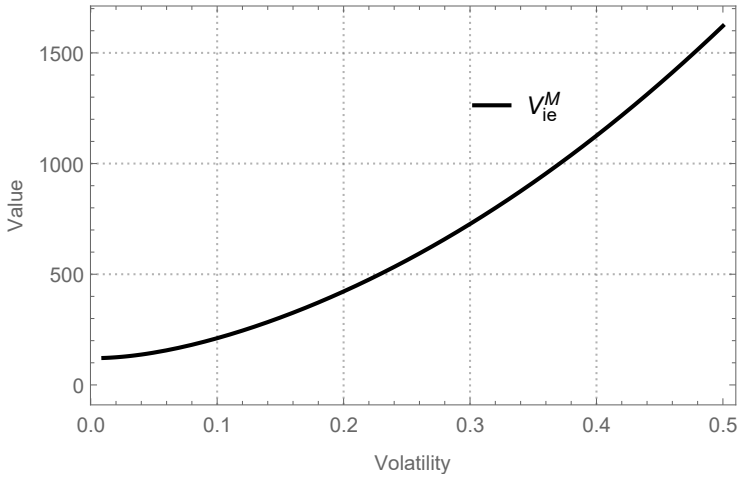

Figure 4.4: The effect of volatility (σ) on the value of the newly merged firm (V_{ie}^{M}). The computation is based on the parameters shown in Table 4.1.

Based on these dynamics, we can infer that both firms will likely favor the direct entry strategy over the merger when operating in highly volatile industries, *ceteris paribus*. Hence, this numerical example leads us to state that,

Corollary 1. *There is a negative relationship between uncertainty and the likelihood of a merger solution being optimal, so that firms tend to optimally choose merger (internal investment) in the presence of low (high) volatility, ceteris paribus.*

This theoretical conclusion may have insightful readings. In the advent of higher levels of uncertainty, organic investments become more frequent than mergers. Traditional real options arguments show that higher volatility implies a lower incentive for options on the buy-side to be exercised, as the value of waiting increases. Additionally, Lukas et al. (2019b) shows that uncertainty has un unequivocal effect of deterring mergers and acquisitions. Our model suggests a complementary result. When volatility spikes, if, and only if, it becomes optimal to enter in a given market, it is more likely that this happens via internal investment.

Another insight generated by our theoretical finding is that it is expected that in highly volatile industries, a technological innovation shock brought by a potential entrant favors the rise of competing markets since entry through internal investment is more valuable for both the entrant and the incumbent. Conversely, in industries with lower levels of risk, it is expected that a technological innovation shock will spur M&A activity.

An interesting avenue for future research would be to empirically confirm these theoretical conclusions.

4.2 The effect of unitary investment in the case of merger k_M

In this subsection, we will analyze how the decision between the internal investment and the merger is impacted by the level of unitary cost of investment in the case of the merger (k_M). In particular, we will analyze the effect of different levels of unitary investment in the case of a merger on the value of our two alternative modes of entering for both the entrant and the incumbent firms. For analytical purposes, we use the ratio between the unitary investment in the case of merger and the unitary investment cost in the case of the internal investment $\left(\frac{k_M}{k_{GF}}\right)$ so that we analyze the relative investment cost of the merger.

Figure 4.5 depicts how the value of the two entry strategies for the entrant firm. The unitary investment cost in the case of a merger has a positive effect on the value

of the option to enter directly in the market. Conversely, the unitary investment in the case of a merger has a negative effect on the payoff of this strategy.

In the incumbent's perspective, the payoff of the merger is only slightly affected by the unitary investment cost in the case of merger. The internal investment is positively impacted by the level of unitary investment cost in the case of merger. This dynamic is shown in Figure 4.6.

The intersection of the value functions in each figure represents the level of relative investment cost of the merger in which both the entrant and the incumbent are indifferent between both strategies. For our base case parameters, the indifference point is reached at $\frac{k_M}{k_{GF}} = 0.23$. Hence, we can infer that the merger deal is optimally chosen when the unitary investment in the case of merger is less than 23% of the unitary investment in the case of the internal investment.

