Designing Optimal M&A Strategies under Uncertainty*

Elmar Lukas†, *Paulo J. Pereira*‡ *and Artur Rodrigues*§

†*Faculty of Economics and Management, Chair in Financial Management and Innovation Finance, University Magdeburg, Germany*

‡*CEF.UP and Faculdade de Economia, Universidade do Porto, Portugal*

§*NIPE and School of Economics and Management, University of Minho, Portugal.*

Abstract

The recent surge in M&A activities highlights firms' motivation to gain or maintain market leadership. Along with the unparalleled volume of M&As, more and more firms favor establishing acquisition programs that lead to multiple subsequent M&As over time. In this paper, we study the entrance in a market by means of M&A when different strategies to acquire a prominent incumbent are available to the acquirer. In particular, the firm might opt for a *big leap*, where it acquires the prominent incumbent; the alternative is to design an *acquisition program* that allows moving in small steps by acquiring a minor company first and the larger prominent player later on. We employ a dynamic game-theoretic real options model to investigate the effect of uncertainty and synergies on the strategy choices and also consider alternative contract designs for the acquisition program, such as hostile, friendly or mixed. Our findings reveal that firms prefer acquisition programs to big leap strategies when the industry exhibits high levels of uncertainty and can occur even when the acquisition of the first target destroys value. Moreover, some acquisition programs profit from a *first-mover pass-through* where the acquirer can jointly utilize his first-mover advantage when negotiating with multiple targets. Finally, novel testable hypotheses are derived from the model.

Keywords: M&A; Real Options; Sequential Investment; Cooperative and Non-cooperative Bargaining

JEL codes: C73; D43; D81; D92; G31.

*This work was carried out within the funding with COMPETE reference n. POCI-01-0145-FEDER-006683 (Artur Rodrigues) and POCI-01-0145-FEDER-006890 (Paulo J. Pereira), FCT/MEC's (Fundação para a Ciência e a Tecnologia, I.P.), and ERDF through the Operational Programme on Competitiveness and Internationalization - COMPETE 2020 under the PT2020 Partnership Agreement. We thank the Editor and the three anonymous referees for their valuable comments and suggestions. We also thank Lenos Trigeorgis, Dean Paxson, Han Smit, Kuno Huisman, Shahriar Khaksari, Nick Huberts, Arkadiy Sakhartov, and participants of the 2017 Annual Real Options Conference in Boston for their helpful comments. Any remaining errors are the sole responsibility of the authors.

Designing Optimal M&A Strategies under Uncertainty

Abstract

The recent surge in M&A activities highlights firms' motivation to gain or maintain market leadership. Along with the unparalleled volume of M&As, more and more firms favor establishing acquisition programs that lead to multiple subsequent M&As over time. In this paper, we study the entrance in a market by means of M&A when different strategies to acquire a prominent incumbent are available to the acquirer. In particular, the firm might opt for a *big leap*, where it acquires the prominent incumbent; the alternative is to design an *acquisition program* that allows moving in small steps by acquiring a minor company first and the larger prominent player later on. We employ a dynamic game-theoretic real options model to investigate the effect of uncertainty and synergies on the strategy choices and also consider alternative contract designs for the acquisition program, such as hostile, friendly or mixed. Our findings reveal that firms prefer acquisition programs to big leap strategies when the industry exhibits high levels of uncertainty and can occur even when the acquisition of the first target destroys value. Moreover, some acquisition programs profit from a *first-mover pass-through* where the acquirer can jointly utilize his first-mover advantage when negotiating with multiple targets. Finally, novel testable hypotheses are derived from the model.

1 Introduction

Mergers and acquisitions (M&A) are a key part of a firm's corporate growth strategy as they allow firms to achieve economies of scale, access to new markets, or respond to economic shocks. Undoubtedly, M&As are among the largest investments that a firm will ever undertake and thus few economic phenomenas gain as much research attention as the diverse forms of corporate takeovers, as stated by Betton et al. (2008). For example, the chip manufacturer Broadcom Ltd recently announced a $103 billion bid for the US-based Qualcomm Inc, which is higher than the gross domestic product (GDP) of European countries such as Luxembourg, Slovak Republic, and Bulgaria.

While much is understood regarding the strategic motivation and economic reasoning of past merger waves (e.g. Schwert 2000), recent M&A patterns, however, have brought a distinctive new feature that lack coherent theoretic reasoning: serial acquisitions. Over recent years, Western and emerging market firms alike have established extensive serial acquisition programs (e.g. Ismail 2008). For example, some of the most active multiple acquirers like Cisco, GE, Microsoft, among others, are engaged in acquisition programs where each acquired more than 50 companies (see Laamanen and Keil 2008, Smit and Moraitis 2015). By now, the literature on serial acquisitions and acquisition programs alike has acknowledged that multiple acquisitions create a strategic momentum due to, e.g., learning, synergies, or risk mitigation, which has motivated an extensive number of empirical research papers in the domain of finance and strategic management (see e.g., Amburgey and Miner 1992, Frick and Torres 2002, Rovit and Lemire 2003, Smit and Moraitis 2015). However, to date less attention has been given to the question why some firms prefer to follow the incremental acquisition steps over single acquisitions. Similarly, the finance literature dealing with the question whether serial acquisitions create substantial value show also mixed results. For example, while Rovit and Lemire (2003) find evidence that serial acquisitions create value, Fuller et al. (2002) and Billett and Qian (2008) find the opposite.

Apart from specifically analyzing strategic acquisition programs, this paper also relates to a broader theoretical literature on M&A dynamics, where merger timing plays an important role. Historically, the finance literature has dealt only rarely with applying game theory to determine optimal terms of mergers. As one of the first attempts to model the negotiation process in takeovers by means of game theory Powers (1987) used a special version of voting games between N-player to analyze the negotiation between several share- and stakeholders. The paper of Roy (1989) is probably the earliest attempt that considered a two-player setting, i.e. a bidder bargaining with one target. Here, the takeover process was modeled as a non-cooperative bargaining game under uncertainty where a buyer proposes a bid and the seller can decide whether to accept the offer or not. The model determines the bidder's optimal offer strategy given that the bidder does not possess information about the true value of the target's reservation price. On the contrary, van den Honert and Stewart (1992) were among the first that use cooperative game-theory to model a friendly merger. The analytical models that emerged since then have followed such a convention, i.e. build on a non-cooperative take-it-or-leave-it approach for modeling hostile takeovers and use a cooperative game-theoretic model for modeling friendly mergers (see e.g. Hirshleifer (1995);Goldman and Qian (2005); Mason and Weeds (2010)).

Nonetheless, these models are mostly static, i.e. the other party cannot decide on the timing, and it is due to the ongoing trend of empirical research in the domain of M&A that dynamic theoretical models have become scarce. A few years ago, literature in the domain of investment under uncertainty has started to close this gap. In particular, this stream of real options literature acknowledges the shared real options available to both parties when negotiating the terms of the agreement in such contracting situations. These recent papers have investigated how merger timing and value creation are affected by the way M&A deals are settled, i.e. either friendly or hostile and followed the past literature modeling pattern with respect to the kind of game theory applied. In particular, Hackbarth and Morellec (2008) and Morellec and Zhdanov (2005) among others looked at friendly mergers between two firms and used a cooperative game-theoretic approach to determine the terms of the merger while others used a non-cooperative approach to determine the terms of hostile takeovers (Lambrecht 2004, Lambrecht and Myers 2007, Thijssen 2008, Lukas and Welling 2012). The findings reveal that in hostile takeovers the bidder can claim a larger stake in the new entity due to its first-mover advantage. However, this is associated with timing inefficiencies, i.e. the hostile takeover occurs inefficiently late when compared with the friendly mergers as being the first-best.

So far, however, the literature has predominantly neglected the follow-up opportunities M&As generate which are at the essence of serial acquisition programs. There are only a few exceptions. First, Alvarez and Stenbacka (2006) look at the possibility of a later sell-off of parts of the new entity to a third party. Second, Hackbarth and Morellec (2008) look at subsequent growth options available to the new entity after a merger. Only recently, two papers have dropped the two-firm perspective and looked at industry dynamics associated with M&A opportunities arising within a N-firm economy. In particular, Hackbarth and Miao (2012) look at the incumbents' propensity to engage in friendly mergers if the industry exhibits competition *à la* Cournot and is subject to random shocks. Their findings reveal that M&As are more likely in industries that are exposed to industry-wide shocks and that overall M&A timing is the more delayed the higher the level of industry concentration is. Dimopoulos and Sacchetto (2017) add to this perspective the possibility that the industry also exhibits new entrants as well as firm exits. As in Hackbarth and Miao (2012), only incumbents are allowed to merge and their findings show that an industry's M&A activity significantly stimulates new entry of firms, which increases productivity, while, at the same time, inducing less productive incumbents to delay their exit strategy. Their findings also reveal that the positive effect of M&A prevails, i.e. merger activity increases an industry's productivity.

However, all these models are silent on the role of serial acquisitions for M&A timing and contracting which are central to our analysis. In particular, neither of the aforementioned papers looks at compounded shared real options, i.e. how bargaining about the terms of the first transaction is affected by the bargaining outcome of a subsequent M&A transaction. As in the classical non-game-theoretic literature on growth options, however, this should have a positive effect on M&A timing and contracting, respectively (see, e.g. Hackbarth and Morellec 2008). Alike, all the aforementioned models only consider friendly mergers where the surplus is shared cooperatively. Since hostile takeovers allow the bidding firm to exploit first-mover advantages we would expect that subsequent hostile takeover opportunities exhibit higher option values and should significantly alter initial merger terms. Hence, to date some important research questions remain: First, under which circumstances is it optimal to engage in a serial acquisition program rather than follow a big leap, i.e. the single acquisition of a large incumbent? Obviously, a trade-off exists since acquiring more than one firm is costly but this acquisition can enhance subsequent bargaining power in follow-up acquisitions. Second, what can we say about the strategy design of an acquisition program (hostile/friendly/mixed) or of a big leap (hostile/friendly) and how do uncertainty and synergies affect the optimal strategy design? Again, a trade-off emerges since a hostile takeover allows the bidding firm to capture a greater share of the surplus but suffers from timing inefficiencies, i.e. hostile takeovers are settled inefficiently late. Consequently, discounting can erode the greater share of the surplus. Finally, it is unclear how subsequent acquisitions affect the contract design and timing of M&As in an acquisition program.

The present paper tries to answer to these questions. Our contribution to the literature is twofold. First, we provide a methodological contribution, i.e. we analytically derive optimal contracts for real option games under uncertainty where the initial bargaining outcome is influenced by a subsequent bargaining game. Our results indicate that under certain circumstances a *first-mover pass-through* exists which enables the first-mover to fully or partially use his first-advantage in subsequent games. Second, our model advances the real option literature on M&As by looking closer at the determinants that drive the choice between acquisition programs and single acquisitions. In particular, our model builds on the assumption that a new entrant has identified two promising incumbents, a large and a smaller one, of which he mostly desires to acquire the larger one. To implement his strategy, he can either acquire the large incumbent right away (big leap) or setting up an acquisition program, i.e. first acquire the small before proceed with acquiring the larger incumbent.

We find that a big leap strategy tends to be preferred when uncertainty is low and for relatively lower synergies between the buyer and a minor incumbent, unless the first acquisition enables access to a high synergistic subsequent acquisition of a large incumbent. We show that for sufficiently large synergies of subsequent deals, the acquisition program may be preferable even when acquiring the minor firm destroys value (has negative synergies). Moreover, our findings indicate that synergies have a significant impact on the deal structure of acquisition programs. In particular, high synergies between the buyer and the minor incumbent increase the propensity of the new entrant to follow a pure friendly merger strategy, where both acquisitions are cooperatively negotiated. On the contrary, we find that higher synergies between the entrant and the large incumbent stimulate a pure hostile acquisition strategy, where both acquisitions are non-cooperatively structured. Finally, we show under which circumstances the deal structure of subsequent M&As affect the contractual design of upstream bilateral bargaining. In particular, our results indicate that, whenever an acquisition program is designed in a way that it is preferable for the new entrant to acquire both incumbents one immediately after the other, i.e. a big-bang solution, rather than acquiring the minor one first followed by a delayed acquisition of the prominent incumbent, then subsequent deal characteristics associated with the large incumbent affect the optimal contract design offered to the minor incumbent. On the contrary, when the acquisitions are truly sequential, the contract design of the initial acquisition is not affected by the characteristics of the subsequent deal.

The paper unfolds as follows. Section 2 presents a description of the acquisition strategies. In Section 3 and 4 the models are derived for two alternative strategies, the big leap and acquisition program, as well as for the different contract designs. Section 5 presents the rules for the choice of best strategy, analyses the optimal strategy choices, and presents some testable predictions that arise from the results. Finally, Section 6 concludes.