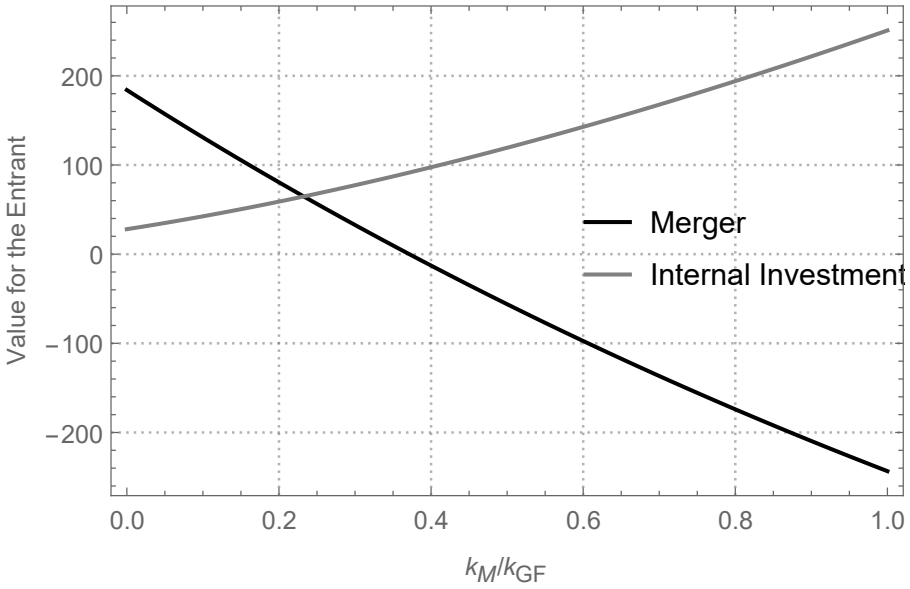

Figure 4.5: The effect of the unitary investment in the case of merger (k_M) on entrant's optimal decision. The black line represents the value range of the payoff of the merger deal for the entrant. The grey line represents the value range of the option to invest internally. The computation is based on the parameters shown in Table 4.1.

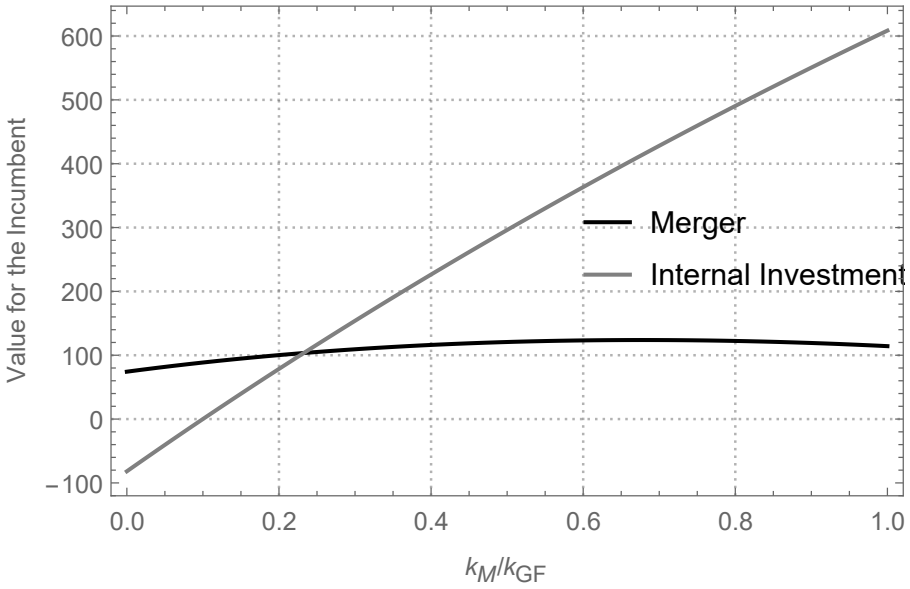

Figure 4.6: The effect of the unitary investment in the case of merger (k_M) on incumbent's optimal decision. The black line represents the value range of the payoff of the merger deal for the incumbent. The grey line represents the value range of the value function of the incumbent in the case of internal investment being optimally chosen by the entrant.The computation is based on the parameters shown in Table 4.1.

Following these conclusions, we can infer that for a sufficiently large unitary investment required in case of the merger, both the entrant and the incumbent will prefer to enter via organic investments rather than through an M&A deal. For that case, the following corollary holds:

Corollary 2. *There is a negative relationship between the level of the unitary investment in case of merger and the likelihood of a merger solution being optimal, so that firms tend to optimally chose to merge (internal investment) in the presence of low (high) unitary investment cost in case of merger, ceteris paribus.*

This corollary of the model captures the intuitive negative effect of high investment cost in the case of merger on the likelihood of M&A deals when compared with internal investments. As the gap between the investment cost of each strategy increases, i.e., the merger investment costs become increasingly cheaper when compared to the internal investment, the entrant and the incumbent will be more willing to engage in an M&A deal. Hence, we conclude that in industries where the level of investment required for an entrant firm to join the market is significantly lower than the investment needed if the entry would happen via merger, the entrant is more keen to avoid a merger deal and invest independently. Hence, our model

theoretically models the idea that industries with higher levels of barriers to entry - captured by a higher level of investment required for an entrant firm to join the market as a new competitor - refracts new competition and favors consolidation via M&A.

4.3 The effect of marginal cost of production of the entrant

In this section, we look at how the efficiency of the entrant firm plays a role in the decision of how a company enters a market. Figure 4.7 and Figure 4.8 show the impact of different levels of marginal cost of production of the entrant firm on the interaction between the internal investment's and merger's value function for the entrant and the incumbent, respectively. For analytical purposes, we use the ratio between the marginal cost of production of the entrant and the marginal cost of production of the incumbent $\left(\frac{c_e}{c_{ci}}\right)$ so that we analyze the relative efficiency of both firms.

Figure 4.7 depicts how the level of marginal cost of production of the entrant affects the value of the option to invest internally and the payoff of the merger from the perspective of the entrant. While the value of the option to enter via internal investment is positively impacted by the cost of the entrant, the payoff of the merger is negatively impacted by this parameter.

In the case of the incumbent, higher levels of the marginal cost of production of the entrant positively impact both the value of the merger deal and the value of internal investment. Nevertheless, from the figure we can retrieve a greater effect on internal investment. This dynamic is shown in Figure 4.8.

The intersection of the two value functions in each figure represents the level of marginal cost of production of the entrant in which both the entrant and the incumbent are indifferent between both strategies. For our base case parameters, the indifference point is reached at $\frac{c_e}{c_i} = 0.267$. For the merger deal to be optimal, the improvement in efficiency brought by the entrant has to be sufficiently larger so that the marginal cost of production of the entrant represents less than 26.7% of the marginal cost of production of the incumbent.

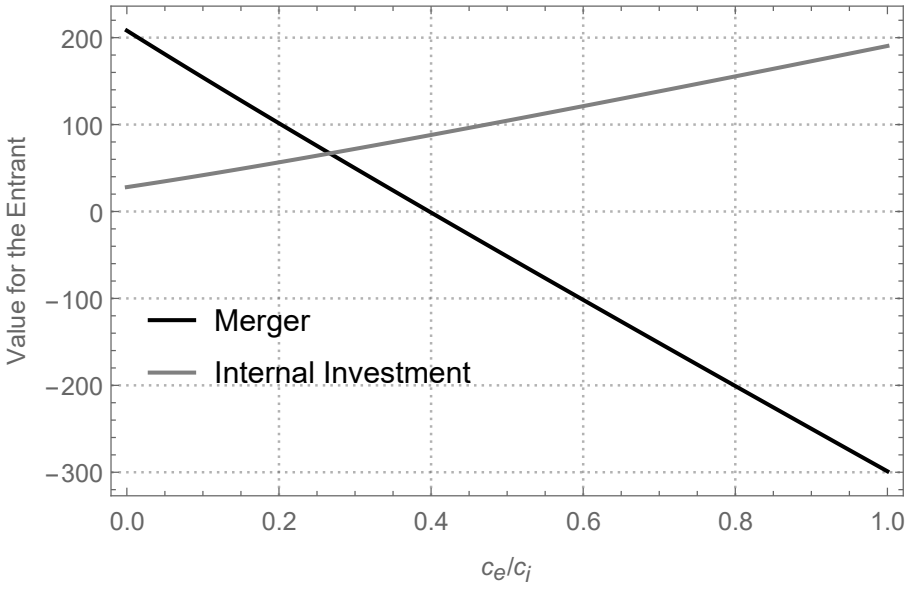

Figure 4.7: The effect of the cost of the entrant firm (c_e) on entrant's optimal decision. The black line represents the value range of the payoff of the merger deal for the entrant. The grey line represents the value range of the option to invest internally. The computation is based on the parameters shown in Table 4.1.