2 Acquisition strategies

Consider a setting of three firms. One firm, i.e. E, is planning to enter a new market and has identified two firms, a large firm L and a minor firm M as potential acquisition targets.[1] While E is not yet active in the market and has thus no capital installed, i.e. $K_E = 0$, each incumbent firm $l \in \{L, M\}$ is endowed with a capital stock K_l and is subject to an industry wide shock modeled by means of a geometric Brownian motion, i.e.:

$$dx(t) = \alpha x(t)dt + \sigma x(t)dW(t) \tag{1}$$

where $\alpha \in \mathbb{R} < r$ denotes the instantaneous drift, under the risk-neutral measure, r is the risk-free interest rate, $\sigma \in \mathbb{R}^+$ denotes the instantaneous variance and dW denotes the standard Wiener increment.[2] We will assume that

$$V_l(t) = K_l x(t), \qquad l \in \{L, M\} \tag{2}$$

[1] Here, L and M are just two firms within an economy -among others- that could be acquired. A good reason for such an assumption might be that both incumbents are publicly traded and thus the new entrant has zero search cost since these firms are listed while other incumbent are hidden, e.g. because they are family owned and thus not listed. Such a setting is in particular very common in continental European states like e.g. Germany, Portugal, Italy, or Austria.

[2] This condition ensures a finite trigger. The condition also ensures that the stochastic discount factor has a meaningful solution. It is not sufficient, however, to guarantee that the trigger is reached almost surely. For the more strict condition $\alpha > \frac{\sigma^2}{2}$, we get a finite expected hitting time, i.e., $E[T^*] < \infty$.

were $V_l(t)$ is the incumbents' individual stand-alone values.

In order to become active in the market, the new entrant E must acquire an incumbent. We will assume that E's main intention is to acquire the prominent incumbent L. To do so, it is faced with two generic strategies. The first is to make a bid right away to the large firm L (the big leap strategy) and the second is to make a bid to the minor firm M and, in a subsequent step, offer a bid to the prominent incumbent (the serial acquisition program). This assumption needs some further explanation. Obviously, in both cases the result would be a very large entity. However, since we assume that there are still other firms in the economy we thereby rule out the formation of monopoly power. Second, the new entrant can also consider to acquire M after acquiring L. However, we believe that most recent serial acquisitions are not driven to form monopolies but to buy the prominent competitor. The recent acquisition of KuKa (Germany) by Midea (China) which was commented by the Bloomberg with the headline "*Chinese-Owned Robot Maker Is Gunning for No. 1 in Booming Market*" might serve as a representative example.[3] Hence, we refrain from explicitly modeling product market competition and concentrate more on the effect of subsequent M&A possibilities that an initial acquisition strategy may generate.

We assume that the new entrant possesses complementary capabilities that enable the acquisition synergies, which gives it the ability to define the best acquisition strategy. Therefore, the incumbent firms have a more passive role. We assume that neither they consider the possibility of whether another acquisition method could increase their value, nor they are able to anticipate that a new firm E will enter the market by means of an acquisition. We also assume that the intention of firm E is only revealed when it enters the market, making the first acquisition. If the incumbent firms anticipate that they can be acquired by an outside firm, they may consider merging in advance, enhancing their bargaining power when facing the new entrant. For them, such a defensive strategy may be more valuable than staying independent, depending on the associated synergies and costs. In this paper we focus in the case where only the new entrant is able to define the optimal strategy and it does not reveal its intention to enter the market before making

[3] Bloomberg News 8. March 2017

the first acquisition.

To implement both generic strategies, i.e. big leap or acquisition program, the new entrant can choose between a hostile takeover bid and a friendly bid. We follow van den Honert and Stewart (1992), Lambrecht (2004), Hackbarth and Morellec (2008), Morellec and Zhdanov (2005) and assume that a friendly merger is modeled as a cooperative game between two firms which jointly decide on the sharing rule of the surplus and on the timing of the merger. In contrast, a hostile takeover is modeled as a non-cooperative game where the bidder offers a premium to the target.[4]. Here we draw upon Lambrecht (2001), Betton et al. (2008), Betton and Moran (2003), Lukas and Welling (2012) and assume that contingent on the premium offered by the bidder, the target then decides on the timing of the takeover. Hence, E's action set is characterized by a 3×2 matrix (see Figure 1). In particular, apart from a merger (hostile takeover) with (of) L, E can choose between a hostile takeover of M followed by a friendly merger with L (mixed acquisition program), a hostile takeover of both M and L (pure hostile takeover program), a friendly takeover of both M and L (pure friendly merger program), or a friendly merger with M followed by a hostile takeover of L (mixed acquisition program).[5]

In the following, we will take a closer look at the new entrants individual strategies. For modeling purposes a pair $\{i, j\}$, appearing in subscript, defines the M&A program, where $i \in \{bh, bf, hh, hf, fh, ff\}$ indicates the strategy where bh and bf refer to hostile/friendly big leap, hh and ff the pure hostile/friendly acquisition program, and hf and fh refer to the mixed acquisition program strategies; and finally $j \in \{EM, M, L\}$ identifies the firm.

[4]The assumption that the bidder is the first-mover is supported by the empirical literature which shows that in the majority of hostile takeover cases it is the potential buyer who submit a formal bid and thus initiating the takeover (e.g. Andrade and Stafford (2004); Boone and Mulherin (2007); Fidrmuc et al. (2012)).

[5]For the sake of simplicity, we rule out the possibility that negotiating triggers a takeover contest, where two or more bidders, i.e. E and L or E and M compete for a particular target. Such an assumption is in line with the findings in the empirical literature indicating that the acquisition process is mostly bilateral, i.e. between two firms, and that auctions have become less common (e.g. Andrade et al. (2001); Boone and Mulherin (2007)).

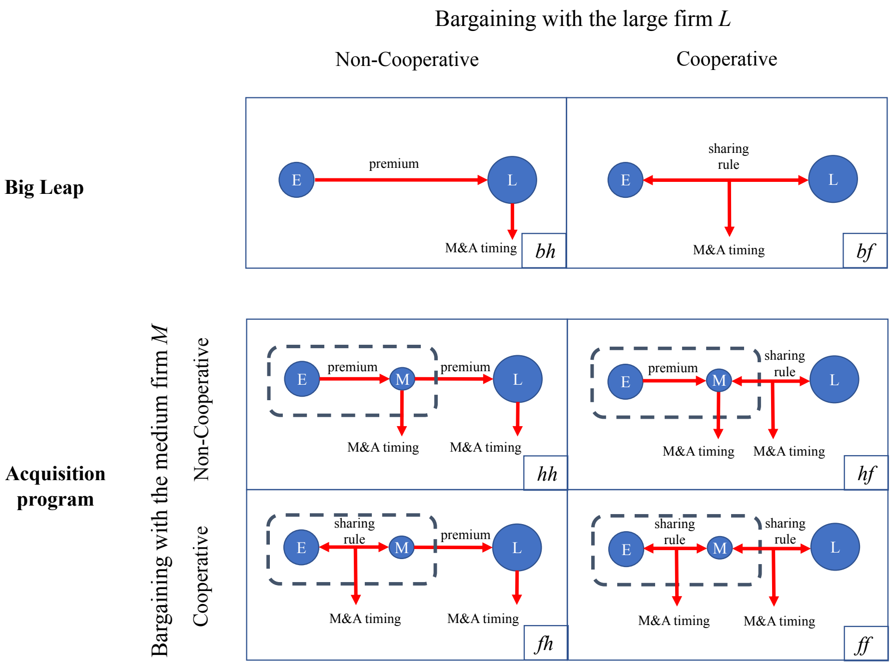


Figure 1: 2×3 matrix characterizing the new entrant's E action set. $i \in \{bh, bf, hh, hf, fh, ff\}$ indicates the strategy, where bh and bf refer to hostile/friendly big leap, hh and ff the pure hostile/friendly acquisition program, and hf and fh refer to the mixed acquisition program strategies.

3 The Big Leap

Let us start by considering the big leap, where the new entrant moves directly to the acquisition of the large firm. Two alternative strategies need to be considered: either the acquisition of the large firm is a cooperative game (i.e., the firm opts for a friendly merger), or, on the contrary, is a non-cooperative game (where the firm places an hostile offer).

There are arguments that may justify each strategy. On the one hand, the entrant prefers to gain a fast entry into the new market, potentially at a lower transaction cost.[6] Obviously, undertaking the non-cooperative takeover would lead to timing inefficiencies and unnecessarily delays the acquisition of L. On the other hand, the hostile takeover strategy allows the new entrant E to capture a greater fraction of the generated surplus since it will hold the greater bargaining power due to the first-mover advantage.

3.1 Non-Cooperative Acquisition of the Large Firm

In order to model the acquisition dynamics, we will rely on a non-cooperative bargaining solution, i.e. the new entrant offers the large incumbent a premium $\psi_{bh,L} > 0$ while the large firm times the acquisition, i.e., L optimally chooses the timing when the acquisition takes place.[7] Let $(\omega_{EL}-1)K_L > 0$ denote the synergies on the large firm's value, $\epsilon_{EL}T_{h,EL}$ and $(1-\epsilon_{EL})T_{h,EL}$ denote the transaction costs of the hostile acquisition assigned to each party, where $\epsilon_{EL} \in (0,1)$ indicates the fraction of the transaction costs ($T_{h,EL}$) assigned to E. The synergies between the new entrant and the incumbent firm may arise from complementary capabilities: exploiting strengths or new processes, or practices, allowing to reduce costs or enhance revenues.

Consequently, the large firm receives $\psi_{bh,L}K_Lx(t)$ in exchange for its assets worth $K_Lx(t)$ and has to bear transaction costs of $(1-\epsilon_{EL})T_{h,EL}$. Following standard real options reasoning, for any given premium level, $\psi_{bh,L}$, L's timing decision to sell the

[6]We allow for different transactions costs for cooperative and non-cooperative acquisitions. It is reasonable to assume that hostile takeovers are more costly than friendly mergers.

[7]Similar dynamics can be found, for instance, in Lukas and Welling (2012).

company solves the following optimization problem:[8]

$$f(x) = \max_{\tau} \left[\mathbf{E} \left[\left((\psi_{bh,L} - 1) K_L x(t) - (1 - \epsilon_{EL}) T_{h,EL} \right) e^{-r\tau} \right] \right], \tag{3}$$

$$= \max_{x^*_{bh,L}(\psi_{bh,L})} \left[\left((\psi_{bh,L} - 1) K_L x^*_{bh,L}(\psi_{bh,L}) - (1 - \epsilon_{EL}) T_{h,EL} \right) \left(\frac{x(t)}{x^*_{bh,L}(\psi_{bh,L})} \right)^{\beta_1} \right] \tag{4}$$

where $\beta_1 = \frac{1}{2} - \frac{\alpha}{\sigma^2} + \sqrt{\left(-\frac{1}{2} + \frac{\alpha}{\sigma^2}\right)^2 + \frac{2r}{\sigma^2}}$ is the positive root of the standard fundamental quadratic equation (see Dixit and Pindyck 1994). On the other side, the new entrant E anticipates the reaction function of the target L and grants an optimal premium such that it maximizes its objective function, i.e.:

$$\max_{\psi_{bh,L}} \left[\left((\omega_{EL} - \psi_{bh,L}) K_L x^*_{bh,L}(\psi_{bh,L}) - \epsilon_{EL} T_{h,EL} \right) \left(\frac{x(t)}{x^*_{bh,L}(\psi_{bh,L})} \right)^{\beta_1} \right] \tag{5}$$

Solving both objective functions recursively leads to the following result:[9]

Proposition 1. *The acquisition of the large firm takes place if the large firm receives an optimal premium* $\psi^*_{bh,L}$ *and waits until* $x(t)$ *hits the optimal trigger value* $x(t) = x^*_{bh,L}$ *where* $\psi^*_{bh,L}$ *and* $x^*_{bh,L}$ *are given by:*

$$\psi^*_{bh,L} = 1 + \frac{(\beta_1 - 1)(1 - \epsilon_{EL})}{\beta_1 - \epsilon_{EL}} (\omega_{EL} - 1) \tag{6}$$

$$x^*_{bh,L} = \frac{\beta_1}{(\beta_1 - 1)^2} \frac{(\beta_1 - \epsilon_{EL}) T_{h,EL}}{(\omega_{EL} - 1) K_L} \tag{7}$$

Proof. See Appendix. □

Notice that, assuming E's offer is a take-it-or-leave-it offer, L finds no incentive to deviate from the optimal decision (e.g., by refusing the bid). In fact, if L rejects the deal

[8] We follow the common assumption in the literature of M&A dynamic models of setting a reserve price for the target equal to the value of the assets in place (e.g., Lambrecht 2004, Lukas and Welling 2012). However, the model can be easily extended to incorporate a larger reserve price, by replacing $(\psi_{bh,L} - 1)K_L x(t)$ by $(\psi_{bh,L} - \alpha)K_L x(t)$, $\alpha > 1$.

[9] When the reserve price of the target is $\alpha K_L x(t)$, $1 < \alpha < \omega_{EL}$, it can be shown that the bidder offers a lower net premium $(\psi^*_{bh,L} - \alpha)$ and the takeover is deterred (higher $x^*_{bh,L}$). When the reserve price is such that it captures all the synergies ($\alpha = \omega_{EL}$), the takeover is deterred forever.

it will end-up in a worse off position, which is not reasonable in our full rational setting.

3.2 Cooperative Acquisition of the Large Firm

Obviously, the new entrant could also acquire L by means of a friendly merger which marks the bf strategy indicated in Figure 1. Hence, both will jointly negotiate the terms of the contract. Following Alvarez and Stenbacka (2006) and Thijssen (2008), let us assume that after the merger, each firm holds an equity stake in the new firm, γ for firm E and $1-\gamma$ for firm L. The large firm will give up its stand-alone value $V_L = K_L x(t)$ and receives a stake in the new venture, upon incurring the transaction cost $(1-\epsilon_{EL})T_{f,EL}$, thereby profiting from the synergies $(\omega_{EL}-1)K_L$ that arise out of the merger. Hence, firm L's net gain becomes:

$$\max\left[((1-\gamma)\omega_{EL}K_L - K_L)\,x(t) - (1-\epsilon_{EL})T_{f,EL};0\right] \tag{8}$$

On the contrary, firm E's net gain amounts to:

$$\max\left[\gamma\omega_{EL}K_L x(t) - \epsilon_{EL}T_{f,EL};0\right] \tag{9}$$

Assuming that both firms possess a certain amount of bargaining power exogenously given, η_{EL} for firm E and $1-\eta_{EL}$ for firm L, then the optimal share each firm has in the new venture solves the following optimization problem:

$$\max_{\gamma}\Big[(((1-\gamma)\omega_{EL}K_L - K_L)x(t) - (1-\epsilon_{EL})T_{f,EL})^{1-\eta_{EL}} \\ (\gamma\omega_{EL}K_L x(t) - \epsilon_{EL}T_{f,EL})^{\eta_{EL}}\Big] \tag{10}$$

Since we are focusing on a cooperative game the optimal investment trigger equals the central planner's optimal investment threshold. Hence, the central planner's objective function equals:

$$G(x) = \max_{\tau} \left[\mathbf{E}\left[\left((\omega_{EL}-1)K_L x(t) - T_{f,EL}\right) e^{-r\tau}\right]\right]$$
$$= \max_{x^*_{bf,L}} \left[\left((\omega_{EL}-1)K_L x^*_{bf,L} - T_{f,EL}\right)\left(\frac{x(t)}{x^*_{bf,L}}\right)^{\beta_1}\right] \tag{11}$$

Consequently, solving the cooperative bargaining game by means of the Nash-Bargaining solution leads to the following proposition:

Proposition 2. *Both firms will agree to merge if $x(t)$ hits the optimal timing threshold $x^*_{bf,L}$ from below:*

$$x^*_{bf,L} = \frac{\beta_1}{\beta_1 - 1}\frac{T_{f,EL}}{(\omega_{EL}-1)K_L}$$
$$= \frac{\beta_1 - 1}{\beta_1 - \epsilon_{EL}}\frac{T_{f,EL}}{T_{h,EL}} x^*_{bh,L} \tag{12}$$

Firm E's optimal stake $\gamma^*_{bf,EL}$ in the merger amounts to:

$$\gamma^*_{bf,EL} = \left(\frac{(\beta_1 - 1)\epsilon_{EL} + \eta_{EL}}{\beta_1}\right)\frac{\omega_{EL}-1}{\omega_{EL}}. \tag{13}$$

Proof. See Appendix. □

It is shown that the hostile takeover produces a trigger that is timing inefficient when compared to that of the friendly merger (even for similar transaction costs). In fact, the latter solution ensures a social (aggregate) first best, while the former is an individual first best that leads to a deal that occurs inefficiently late.[10]

4 The Acquisition Program

Let us assume now that firm E can, alternatively to the big leap, start an acquisition program by making an offer to the minor firm M, with the ultimate goal of acquiring

[10]Given that $\epsilon_{EL} < 1$, $x^*_{bf,L} < x^*_{bh,L}$, for $T_{f,EL} \leqslant T_{h,EL}$. Similar results already appear in the related literature. The decision regarding the strategy to be followed by the bidder will be discussed in section 5.

L. In particular, the new entrant can offer the minor incumbent a premium in a non-cooperative takeover or can acquire it by means of a friendly merger. After acquiring the minor firm, the new entity EM can acquire the large incumbent L by means of a hostile takeover or a friendly merger. The solutions for each of the four combinations presented in Figure 1 are determined in a backwards procedure, starting from the two alternatives for acquiring L.

4.1 Non-Cooperative Acquisition of the Large Firm

We start by considering that EM (which labels the new entity E *and* M after the first acquisition takes place) decides to acquire L under an hostile takeover. The dynamics of this game has already been presented in Section 3.1 and consist in EM offering a premium to L, while L times the merger. Since we assume E's capabilities are what enables the synergies, we model them as $(\omega_{ML}-1)K_L$, with $\omega_{ML}>1$.[11] The overall value of the firm, after EM and L have combined, is $\omega_{ML}K_L+\omega_{EM}K_M$, where $\omega_{EM}K_M$ is the value of EM, resulting from the acquisition of M by the new entrant E. Following the same procedures as before we state that,

Proposition 3. *For the non-cooperative takeover, the large firm receives an optimal premium $\psi^*_{ih,L}$, $i\in\{f,h\}$, and waits optimally until $x(t)$ hits the trigger value $x^*_{ih,L}$, given by:*

$$\psi^*_{ih,L}=1+\frac{(\beta_1-1)(1-\epsilon_{ML})}{(\beta_1-\epsilon_{ML})}(\omega_{ML}-1) \tag{14}$$

and,

$$x^*_{ih,L}=\frac{\beta_1}{(\beta_1-1)^2}\frac{(\beta_1-\epsilon_{ML})T_{h,ML}}{(\omega_{ML}-1)K_L} \tag{15}$$

Proof. See Appendix. □

4.2 Cooperative Acquisition of the Large Firm

Let us now consider the second alternative, where EM opts for negotiating a friendly merger with L. Following similar steps as in Section 3.2, we assume that the large firm

[11] The generic synergies may also take the form of additional market power (Thijssen 2008) or economies of scale (Lambrecht 2004).

will give up his stand-alone value $V_L = K_L x(t)$ and will receive upon paying the transaction cost $(1-\epsilon_{ML})T_{ML}$ a stake $(1-\gamma)$ in the new venture thereby profiting from the synergies $(\omega_{ML}-1)K_L > 0$ that arise out of the merger. Hence, firm L's net gain becomes:

$$\max\left[((1-\gamma)(\omega_{ML}K_L + \omega_{EM}K_M) - K_L)x(t) - (1-\epsilon_{ML})T_{f,ML}; 0\right] \tag{16}$$

where $\omega_{EM}K_M$ reflects the first acquisition, occurred in an earlier stage. Similarly, firm EM's net gain amounts to:

$$\max\left[(\gamma(\omega_{ML}K_L + \omega_{EM}K_M) - \omega_{EM}K_M)x(t) - \epsilon_{ML}T_{f,ML}; 0\right] \tag{17}$$

Assuming that both firms possess a certain amount of bargaining power, η_{ML} for firm EM and $1-\eta_{ML}$ for firm L, then the optimal share each firm has in the new venture (with an overall value of $\omega_{ML}K_L + \omega_{EM}K_M$), solves the following optimization problem:

$$\begin{aligned} \max_{\gamma} \Big[&(((1-\gamma)(\omega_{ML}K_L + \omega_{EM}K_M) - K_L)x(t) - (1-\epsilon_{ML})T_{f,ML})^{1-\eta_{ML}} \\ &((\gamma(\omega_{ML}K_L + \omega_{EM}K_M) - \omega_{EM}K_M)x(t) - \epsilon_{ML}T_{f,ML})^{\eta_{ML}} \Big] \end{aligned} \tag{18}$$

where the bargaining power is assumed to correspond to the relative value of each entity. Accordingly:

$$\eta_{ML} = \frac{\omega_{EM}K_M}{\omega_{EM}K_M + K_L} \tag{19}$$

As in Section 3.2, solving the cooperative bargaining game by means of the Nash-bargaining solution leads to the following proposition:

Proposition 4. *Both firms, EM and L, will agree to merge if $x(t)$ hits the optimal timing threshold $x^*_{if,L}$, $i \in \{f,h\}$, from below:*

$$\begin{aligned} x^*_{if,L} &= \frac{\beta_1}{\beta_1 - 1}\frac{T_{f,ML}}{(\omega_{ML}-1)K_L} \\ &= \frac{\beta_1 - 1}{\beta_1 - \epsilon_{ML}}\frac{T_{f,ML}}{T_{h,ML}} x^*_{ih,L} \end{aligned} \tag{20}$$

Firm EM's optimal stake $\gamma^*_{if,EM}$ in the merger amounts to:

$$\gamma^*_{if,EM} = \frac{\omega_{EM} K_M}{\omega_{EM} K_M + \omega_{ML} K_L} + \left(\frac{(\beta_1 - 1)\epsilon_{ML} + \eta_{ML}}{\beta_1}\right) \frac{(\omega_{ML} - 1)K_L}{\omega_{EM} K_M + \omega_{ML} K_L} \tag{21}$$

Proof. See Appendix. □

As for the big leap, whenever the transactions costs of the hostile acquisition are larger than those of the friendly merger, the non-cooperative takeover occurs later than the cooperative merger.[12]

4.3 Non-Cooperative Acquisition of the Minor Firm

Let us now move backwards to the first stage to modeling the acquisition of M. Assume this first acquisition takes the form of an hostile takeover. Under this setting, the new entrant offers the minor incumbent a premium $\psi_{hj,M} > 0$ while the latter firm times the acquisition. In the generic premium $\psi_{hj,M}$, the subscript $j \in \{f, h\}$ represents the strategy followed by EM when acquiring L, as the complete solution needs to consider the subsequent type of deal, as shown in Figure 1.

Let $(\omega_{EM} - 1)K_M$ denote the resulting synergies, $\epsilon_{EM} T_{h,EM}$ and $(1 - \epsilon_{EM})T_{h,EM}$ denote the transaction costs assigned to each party where $\epsilon_{EM} \in (0, 1)$ indicates the fraction of the transaction costs ($T_{h,EM}$) assigned to E. Hence, for any given premium level $\psi_{hj,M} > 0$ M's timing decision to sell the company solves the following optimization problem which is analogous to the one of the large firm alluded to earlier:

$$g(x) = \max_{\tau} \left[\mathbf{E}\left[\left((\psi_{hj,M} - 1)K_M x(t) - (1 - \epsilon_{EM})T_{h,EM}\right) e^{-r\tau}\right]\right], \tag{22}$$

$$= \max_{x^*_{hj,M}(\psi_{hj,M})} \left[\left((\psi_{hj,M} - 1)K_M x^*_{hj,M} - (1 - \epsilon_{EM})T_{h,EM}\right) \left(\frac{x(t)}{x^*_{hj,M}(\psi_{hj,M})}\right)^{\beta_1}\right] \tag{23}$$

where β_1 comes as before.

Again, firm E anticipates the reaction function of the minor firm and grants an optimal

[12] $x^*_{ih,L} > x^*_{if,L}$, for $T_{f,ML} \leqslant T_{h,ML}$, given that $\epsilon_{ML} < 1$.

premium such that it maximizes its objective function. However, since the new entrant's true intention is to buy the large firm, a subsequent option emerges, i.e. to buy the large firm after acquiring the minor one. Hence, firm E's objective function becomes:

$$\max_{\psi_{hj,M}} \left[\left((\omega_{EM} - \psi_{hj,M}) K_M x^*_{hj,M}(\psi_{hj,M}) + F_j(.) - \epsilon_{EM} T_{h,EM} \right) \left(\frac{x(t)}{x^*_{hj,M}(\psi_{hj,M})} \right)^{\beta_1} \right] \tag{24}$$

where $F_j(.)$, with $j \in \{f, h\}$, denotes the option to buy the large firm after successful acquisition of the minor firm. Obviously, a solution to the decision problem is only obtainable once a flexibility value can be assigned to the subsequent option to merge with the large firm, and depends on the strategy followed in that acquisition, which can either be friendly (forming a mixed acquisition strategy) or hostile (leading to a pure hostile strategy). We start with the latter.