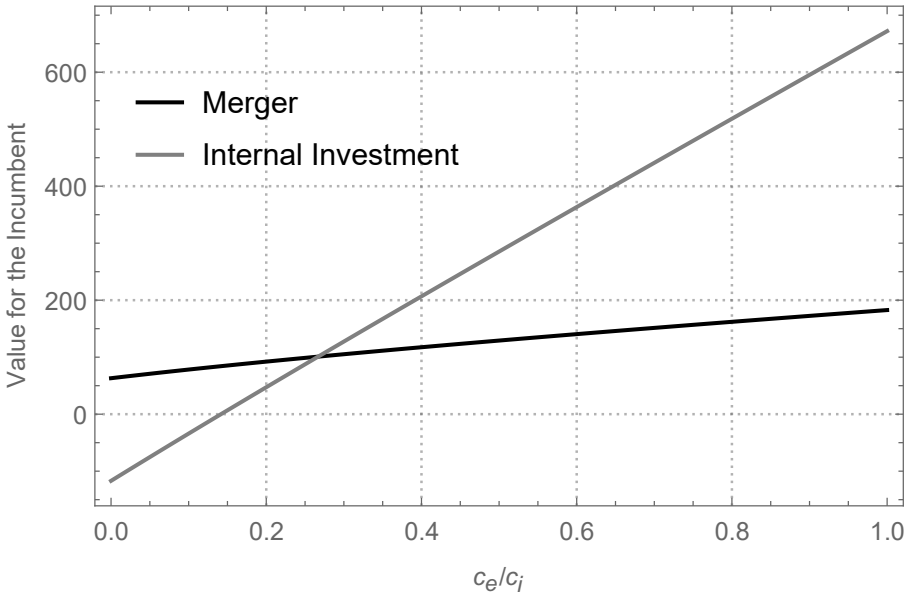

Figure 4.8: The effect of the cost of the entrant firm (c_e) on incumbent's optimal decision. The black line represents the value range of the payoff of the merger deal for the incumbent. The grey line represents the value range of the value function of the incumbent in the case of internal investment being optimally chosen by the entrant. The computation is based on the parameters shown in Table 4.1.

Following this, we can infer that a sufficiently lower cost of the entrant makes merger more attractive relative to internal investment. Hence, this numerical example leads us to state that

Corollary 3. *There is a negative relationship between the level of the marginal cost of production of the entrant and the likelihood of a merger solution being optimal, so that firms tend to optimally choose merger (internal investment) in the presence of low (high) cost of entrant, ceteris paribus.*

From this feature of the model, one intuitive insight may be derived. The relative efficiency of the acquirer and the seller in a M&A deal may be a key factor influencing the likelihood of internal investments to happen. From our model, we can conclude that firms are only willing to merge when the advantage in terms of cost brought by the entrant firm is significant. We assume the source of the improvement in profitability is the patent for a disruptive technological innovation that the entrant firm owns. Hence, we can infer that when a technological innovation provides a high advantage in terms of cost, M&A strategies are more valuable for both the acquirer and the seller. Conversely, a slight improvement in profitability increases the likelihood of the market structure changing to duopoly as the entrant optimally choose to invest organically.

Chapter 5

Conclusion

This dissertation studies the entrance in a market considering two alternative strategies available to the entrant firm. One is the internal investment, consisting of assembling the set of assets required to enter a given market through individual investments; the other strategy is to merge with the monopolistic incumbent. We employ a dynamic real options model to provide an analysis of which factors govern the optimal strategy choice.

We first derive analytical solutions for internal investment and the M&A deal. We find that the optimal internal investment trigger is a function of uncertainty, the investment cost and the marginal cost of production of the entrant. In particular, we add value to the existing literature by deriving the optimal capacity if a firm optimally chooses to enter the market by investing in capacity. In line with the literature, we find that as uncertainty goes higher, firms invest later in larger capacity. In the case of the M&A deal, we use a cooperative game-theoretic approach to determine the terms of the merger.

The combination of real options and game theory proposed in this dissertation offers a number of interesting insights. Our model explains why entry might occur by internal investment in some cases and through merger in others. We show that depending on the characteristics of the industry, the investment cost and the relative efficiency of the potential entrant, there is a preferred path of entry into an industry. Our findings reveal that firms may be more prone to choose internal investment over a merger when operating in highly volatile industries. Regarding the investment cost, we find that as the merger investment cost becomes increasingly cheaper when compared to the internal investment cost, the more attractive M&A deals will be when deciding the optimal strategy. When we account for the relative efficiency, we show that mergers require a sufficiently large improvement in profitability to become preferable over internal investment.

The model and ulterior findings should be the subject of further scientific scrutiny. A thorough analysis of the effects of different critical variables on the optimal mode of entry is an interesting avenue for future research, theoretically and empirically.

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