4.3.1 Pure hostile strategy (*hh*)

For the pure hostile strategy we need to incorporate the solution of the non-cooperative acquisition of L into the non-cooperative acquisition of M. Having derived the optimal policy for the latter in Section 4.1, we can deduce firm EM's ex-ante option value for this strategy, i.e.:

$$F_h(x) = \begin{cases} \left(\left(\left(\omega_{ML} - \psi^*_{hh,L} \right) K_L - \omega_{EM} K_M \right) x^*_{hh,L} - \epsilon_{ML} T_{h,ML} \right) \left(\frac{x(t)}{x^*_{hh,L}} \right)^{\beta_1} & x(t) < x^*_{hh,L} \\ \left(\left(\omega_{ML} - \psi^*_{hh,L} \right) K_L - \omega_{EM} K_M \right) x(t) - \epsilon_{ML} T_{h,ML} & x(t) \geqslant x^*_{hh,L} \end{cases} \tag{25}$$

By inserting $F_h(x^*_{hh,M}(\psi_{hh,M}))$ into Equation (24) we can now solve for the optimal premium $\psi^*_{hh,M}$ and acquisition threshold $x^*_{hh,M}$ marking the first phase of the sequential acquisition program.

A closer look, however, reveals that two cases are possible. On the one hand, the acquisitions by E follow a real sequence, i.e. after buying the minor firm it will wait and buy, later on, the large incumbent. In such a case, the ordering of the acquisition threshold follows $x^*_{hh,M} < x^*_{hh,L}$, which means the trigger for acquiring M under the pure hostile strategy is smaller than the trigger to acquire L after the acquisition of M takes place. On the other hand, the entry might be characterized by a big-bang solution where E buys both firms at the investment trigger $x^*_{hh,M}$ (the acquisition of L taking place immediately after the acquisition of M), which occurs when $x^*_{hh,M} \geqslant x^*_{hh,L}$. Next we present the solutions for both cases.

Case 1: Sequential Entry ($x^*_{hh,M} < x^*_{hh,L}$)

In this case of sequential acquisitions, where E firstly acquires M at $x(t) = x^*_{hh,M}$ and then waits for $x(t) = x^*_{hh,L}$ to acquire L, the following propositions summarize the findings regarding an optimal contract design.

Proposition 5. *For the first takeover, firm E offers the premium $\psi^*_{hh,L}$ and waits optimally until $x(t)$ hits the trigger value $x^*_{hh,M}$, given by:*

$$\psi^*_{hh,M} = 1 + \frac{(\beta_1 - 1)(1 - \epsilon_{EM})}{\beta_1 - \epsilon_{EM}}(\omega_{EM} - 1) \tag{26}$$

and,

$$x^*_{hh,M} = \frac{\beta_1}{(\beta_1 - 1)^2} \frac{(\beta_1 - \epsilon_{EM})T_{h,EM}}{(\omega_{EM} - 1)K_M} \tag{27}$$

Proof. See Appendix. □

From the optimal results we see that the merger between M and L is irrelevant for both the firm E's optimal offered premium as well as for the minor incumbent's timing decision. Neither $\psi^*_{hh,M}$ nor $x^*_{hh,M}$ depend on the characteristics of the subsequent merger with L, e.g. its synergies, transaction costs or premium offered.

Case 2: Big-bang takeover ($x^*_{hh,M} \geqslant x^*_{hh,L}$)

In the second case, however, firm E assigns no additional flexibility value to merge subsequently with the large incumbent L. Rather, it is already optimal to merge with L. Consequently, $F_h(.)$ just reflects the intrinsic value assigned to the immediate acquisition. As soon as E finds it optimal to give up the option to wait to acquire the minor firm it will exercise the option to merge with the large firm, too. Since the acquisition of L can only occur after the acquisition of M, and given that, for the sake of simplicity, we are assuming that an acquisition does not take time to be completed, the two acquisitions happen in sequence, the second immediately after the first. Hence, the following propositions summarizes the optimal contract for such a big-bang entry.

Proposition 6. *For the first takeover, the firm E offers the premium $\psi^*_{hh,M}$ and waits optimally until $x(t)$ hits the trigger value $x^*_{hh,M}$, given by:*

$$\psi^*_{hh,M} = 1 + \frac{(\beta_1 - 1)(1 - \epsilon_{EM})T_{h,EM}}{(\beta_1 - \epsilon_{EM})T_{h,EM} + (\beta_1 - \epsilon_{ML})T_{h,ML}} \frac{z_h}{K_M} \tag{28}$$

$$x^*_{hh,M} = \frac{\beta_1}{(\beta_1 - 1)^2} \frac{(\beta_1 - \epsilon_{EM})T_{h,EM} + (\beta_1 - \epsilon_{ML})T_{h,ML}}{z_h} \tag{29}$$

with

$$z_h = (\omega_{EM} - 1)K_M + (\omega_{ML} - 1)K_L \tag{30}$$

The premium offered in the second acquisition (to L), $\bar{\psi}_{hh,L}$, is such that $x^*_{hh,M}(\bar{\psi}_{hh,L}) = x^*_{hh,L}(\bar{\psi}_{hh,L})$, which corresponds to:

$$\bar{\psi}_{hh,L} = 1 + \frac{(\beta_1 - 1)(1 - \epsilon_{ML})T_{h,ML}}{(\beta_1 - \epsilon_{EM})T_{h,EM} + (\beta_1 - \epsilon_{ML})T_{h,ML}} \frac{z_h}{K_L} < \psi^*_{hh,L}, \tag{31}$$

which is smaller than the premium for the sequential case. The premium offered in the first acquisition (to M) is higher in the big-bang case than in the sequential case.

Proof. See Appendix. □

Obviously, assuming that $x^*_{hh,M} > x^*_{hh,L}$, i.e. a strict inequality would also result in a premium offered to M such that a big-bang solution is optimal. However, such a premium would only be second-best. To see this, consider that E is the proposer in both M&As. Hence, any ψ offered to L that leads to $x^*_{hh,M} > x^*_{hh,L}$ indicates that EM has paid too much for L. Consequently, EM could offer less such that it induces L to time the M&A later. The proceeds can be used to stimulate earlier M&A timing of M by paying it a higher premium. We will refer to this as a *first-mover pass-through* where E can pass its initial first-mover advantage on to subsequent negotiations. Consequently, there is only one first-best premium $\bar{\psi}_{hh,L}$ offered such that it aligns both thresholds, i.e. $x^*_{hh,M}(\psi^*_{hh,M}) = x^*_{hh,L}(\bar{\psi}_{hh,L})$. There is a joint effect in lowering the premium. One the one hand, by paying less to L its takeover will happen later (i.e., L's trigger for selling the assets will be higher if the offered premium is smaller) but, on the other hand, a lower premium means a higher stake for EM, making the first acquisition more attractive, and so happening sooner. Finally, the entrant E is willing to pay a higher premium to M, lowering its threshold, to get access as soon as possible to the valuable second acquisition.

Moreover, we see that the determinants of the subsequent M&A deal now strongly affect the contract design between E and M (see Equations (28) and (29)). Interestingly, the first acquisition needs not produce positive synergies ($\omega_{EM} - 1$ can be negative), as long as the subsequent acquisition synergies compensate sufficiently in order to make z_h positive, which is the only condition needed to produce a meaningful threshold.[13] This is in contrast to the pure sequential case where an acquisition of M is only likely if $\omega_{EM} - 1 > 0$.

Finally, we can provide an answer to the question about the key determinants when choosing between the sequential entry and the big-bang solution. A closer look reveals that the ordering of the investment thresholds depends on the level of achievable synergies, the transaction costs and the sizes of the capital stock. An analytical solution can be provided that marks the choice between the big-bang and sequential acquisition which is summarized by the following proposition.

Proposition 7. *The new entrant will switch from sequentially acquiring the incumbent firms M and L to a big-bang takeover of M and L should the factor of the achievable synergies ω_{ML} due to acquiring the large firm be higher than:*

$$\omega_{ML} > \Omega_{hh} = 1 + \frac{(\beta_1 - \epsilon_{ML})T_{h,ML}}{(\beta_1 - \epsilon_{EM})T_{h,EM}} \times \frac{(\omega_{EM} - 1)K_M}{K_L} \tag{32}$$

Proof. See Appendix. □

A big-bang takeover occurs when the threshold of the first acquisition is above the threshold of the second acquisition ($x^*_{hh,M} > x^*_{hh,L}$), which requires a sufficiently large

[13]Notice, however, that the second acquisition must produce positive synergies, otherwise it will never be optimal.

synergy (attractiveness) of the second acquisition ($\omega_{ML} > \Omega_{hh}$). When that synergy is low, the entrant will prefer to wait to acquire L after the acquisition of M. A more attractive first acquisition (higher ω_{EM}) hastens the first acquisition, and, therefore, requires a more attractive second acquisition (higher Ω_{hh}) to make the big-bang preferable to the sequential entry.

4.3.2 Mixed acquisition strategy (*hf*)

Consider now the mixed alternative. For this case we need to incorporate the solution of the friendly merger with L into the non-cooperative acquisition of M. The value function for the latter is as follows:

$$F_f(x) = \begin{cases} \left(\phi_{hf} x^*_{hf,L} - \epsilon_{ML} T_{f,ML}\right) \left(\dfrac{x(t)}{x^*_{hf,L}}\right)^{\beta_1} & x(t) < x^*_{hf,L} \\ \phi_{hf} x(t) - \epsilon_{ML} T_{f,ML} & x(t) \geqslant x^*_{hf,L} \end{cases} \tag{33}$$

where

$$\phi_{hf} = \gamma^*_{hf,EM}(\omega_{ML} K_L + \omega_{EM} K_M) - \omega_{EM} K_M. \tag{34}$$

By inserting $F_f(.)$ into Equation (24) we can now solve for the optimal premium $\psi^*_{hf,M}$ and acquisition threshold $x^*_{hf,M}$. As before, two possible cases need again to be considered. In the first case, E acquires M and waits before moving towards L, as the trigger to acquire the latter has not yet been achieved ($x^*_{hf,M} < x^*_{hf,L}$), while in the second, that occurs when $x^*_{hf,M} \geqslant x^*_{hf,L}$, firm E takes M and immediately after acquires L (the big-bang solution).

Case 1: Sequential Entry ($x^*_{hf,M} < x^*_{hf,L}$)

In this case, firm EM can capture the full value of the option to merge subsequently with the large incumbent L when offering the bid to M. The following proposition summarizes the optimal contract.

Proposition 8. *The acquisition of the minor firm takes place if the minor firm receives an optimal premium $\psi^*_{hf,M}$ and waits until $x(t)$ hits the optimal trigger value $x(t) = x^*_{hf,M}$*

from below, where $\psi^*_{hf,M}$ *and* $x^*_{hf,M}$ *are given by:*

$$\psi^*_{hf,M} = 1 + \frac{(\beta_1 - 1)(1 - \epsilon_{EM})}{\beta_1 - \epsilon_{EM}}(\omega_{EM} - 1) = \psi^*_{hh,M} \tag{35}$$

$$x^*_{hf,M} = \frac{\beta_1}{(\beta_1 - 1)^2}\frac{(\beta_1 - \epsilon_{EM})T_{h,EM}}{(\omega_{EM} - 1)K_M} = x^*_{hh,M} \tag{36}$$

Proof. See Appendix. □

Again, the findings reveal that in the case of sequential entry by means of acquisitions the optimal contract offers to M is not affected by the subsequent merger with L. Therefore, when the sequential merger is optimal, both strategies occur at the same timing and with the same premiums ($x^*_{hf,M} = x^*_{hh,M}$ and $\psi^*_{hf,M} = \psi^*_{hh,M}$).

Case 2: Big-bang Entry ($x^*_{hf,M} \geqslant x^*_{hf,L}$)

In this case the two acquisitions happen one immediately after the other. Obviously, as in the case for the pure hostile acquisition program, we would expect that in such a setting the contract design with M is affected by the characteristics of the subsequent takeover with L which is supported by the results.

Proposition 9. *The acquisition of the minor firm takes place if the minor firm receives an optimal premium* $\psi^*_{hf,M}$ *and waits until* $x(t)$ *hits the optimal trigger value* $x(t) = x^*_{hf,M}$ *from below, where* $\psi^*_{hf,M}$ *and* $x^*_{hf,M}$ *are given by:*

$$\psi^*_{hf,M} = 1 + \frac{(\beta_1 - 1)(1 - \epsilon_{EM})T_{h,EM}}{(\beta_1 - \epsilon_{EM})T_{h,EM} + \eta_{ML}(\beta_1 - 1)T_{f,ML}}\frac{z_f}{K_M} \tag{37}$$

$$x^*_{hf,M} = \frac{\beta_1}{(\beta_1 - 1)^2}\frac{(\beta_1 - \epsilon_{EM})T_{h,EM} + \eta_{ML}(\beta_1 - 1)T_{f,ML}}{z_f} \tag{38}$$

with

$$\begin{aligned} z_f &= (\omega_{EM} - 1)K_M + \eta_{ML}(\omega_{ML} - 1)K_L \\ &= z_h - (1 - \eta_{ML})(\omega_{ML} - 1)K_L \leqslant z_h \end{aligned} \tag{39}$$

In the big-bang strategy the premium paid in the first acquisition is higher than that paid in the sequential case.

Proof. See Appendix. □

Comparing the findings with the big-bang solution of the pure hostile acquisition, it becomes apparent that the contract design is different. In particular, since the trigger for the friendly merger can not be manipulated (e.g. postponed), as it is a central planner's trigger, there is no *first-mover pass-through* possible and thus the alignment of the two merger thresholds is not possible. However, since the takeover of M immediately leads to the merger with L, firm E settles a higher premium to be offered to M (when compared to the premium paid in the sequential case), which anticipates the takeover. Notice that, as the alignment is not possible, two triggers are in place, $x^*_{hf,M}$ (Equation (37)) and $x^*_{hf,L}$, but the former is the one that drives the timing for initiating the acquisition program. Naturally, since $x^*_{hf,L} < x^*_{hf,M}$, the sharing rule is determined at $x^*_{hf,M}$ (i.e. when the acquisition program is initiated), and not at $x^*_{hf,L}$.[14] As for the pure hostile big-bang case, the first acquisition needs not produce positive synergies, as long as the subsequent acquisition synergies compensate sufficiently in order to make z_f positive.

The choice between the big-bang entry and the sequential acquisition is summarized by the following proposition.

Proposition 10. *The new entrant will switch from sequentially acquiring the firm M and merge with L to a big-bang solution should the factor of the achievable synergies ω_{ML} due to acquiring the large firm be higher than:*

$$\omega_{ML} > \Omega_{hf} = 1 + \frac{(\beta_1 - 1)T_{f,ML}}{(\beta_1 - \epsilon_{EM})T_{h,EM}} \times \frac{(\omega_{EM} - 1)K_M}{K_L} = 1 + \frac{(\beta_1 - 1)T_{f,ML}}{(\beta_1 - \epsilon_{ML})T_{h,ML}}(\Omega_{hh} - 1) \tag{40}$$

Proof. See Appendix. □

For identical or lower transaction costs, a big-bang entry requires lower synergies for the

[14] Please refer to the proof of Proposition 9.

mixed hostile-friendly strategy than for the pure hostile strategy.[15] This happens because the friendly merger with L happens sooner than the hostile takeover and, therefore, lower ω_{ML} synergies are required to move the threshold below that of the first acquisition.

4.4 Cooperative Acquisition of the Minor Firm

Let us now complete our analysis by considering that the acquisition of M takes the form of a friendly merger. As before, the complete solution for this strategy depends on the type of the subsequent acquisition of L, friendly or hostile, as shown in Figure 1. The optimal share for each firm is given by the following maximization problem:

$$\max_{\gamma} \Big[((1-\gamma)(\omega_{EM} K_M x(t) + F_j(.)) - K_M x(t) - (1-\epsilon_{EM}) T_{f,EM})^{1-\eta_{EM}} \\ (\gamma(\omega_{EM} K_M x(t) + F_j(.)) - \epsilon_{EM} T_{f,EM})^{\eta_{EM}} \Big] \tag{41}$$

where $F_j(.)$ represent the subsequent hostile ($j = h$) or friendly ($j = f$) acquisition of L (see Equations (25) and (33), respectively).

4.4.1 Mixed acquisition strategy (*fh*)

Let us start by considering the case where the acquisition of L takes the form of a hostile takeover. As before, two types of solutions occur regarding the acquisition program: either E merges with M and then the new entity waits for the optimal moment to acquire L, or this takeover happens immediately after the first merger. The solutions for both cases are presented below.

Case 1: Sequential Entry ($x^*_{fh,M} < x^*_{fh,L}$)

For the case where the optimal acquisition of L happens later than the merger with M, the following proposition applies:

Proposition 11. *In the first takeover firms E and M will reach an acquisition agreement*

[15] $\Omega_{hf} < \Omega_{hh}$, for $T_{f,ML} \leqslant T_{h,ML}$.

if $x(t)$ hits the optimal timing threshold $x^*_{fh,M}$ from below:

$$x^*_{fh,M} = \frac{\beta_1}{\beta_1 - 1} \frac{T_{f,EM}}{(\omega_{EM} - 1)K_M} \tag{42}$$

Firm E's optimal stake $\gamma^*_{fh,EM}$ in the merger amounts to:

$$\gamma^*_{fh,EM} = \frac{\left(\frac{(\beta_1 - 1)\epsilon_{EM} + \eta_{EM}}{\beta_1 - 1}\right) T_{f,EM} + \eta_{EM} F_h(x^*_{fh,M})}{\left(\frac{\beta_1}{\beta_1 - 1}\frac{\omega_{EM}}{\omega_{EM} - 1}\right) T_{f,EM} + F_h(x^*_{fh,M})}. \tag{43}$$

Proof. See Appendix. □

As in the previous cases where the acquisitions take place sequentially, the timing for merging with M reveals is not affected by the subsequent takeover of L. Differently from what we saw regarding the optimal premiums, the solutions now show that the sharing rule will depend on the subsequent option to acquire L.

Case 2: Big-bang entry ($x^*_{fh,M} \geqslant x^*_{fh,L}$)

On the other hand, for the big-bang solution, where the acquisition of L occurs immediately after the merger with M, the optimal solutions are:

Proposition 12. *In the first takeover firms E and M will reach an acquisition agreement if $x(t)$ hits the optimal timing threshold $x^*_{fh,M}$ from below:*

$$x^*_{fh,M} = \frac{\beta_1}{\beta_1 - 1} \frac{T_{f,EM} + T_{h,ML}}{z_h} \tag{44}$$

Firm E's optimal stake $\gamma^*_{fh,EM}$ in the merger amounts to:

$$\gamma^*_{fh,EM} = \frac{((\beta_1 - 1)\epsilon_{EM} + \eta_{EM})\, T_{f,EM} + \eta_{EM}\epsilon_{EM} T_{h,ML}}{\beta_1(K_M + z_h)T_{f,EM} + (\beta_1 K_M + z_h \epsilon_{ML})T_{h,ML}} z_h. \tag{45}$$

The premium offered in the second acquisition (to L), $\bar{\psi}_{fh,L}$, is such that $x^*_{fh,M} = x^*_{fh,L}(\bar{\psi}_{fh,L})$, *which corresponds to:*

$$\bar{\psi}_{fh,L} = 1 + \frac{(1-\epsilon_{ML})T_{h,ML}}{T_{f,EM}+T_{h,ML}} \frac{z_h}{K_L} \gtrless \psi^*_{fh,L}. \qquad (46)$$

Proof. See Appendix. □

As for the other big-bang solutions the characteristics of subsequent deal will influence the timing, as well as the sharing rule, of the first acquisition. Since the acquisition of L is done by means of a hostile takeover, EM can use its first-mover advantage to manipulate the contract design of the subsequent hostile takeover, corresponding to a *partial first-mover pass-through.* Differently to the pure hostile big-bang solution, however, EM could be, under some particular conditions, better off by offering a higher (not lower) premium to L, maximizing the merger surplus that includes the synergies of the second acquisition and anticipating even more the hostile takeover.

The level of the synergy factor ω_{ML} that separates the regions for the sequential acquisition and the big-bang is as follows:

Proposition 13. *The new entrant will switch from merging with M and acquiring L sequentially to a big-bang solution should the factor of the achievable synergies ω_{ML} due to acquiring the large firm be higher than:*

$$\omega_{ML} > \Omega_{fh} = 1 + \frac{(\beta_1 - \epsilon_{ML})T_{h,ML}}{(\beta_1 - 1)T_{f,EM}} \times \frac{(\omega_{EM}-1)K_M}{K_L} \qquad (47)$$

Proof. See Appendix. □

4.4.2 Pure friendly (*ff*)

Finally, let us consider the pure friendly acquisition program, where both deals take the form of friendly mergers. As before, true sequential mergers and big-bangs are possible.

Case 1: Sequential Entry ($x^*_{ff,M} < x^*_{ff,L}$)

If the trigger of the first merger happens to be smaller than that of the merger with L, the set of solution is as follows:

Proposition 14. *In the first merger firms E and M will reach an acquisition agreement, if $x(t)$ hits the optimal timing threshold $x^*_{ff,L}$ from below:*

$$x^*_{ff,M} = \frac{\beta_1}{(\beta_1 - 1)} \frac{T_{f,EM}}{(\omega_{EM} - 1)K_M} = x^*_{fh,M} \tag{48}$$

Firm E's optimal stake $\gamma^*_{ff,EM}$ in the merger amounts to:

$$\gamma^*_{ff,EM} = \frac{\left(\frac{(\beta_1 - 1)\epsilon_{EM} + \eta_{EM}}{\beta_1 - 1}\right) T_{f,EM} + \eta_{EM} F_f(x^*_{ff,M})}{\left(\frac{\beta_1}{\beta_1 - 1} \frac{\omega_{EM}}{\omega_{EM} - 1}\right) T_{f,EM} + F_f(x^*_{ff,M})}. \tag{49}$$

Proof. See Appendix. □

As the subsequent acquisition of L does not influence the merger with M (however influencing the sharing rule), the trigger here obtained is the same that of the mixed friendly-hostile strategy.

Case 2: Big-bang Entry ($x^*_{ff,M} \geqslant x^*_{ff,L}$)

Similarly to what happens to the mixed hostile-friendly program, the trigger of the second merger can not be manipulated, as it is a central planner's threshold, making the alignment of the triggers unfeasible. Consequently, the big-bang entry by means of a pure friendly M&A exhibits no *first-mover pass-through.* However, given that the merger with M immediately leads to the second merger with L, its higher intrinsic value influences the first trigger, hastening the merger with M. The design of the deal is stated below.

Proposition 15. *In the first merger firms E and M will reach an acquisition agreement if $x(t)$ hits the optimal timing threshold $x^*_{ff,M}$ from below:*

$$x^*_{ff,M} = \frac{\beta_1}{\beta_1 - 1} \frac{T_{f,EM} + \eta_{ML} T_{f,ML}}{z_f} \tag{50}$$

Firm E's optimal stake $\gamma^*_{ff,EM}$ in the merger amounts to:

$$\gamma^*_{ff,EM} = \frac{((\beta_1 - 1)\epsilon_{EM} + \eta_{EM})\, T_{f,EM} + \eta_{EM}\eta_{ML} T_{f,ML}}{\beta_1(K_M + z_{ff})T_{f,EM} + \eta_{ML}(\beta_1 K_M + z_f)T_{f,ML}} z_f. \tag{51}$$

Proof. See Appendix. □

As in similar case, the sharing rule is calculated for the trigger where the big-bang takes place (and not at $x^*_{ff,L}$).

The synergy factor ω_{ML} that separates the regions for the sequential mergers and the big-bang are as follows:

Proposition 16. *The new entrant will switch from sequentially acquiring the incumbent firms M and L to a simultaneous acquisition of M and L should the factor of the achievable synergies ω_{ML} due to acquiring the large firm be higher than:*

$$\begin{aligned}\omega_{ML} > \Omega_{ff} &= 1 + \frac{T_{f,ML}}{T_{f,EM}} \frac{(\omega_{EM} - 1)K_M}{K_L} \\ &= 1 + \frac{(\beta_1 - 1)}{(\beta_1 - \epsilon_{EM})} \frac{T_{f,ML}}{T_{h,ML}} \Omega_{fh}\end{aligned} \tag{52}$$

Proof. See Appendix. □

For identical or lower transaction costs, a big-bang entry requires lower synergies for the pure friendly strategy than for the mixed friendly-hostile strategy, as the subsequent merger becomes optimal later for the pure hostile strategy.[16]

5 Choosing the best strategy

5.1 The value of strategies

Taking the derived optimal contract solutions into account and assuming that the initial value of $x(t)$ is sufficiently small compared to each strategy's optimal exercise threshold then the optimal real option values can be expressed as:

$$F_j = A_i \; x^{\beta_1}, \quad i \in \{bh, bf, hh, hf, fh, ff\} \tag{53}$$

where

[16] $\Omega_{ff} < \Omega_{fh}$, for $T_{f,ML} \leqslant T_{h,ML}$.

$$A_{bh} = \frac{\beta_1 - \epsilon_{EL}}{(\beta_1 - 1)^2} T_{h,EL} \left(\frac{1}{x^*_{bh,L}} \right)^{\beta_1} \tag{54}$$

$$A_{bf} = \frac{\eta_{EL}}{\beta_1 - 1} T_{f,EL} \left(\frac{1}{x^*_{bf,L}} \right)^{\beta_1} \tag{55}$$

$$A_{hh} = \left(\frac{\beta_1 - \epsilon_{EM}}{(\beta_1 - 1)^2} T_{h,EM} + \frac{\beta_1 - \epsilon_{ML}}{(\beta_1 - 1)^2} T_{h,ML} \times \begin{cases} \left(\frac{\omega_{ML} - 1}{\Omega_{hh} - 1} \right)^{\beta_1} & \omega_{ML} < \Omega_{hh} \\ 1 & \omega_{ML} \geqslant \Omega_{hh} \end{cases} \right) \left(\frac{1}{x^*_{hh,M}} \right)^{\beta_1} \tag{56}$$

$$A_{hf} = \left(\frac{\beta_1 - \epsilon_{EM}}{(\beta_1 - 1)^2} T_{h,EM} + \frac{\eta_{ML}}{\beta_1 - 1} T_{f,ML} \times \begin{cases} \left(\frac{\omega_{ML} - 1}{\Omega_{hf} - 1} \right)^{\beta_1} & \omega_{ML} < \Omega_{hf} \\ 1 & \omega_{ML} \geqslant \Omega_{hf} \end{cases} \right) \left(\frac{1}{x^*_{hf,M}} \right)^{\beta_1} \tag{57}$$

$$A_{fh} = \left(\frac{\eta_{EM}}{\beta_1 - 1} T_{f,EM} + \eta_{EM} T_{h,ML} \times \begin{cases} \frac{\beta_1 - \epsilon_{ML}}{(\beta_1 - 1)^2} \left(\frac{\omega_{ML} - 1}{\Omega_{fh} - 1} \right)^{\beta_1} & \omega_{ML} < \Omega_{fh} \\ \frac{\epsilon_{ML}}{\beta_1 - 1} & \omega_{ML} \geqslant \Omega_{fh} \end{cases} \right) \left(\frac{1}{x^*_{fh,M}} \right)^{\beta_1} \tag{58}$$

$$A_{ff} = \left(\frac{\eta_{EM}}{\beta_1 - 1} T_{f,EM} + \eta_{EM} \frac{\eta_{ML}}{\beta_1 - 1} T_{f,ML} \times \begin{cases} \left(\frac{\omega_{ML} - 1}{\Omega_{ff} - 1} \right)^{\beta_1} & \omega_{ML} < \Omega_{ff} \\ 1 & \omega_{ML} \geqslant \Omega_{ff} \end{cases} \right) \left(\frac{1}{x^*_{ff,M}} \right)^{\beta_1} \tag{59}$$

For defining the strategy to follow over the remaining alternatives, E should compare the values of $A_i, i \in \{bh, bf, hh, hf, fh, ff\}$, choosing the alternative with the highest value. If A_{bh} (A_{bf}) is the most valuable, E chooses the big leap strategy and places an hostile (friendly) bid for L, if not, the firm should follow the acquisition program strategy. Here, E will follow a mixed acquisition program or a pure hostile (friendly) takeover program depending on the relative values of A_i.

Regarding the two possible strategies for the big leap and the acquisition program (friendly or hostile), it is trivial to show that a higher power in the bargaining game favors

Table 1: Base-case parameters

Parameter	$i = EL$	$i = EM$	$i = ML$
Synergies - ω_i	1.15	1.20	1.15
Bargaining powers - η_i	0.4	0.5	$\dfrac{\eta_{EM}K_M}{\eta_{EM}K_M + K_L}$
Transaction costs (hostile) - $T_{h,i}$	0.15	0.10	0.10
Transaction costs (friendly) - $T_{f,i}$	0.12	0.08	0.08
Fraction of T - ϵ_i	0.5	0.5	0.5
Size of M - K_M		1.0	
Size of L - K_L		1.5	
β_1		2.5	

a friendly approach.[17] When E has a sufficiently high bargaining power, it will negotiate a friendly acquisition of L or M. Obviously, the transactions costs can also determine the choice of the best strategy. It can be shown that a strategy with lower transaction costs is preferable.[18]

The effects of volatility (through β_1) and synergies (ω_{EL}, ω_{EM}, and ω_{ML}) are not straightforward. Not only are several of the partial derivatives of the individual As non-monotonic, but also their dominance over the others is non-monotonic. In the next section we use a numerical comparative statics, with different sets of parameters, to study the effects of uncertainty and synergies on the optimal strategy choice.

5.2 The choice of the optimal strategy

In the following, we analyze which of the generic entry strategies, i.e. single takeover of L or sequential acquisition program, either friendly or hostile, is more valuable to E, by means of a comparative-static analysis.

Table 1 presents the base-case parameters. We will assume that the transaction costs that arise are split evenly between the parties, i.e. $\epsilon_{EL} = \epsilon_{EM} = \epsilon_{ML} = 0.5$ and that the absolute transaction costs for a friendly merger are smaller than for a hostile takeover,

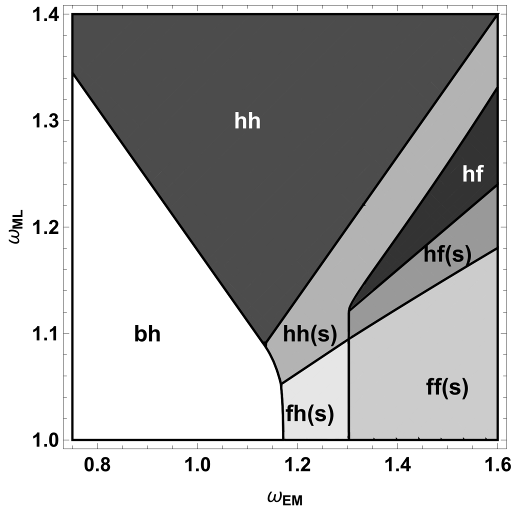
[17] $\frac{\partial A_{bf}}{\partial \eta_{EL}} > 0$, $\frac{\partial A_{fh}}{\partial \eta_{EM}} > 0$, and $\frac{\partial A_{ff}}{\partial \eta_{EM}} > 0$.

[18] All the partial derivatives of each A_i to the T's involved are positive.

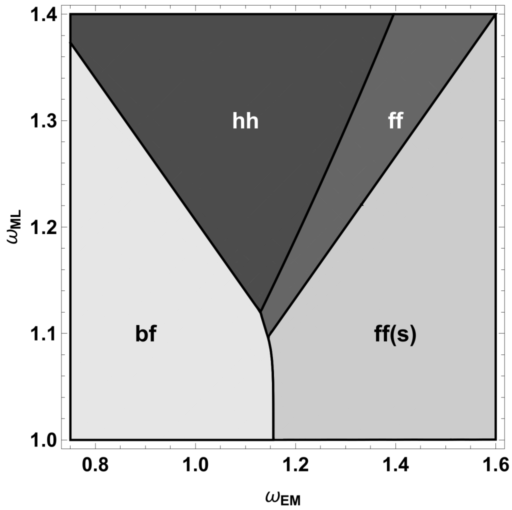
$T_f < T_h$. We also acknowledge the fact that it is more expensive to acquire the larger incumbent than the smaller firm when entering the market for the first time ($T_{f,EL} > T_{f,EM}, T_{h,EL} > T_{h,EM}$).

Against the background of the M&A literature we first want to discuss the impact of synergies and how they impact the optimal entry strategy. In particular, each generic entry strategy is associated with specific synergy multipliers, i.e. ω_{EL}, ω_{EM}, and ω_{ML}. Figure 2 depicts how the level of synergies affects the choice between the big leap and the acquisition program, for different levels of uncertainty and synergies. In particular, for a synergy factor $\omega_{EM} < 1$, i.e. when acquiring the minor firm would destroy value, a serial acquisition program may still be optimal if the synergies of the following acquisition of the large incumbent (ω_{ML}) are sufficiently large, otherwise the big leap strategy's option value exceeds the alternatives' option values (regions bh/bf). For a sufficiently large ω_{EM}, we see that the firm will prefer an acquisition program over the big leap strategy. In particular, the firm will initially prefer to acquire M and L by means of pure hostile strategy (region hh), if the subsequent synergies are large enough (ω_{ML}). Should, however, the synergy factor ω_{EM} further increase then the likelihood increases that E prefers to switch from a hostile takeover of L to a friendly merger with L (regions hf/ff). In general, we can conclude that *ceteris paribus* as synergy factor ω_{EM} further increase relatively ω_{ML} an acquisition program with a pure friendly strategy becomes more and more dominant. This is due to the fact that higher first acquisition synergies (ω_{EM}) increase the bargaining power of EM when it subsequently completes a friendly merger with L. Additionally, M's size increases the bargaining power of EM when acquiring L and enhances the effect of ω_{EM}. *Ceteris paribus*, as synergy factor ω_{ML} further increase relatively ω_{EM}, an acquisition program with a pure hostile strategy becomes more and more dominant. Mixed strategies (regions hf and fh) are optimal for similar ω_{EM} and ω_{ML} and high uncertainty (Figures 2(a) and 2(c)). Under low uncertainty, only pure strategies become optimal (Figures 2(b) and 2(d)).

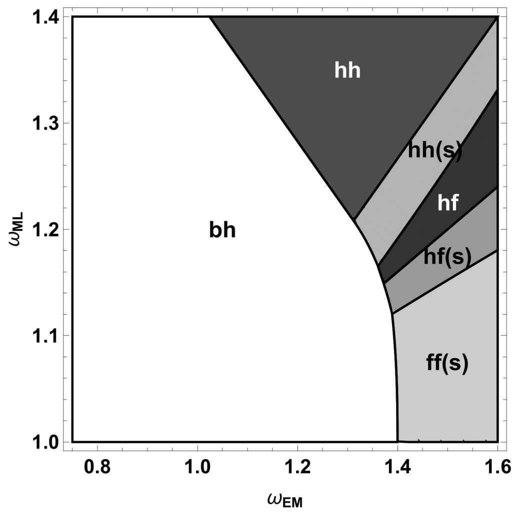
To further investigate how uncertainty affects the choice of the acquisition program, Figure 3 shows the different strategy choices as a function of uncertainty (measured by the



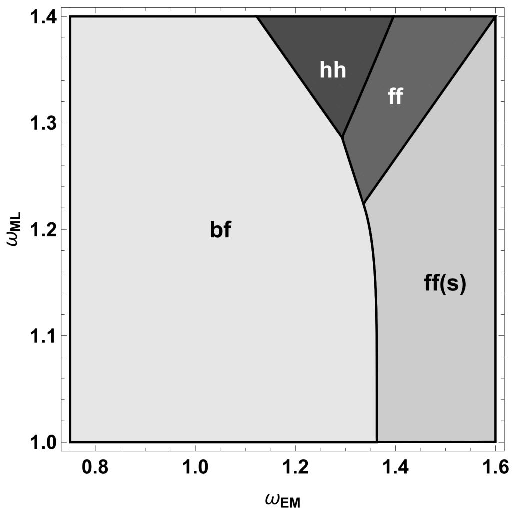
(a) $\beta_1 = 2.5; \omega_{EL} = 1.15$



(b) $\beta_1 = 5; \omega_{EL} = 1.15$



(c) $\beta_1 = 2.5; \omega_{EL} = 1.4$



(d) $\beta_1 = 5; \omega_{EL} = 1.4$

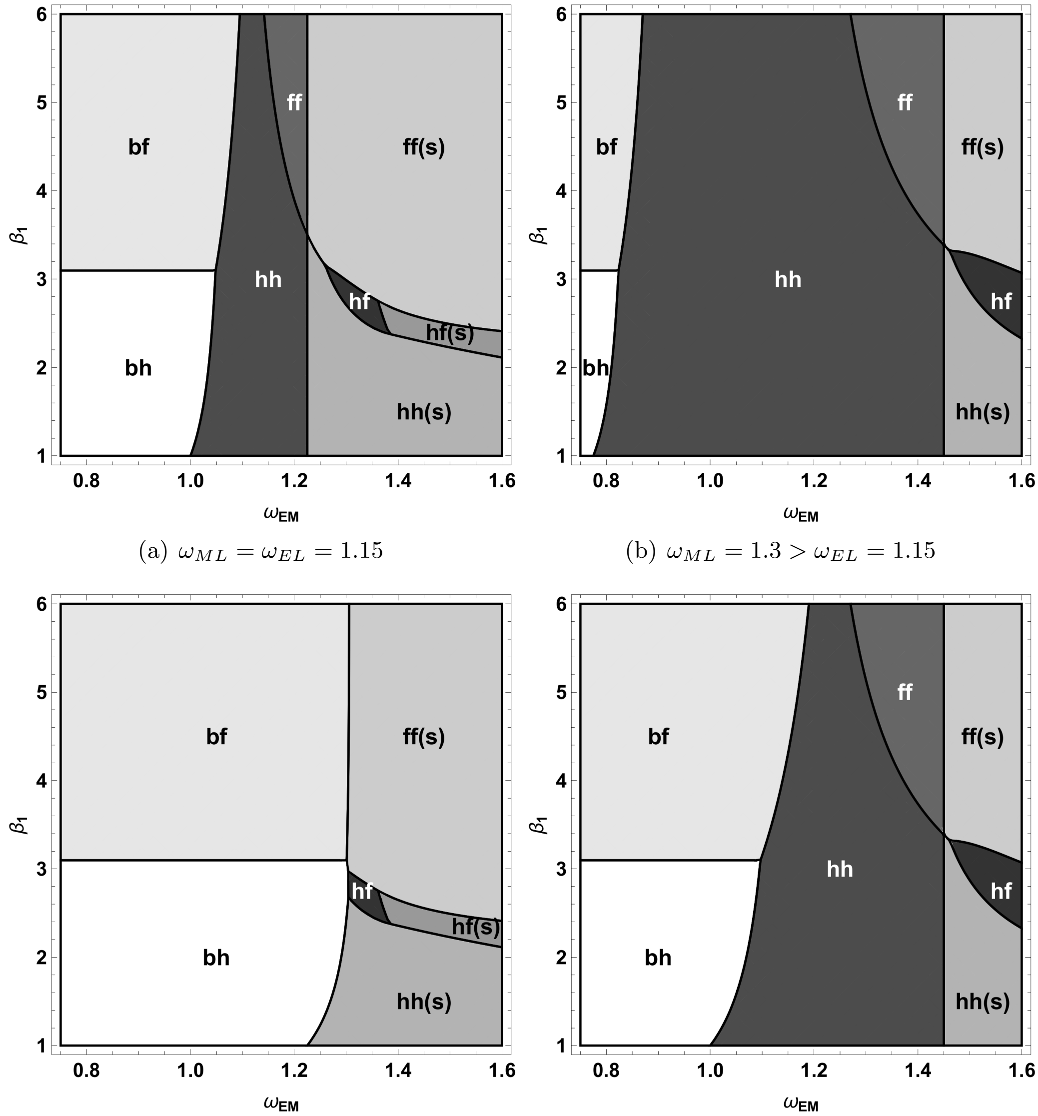
Figure 2: Optimal acquisition strategy choice depending on synergy levels ω_{ML}, ω_{EM}. Here, regions bh and bf mark the big leap hostile takeover of L/friendly merger with L strategies, regions ij with $i, j \in \{f, h\}$ characterize acquisition program strategies where E prefers to acquire M and L by means of a hostile takeover (h) or friendly acquisition (f). (s) indicates that the acquisition program is implemented sequentially. The figure shows the highest option value according to Equation (53) using the parameters in Table 1.

β_1 factor with $\partial\beta_1/\partial\sigma < 0$) and the synergy factor ω_{EM} between M and E, for different levels of the acquisition program synergies (ω_{EM} and ω_{ML}). Our results suggest that the choice between the big leap strategy and the acquisition program strategies is moderately affected by the level of uncertainty: for low uncertainty the big leap strategy has more value than that of the acquisition program. Additionally, it becomes apparent that in the case of increasing uncertainty the strategy to acquire both incumbents by means of a pure hostile takeover program cannibalizes the other strategies. In particular, as uncertainty increases we see that the other alternatives' option values, i.e. acquiring the prominent incumbent (big leap) as well as the mixed acquisition program and pure friendly strategies get more and more dominated by the pure hostile takeover acquisition program for a wider range of the synergy factor ω_{EM}.

Consequently, there are two different economic reasons for this. First, consider the case of low EM synergies, i.e. $\omega_{EM} \simeq 1$, similar ML and EL synergies ($\omega_{ML} \simeq \omega_{EL}$) and high uncertainty, i.e. low β_1 (Figures 3(a) and 3(d)). At first glance, it seems unprofitable to acquire M at all, however, the firm favors the acquisition of M over the big leap. The intuition behind this dominance of the acquisition program over the big leap is that uncertainty increases the option value to subsequently acquire the large incumbent which offsets the loss due to low synergies when acquiring M. Second, for a very high synergy factor ω_{EM} the pure hostile acquisition program will dominate the mixed and pure friendly acquisition programs as uncertainty increases because the subsequent hostile takeover of L adds an additional gain as opposed to the friendly merger and this might offset latter's earlier timing advantages. In particular, when negotiating the unfriendly takeover the entrant E acts again as a proposer and thus possesses a first-mover advantage. Hence, as opposed to the friendly takeover this advantage allows him to better adapt to the changing environment. For example, when uncertainty is high and the synergies between the large incumbent L and the new entity EM are high, E can use its better bargaining power to stimulate an earlier sale of the minor firm M - this will work against the discounting effect - by proposing a lower premium to the prominent incumbent L. In contrast, in a friendly merger E cannot act in this manner. Obviously, the higher the uncertainty the more valuable becomes the additional degree of freedom the unfriendly takeover provides and explains why the pure hostile acquisition program will dominate the mixed acquisition program. In general, a higher uncertainty favors hostile takeovers over friendly mergers, both in the big leap and acquisition program strategies. Finally, when the synergies of the big leap are relatively smaller/larger than the acquisition program synergies, the big leap strategy dominates over a smaller/larger range of ω_{EM} (Figures 3(b) and 3(c)).

Apart from looking whether the big leap or the acquisition program is more valuable, we want to look closer at the contract structure of each of the acquisition programs. As the results in the previous section have indicated, there exists a unique boundary that separates the stepwise acquisition of assets from the big-bang acquisition (see Propositions (7), (10), (13), and (16)). Consequently, each of the four regions that mark the possible strategies of an acquisition program can further be divided in stepwise and big-bang acquisitions.

In particular, Figure 2's regions hh, hf, fh and ff illustrate that the new entrant will prefer to acquire both firms M and L one immediately after the other (big-bang), while regions with (s) indicates that the firm will favor to first acquire M and then wait to acquire L subsequently. As the analytical results indicate, this has consequences for the acquisition thresholds and deal values. In particular, the contract stimulating the big-bang acquisition explicitly accounts for the subsequent acquisition possibility expressed by the characteristics of the prominent incumbent L, e.g. $\omega_{ML}, K_L, T_{f,ML}, T_{h,ML}$. (see propositions (6), (9), (12), and (15)). The economic rationale for this is that a big-bang acquisition occurs because the subsequent acquisition is much more attractive than the first acquisition, i.e. $x^*_{ij,L} \leqslant x^*_{ij,M}$ with $i, j \in \{f, h\}$. When the first acquisition is hostile, the new entrant E has to pay M a little bit more in order to induce it to sell the assets sooner, to get access to the second and more synergistic acquisition. For the same reason, when the first acquisition is friendly, both firms agree to anticipate the merger, jointly maximizing the merger surplus that includes the synergies of the second acquisition. When the second acquisition is not sufficiently attractive, a stepwise sequential acquisition is preferred (bottom-right quadrant of Figure 2 and right-end side of Figure 3).



(a) $\omega_{ML} = \omega_{EL} = 1.15$

(b) $\omega_{ML} = 1.3 > \omega_{EL} = 1.15$

(c) $\omega_{ML} = 1.15 < \omega_{EL} = 1.3$

(d) $\omega_{ML} = \omega_{EL} = 1.3$

Figure 3: Optimal acquisition strategy choice depending on synergy levels ω_{EM} and uncertainty level as measured by $\beta_1(\sigma)$. Here, regions bh and bf mark the big leap hostile takeover of L/friendly merger with L strategies, regions ij with $i, j \in \{f, h\}$ characterize acquisition program strategies where E prefers to acquire M and L by means of a hostile takeover (h) or friendly acquisition (f). (s) indicates that the acquisition program is implemented sequentially. The figure shows the highest option value according to Equation (53) using the parameters in Table 1.

5.3 Testable predictions

Our results generate several new predictions which might motivate empirical research. In particular we find:

1. If synergies in an acquisition program are dominantly driven by the minor firm's synergies, i.e. $1 < \omega_{ML} << \omega_{EM}$ the new entrant will prefer pure friendly acquisition programs.

2. If synergies in an acquisition program are dominantly driven by the large firm's synergies, i.e. $1 < \omega_{EM} << \omega_{ML}$ the new entrant will prefer pure hostile acquisition programs.

3. The new entrant will favor pure hostile acquisition programs over mixed and pure friendly acquisition programs when entering highly volatile industries.

4. Highly volatile industries are characterized by a higher frequency of acquisition programs than single acquisitions of the industry's prominent incumbent.

6 Conclusions

This paper studies the entrance in a market by means of M&A considering two alternative strategies available to the acquirer. One is the big leap, consisting in the acquisition of the large incumbent; the other strategy is to set an acquisition program moving in small steps, first acquiring a minor firm with the option to acquire the larger player later on. The paper also considers alternative contract designs for the big leap and the acquisition program, such as hostile, friendly or mixed. We derive analytical closed-form solutions for the optimal offers to both targets in the case of the acquisition program and contrast them against the single acquisition possibility.

Our findings reveal that synergies impact on the optimal entry strategy. In particular, if the acquisition of the minor firm produces relatively low synergies the big leap strategy tends to be more attractive, unless the former enables access to a high synergistic subsequent acquisition of the large incumbent. We show that for sufficiently large synergies of subsequent deals, the acquisition program may be preferable even when acquiring the minor firm destroys value (has negative synergies). Regarding the acquisition program, we find that the higher the synergies between the buyer and the minor incumbent, the more likely he chooses a pure friendly merger strategy, where both acquisitions are cooperative, while higher synergies between the buyer and the large incumbent stimulate a pure hostile acquisition strategy, where both acquisitions are non-cooperative. Additionally, by analyzing the effect of uncertainty on the acquisition strategy we show that highly uncertain industries will exhibit more pure hostile motivated acquisitions than industries with less significant uncertainties. Our model also suggests that in such highly uncertain industries acquisition programs are more frequent than single big leap acquisitions.

When structuring the serial acquisition program, two contract solutions have been considered. First, the new entrant might stepwise acquire the two incumbents, i.e. first acquire the minor firm and then wait for the acquisition of the large incumbent at the optimal timing. Secondly, the new entrant may prefer to acquire both incumbents immediately one after the other, which resembles a big-bang solution. In such a case, the characteristics associated with the large incumbent affect the optimal contract design offered to the minor incumbent. When that acquisition is hostile, a higher premium is paid to the minor firm in order to induce it to sell the assets sooner, whereas when it is friendly, both firms agree to anticipate the deal, jointly maximizing the merger surplus. When the second acquisition is not sufficiently attractive, a stepwise sequential acquisition is preferred.

In this paper we assume the new entrant's capabilities enable the acquisition synergies, which gives him the ability to define the best acquisition strategy. In our setting, the incumbent firms have a more passive role, i.e. we assume they do not consider the possibility of whether another acquisition method could increase their value. Further research could explore the case of a more active role of the other firms, for instance, in the choice between a friendly merger or a hostile takeover. Additionally, the paper could also be extended to allow the order of the acquisitions to be endogenously determined. Finally, the capital markets reactions to the deal announcements could be studied and linked to the premiums and shares captured by the firms.

References

Alvarez, L. H. R. and Stenbacka, R.: 2006, Takeover timing, implementation uncertainty, and embedded divestment options, *Review of Finance* **10**(3), 417–441.

Amburgey, T. L. and Miner, A. S.: 1992, Strategic momentum: The effects of repetitive, positional, and contextual momentum on merger activity, *Strategic Management Journal* **13**(5), 335–348.

Andrade, G., Mitchell, M. and Stafford, E.: 2001, New Evidence and Perspectives on Mergers, *Journal of Economic Perspectives* **15**(2), 103–120.

Andrade, G. and Stafford, E.: 2004, Investigating the economic role of mergers, *Journal of Corporate Finance* **10**(1), 1–36.

Betton, S., Eckbo, B. E. and Thorburn, K. S.: 2008, Corporate takeovers, *Handbook of Corporate Finance: Empirical Corporate Finance* **2**, 291–430.

Betton, S. and Moran, P.: 2003, A dynamic model of corporate acquisitions, *EFA 2004 Maastricht Meetings Paper No. 4060* .

Billett, M. T. and Qian, Y.: 2008, Are overconfident CEOs born or made? evidence of self-attribution bias from frequent acquirers, *Management Science* **54**(6), 1037–1051.

Boone, A. L. and Mulherin, J. H.: 2007, How are firms sold?, *Journal of Finance* **62**(2), 847–875.

Dimopoulos, T. and Sacchetto, S.: 2017, Merger activity in industry equilibrium, *Journal of Financial Economics* **126**(1), 200–226.

Dixit, A. K. and Pindyck, R. S.: 1994, *Investment under uncertainty*, Princeton University Press.

Fidrmuc, J. P., Roosenboom, P., Paap, R. and Teunissen, T.: 2012, One size does not fit all: Selling firms to private equity versus strategic acquirers, *Journal of Corporate Finance* **18**(4), 828–848.

Frick, K. A. and Torres, A.: 2002, Learning from high-tech deals, *The McKinsey Quarterly* pp. 113–124.

Fuller, K., Netter, J. and Stegemoller, M.: 2002, What do returns to acquiring firms tell us? evidence from firms that make many acquisitions, *The Journal of Finance* **57**(4), 1763–1793.

Goldman, E. and Qian, J.: 2005, Optimal toeholds in takeover contests, *Journal of Financial Economics* **77**(2), 321–346.

Hackbarth, D. and Miao, J.: 2012, The dynamics of mergers and acquisitions in oligopolistic industries, *Journal of Economic Dynamics and Control* **36**(4), 585–609.

Hackbarth, D. and Morellec, E.: 2008, Stock returns in mergers and acquisitions, *The Journal of Finance* **63**(3), 1213–1252.

Hirshleifer, D.: 1995, Mergers and Acquisitions: Strategic and Informational Issues, *Handbooks in Operations Research and Management Science*, Vol. 9, pp. 839–885.

Ismail, A.: 2008, Which acquirers gain more, single or multiple? Recent evidence from the USA market, *Global Finance Journal* **19**(1), 72–84.

Laamanen, T. and Keil, T.: 2008, Performance of serial acquirers: Toward an acquisition program perspective, *Strategic Management Journal* **29**(6), 663–672.

Lambrecht, B.: 2001, The timing and terms of mergers, stock offers and cash offers, *Judge Institute of Management, Working Paper 03/2001, University of Cambridge* .

Lambrecht, B.: 2004, The timing and terms of mergers motivated by economies of scale, *Journal of Financial Economics* **72**(1), 41–62.

Lambrecht, B. and Myers, S.: 2007, A Theory of Takeovers and Disinvestment, *The Journal of Finance* **62**(2), 809–845.

Lukas, E. and Welling, A.: 2012, Negotiating M&As under uncertainty: The influence of managerial flexibility on the first-mover advantage, *Finance Research Letters* **9**(1), 29–35.

Mason, R. and Weeds, H.: 2010, The timing of takeovers in growing and declining markets, *C.E.P.R. Discussion Papers, CEPR Discussion Papers* .

Morellec, E. and Zhdanov, A.: 2005, The dynamics of mergers and acquisitions, *Journal of Financial Economics* **77**(3), 649–672.

Powers, I. Y.: 1987, A Game-Theoretic Model of Corporate Takeovers by Major Stockholders, *Management Science* **33**(4), 467–483.

Rovit, S. and Lemire, C.: 2003, Your best M&A strategy, *Harvard Business Review* **81**(3), 16–16.

Roy, A.: 1989, Optimal Offer Strategies in Mergers and Acquisitions, *Decision Sciences* **20**(3), 591–601.

Schwert, G. W.: 2000, Hostility in takeovers: in the eyes of the beholder?, *The Journal of Finance* **55**(6), 2599–2640.

Smit, H. and Moraitis, T.: 2015, *Playing at acquisitions: Behavioral option games*, Princeton University Press.

Thijssen, J.: 2008, Optimal and strategic timing of mergers and acquisitions motivated by synergies and risk diversification, *Journal of Economic Dynamics and Control* **32**(5), 1701–1720.

van den Honert, R. C. and Stewart, T. J.: 1992, A game-theoretic model for mergers and acquisitions, *European Journal of Operational Research* **59**(2), 275–287.

Appendix

Proof of Proposition 1. Solving the maximization problem in Equation (4), the L's trigger for any given $\psi_{bh,L}$ is obtained:

$$x^*_{bh,L}(\psi_{bh,L}) = \frac{\beta_1}{\beta_1 - 1} \frac{(1-\epsilon_{EL})T_{h,EL}}{(\psi_{bh,L} - 1)K_L} \tag{60}$$

This optimal trigger is anticipated by E. Incorporating (60) into Equation (5) and maximizing for $\psi_{bh,L}$, the solution presented in Equation (6) is obtained. Finally, the trigger that incorporates the optimal premium is $x^*_{bh,L} \equiv x^*_{bh,L}(\psi^*_{bh,L})$, for which simply incorporate (6) into (60) and obtain (7). □

Proof of Proposition 2. The central planner's trigger reflects both firms' aggregate positions and comes from the solution of the standard smooth-pasting condition at $x(t) = x^*_{bf,L}$:

$$\beta_1 \left((\omega_{EL} - 1)K_L x(t) - T_{f,EL}\right) = (\omega_{EL} - 1)K_L x(t) \tag{61}$$

which leads to Equation (12). The general solution for the maximization problem (10) is:

$$\gamma(x(t)) = \frac{\epsilon_{EL}T_{f,EL} - \left(T_{f,EL} - K_L(\omega_{EL} - 1)x(t)\right)\eta_{EL}}{K_L \omega_{EL} x(t)} \tag{62}$$

Substituting $x^*_{bf,L}$ for $x(t)$ leads to (13). □

Proof of Proposition 3. Similarly to the proof of Proposition 1, firm L times the merger conditional on the $\psi_{ih,L}$ offered by EM:

$$\max_{x^*_{ih,L}(\psi_{ih,L})} \left[\left((\psi_{ih,L} - 1)K_L x^*_{ih,L}(\psi_{ih,L}) - (1-\epsilon_{ML})T_{h,ML}\right) \left(\frac{x(t)}{x^*_{ih,L}(\psi_{ih,L})}\right)^{\beta_1} \right] \tag{63}$$

obtaining the trigger:

$$x^*_{ih,L}(\psi_{ih,L}) = \frac{\beta_1}{\beta_1 - 1} \frac{(1-\epsilon_{ML})T_{h,ML}}{(\psi_{ih,L} - 1)K_L} \tag{64}$$

which is anticipated by EM who optimally finds the premium:

$$\max_{\psi_{ih,L}} \left[\left(\left((\omega_{EM} K_M + \omega_{ML} K_L) - \omega_{EM} K_M - \psi_{ih,L} K_L \right) x^*_{ih,L}(\psi_{ih,L}) - \epsilon_{ML} T_{h,ML} \right) \left(\frac{x(t)}{x^*_{ih,L}(\psi_{ih,L})} \right)^{\beta_1} \right] \tag{65}$$

By solving (65), we obtain $\psi^*_{ih,L}$ as presented in (14). Incorporating $\psi^*_{ih,L}$ into (64) and rearranging we get (15). □

Proof of Proposition 4. The cooperative trigger is obtained by solving the maximization problem:

$$\max_{x^*_{if,L}} \left[\left((\omega_{ML} - 1) K_L x^*_{if,L} - T_{f,ML} \right) \left(\frac{x(t)}{x^*_{if,L}} \right)^{\beta_1} \right] \tag{66}$$

Equation (20) is the solution. The solution for the optimization problem (18), for any $x(t)$ is:

$$\gamma^*(x(t)) = \frac{T_{f,ML}(\epsilon_{ML} - \eta_{ML}) \left(\omega_{EM} K_M + \eta_{ML}(\omega_{ML} - 1) K_L \right) x(t)}{(\omega_{EM} K_M + \omega_{ML} K_L) x(t)} \tag{67}$$

Computing the optimal stake at the optimal trigger, i.e., setting $x(t) = x^*_{if,L}$, substituting η_{ML} according (19), and rearranging we get (21). □

Proof of Proposition 5. Proceed as for Proposition 3. The continuation value to be incorporated as $F_h(.)$ into Equation (24) to maximize for $\psi_{hh,M}$ is the upper branch of Equation (25). Firm M optimizes for the timing:

$$x^*_{hh,M}(\psi_{hh,M}) = \frac{\beta_1}{\beta_1 - 1} \frac{(1 - \epsilon_{EM}) T_{h,EM}}{(\psi_{hh,M} - 1) K_M}, \tag{68}$$

and firm E anticipates this outcome, incorporates it into 24 and maximizes for $\psi^*_{hh,M}$ leading to (26). Equation (27) is obtained incorporating (26) into (68). □

Proof of Proposition 6. As the acquisition of L is now in-the-money, the relevant value function to be incorporated as $F_h(.)$ into (24) is the lower branch of Equation (25). At $x^*_{hh,M}$ the premium $\psi_{hh,L}$ to be offered to L is the one that solves $x^*_{hh,L}(\psi_{hh,L}) =$

$x^*_{hh,M}(\psi_{hh,M})$, i.e., the one that aligns the triggers, which leads to:

$$\bar{\psi}_{hh,L} = 1 + \frac{(\psi_{hh,M} - 1)(1 - \epsilon_{ML})T_{h,ML}K_M}{(1 - \epsilon_{EM})T_{h,EM}K_L} \tag{69}$$

Incorporating (69), the lower branch of (25) comes:

$$\left(\left(\omega_{ML} - \bar{\psi}_{hh,L}\right) K_L - \omega_{EM}K_M\right) x(t) - \epsilon_{ML}T_{h,ML} \tag{70}$$

All the remaining maximizing procedures for finding $\psi^*_{hh,M}$ and $x^*_{hh,M}(\psi^*_{hh,M})$ are as before and lead to the solutions presented in (28) and (29).

Regarding Equation (31), substitute in (69) $\psi_{hh,M}$ by $\psi^*_{hh,M}$. It is trivial to show that $\bar{\psi}_{hh,L} < \psi^*_{hh,L}$. □

Proof of Proposition 7. Set Equations (27) and (29) equal and solve for ω_{ML} for finding the level of synergies that separate the sequential and the big-bang regions. □

Proof of Proposition 8. To obtain the solutions simply follow the procedure presented earlier, for proving Proposition 5. Notice, however, that the objective function (24) includes the value of the subsequent acquisition $F_f(.)$. Under a sequential entry, where the subsequent acquisition is cooperative, the value of this function is obtained from the first branch of (33). □

Proof of Proposition 9. Proceed as in Proposition 6. The relevant value function to incorporate in Equation (24) is now the one represented in the second branch of (33). Notice that the optimal γ needs to be computed at $x(t) = x^*_{hf,M}$, and not at $x(t) = x^*_{hf,L}$, as in Equation (21). Use Equation (62) for this purpose.

Regarding the relative value of the premiums, start with Equations (35) and (37). The difference between the latter and the former is positive if:

$$K_LT_{h,EM}(\beta_1 - \epsilon_{EM})(\omega_{ML} - 1) + K_MT_{f,ML}(\beta_1 - 1)(\omega_{EM} - 1) > 0 \tag{71}$$

which is respected if:

$$\omega_{ML} > 1 + \frac{(\beta_1 - 1)T_{f,ML}}{(\beta_1 - \epsilon_{EM})T_{h,EM}} \times \frac{(\omega_{EM} - 1)K_M}{K_L} = \Omega_{hf} \tag{72}$$

Accordingly, if ω_{ML} is sufficiently large to produce a big-bang solution, then it also leads to a premium paid (to M) larger than that paid in the case of a sequential acquisitions.

□

Proof of Proposition 10. Set Equations (36) and (38) equal and solve for ω_{ML} for finding the level of synergies that separate the sequential and the big-bang regions. □

Proof of Proposition 11. In the sequential case, the first branch of (25) is used to incorporate as $F_j(.)$ into (41). The trigger, given by Equation (42), corresponds to that of a central planner and is the solution of the smooth-pasting condition at $x(t) = x^*_{fh,M}$:

$$\beta_1 \left((\omega_{EM} - 1)K_M x(t) + A_h x(t)^{\beta_1} - T_{f,EM} \right) = (\omega_{EM} - 1)K_M x(t) + \beta_1 A_h x(t)^{\beta_1} \tag{73}$$

where $A_h = \left(\left(\left(\omega_{ML} - \psi^*_{hh,L} \right) K_L - \omega_{EM} K_M \right) x^*_{hh,L} - \epsilon_{ML} T_{h,ML} \right) \left(\frac{1}{x^*_{hh,L}} \right)^{\beta_1}$. Equation (43) is the solution of the maximization problem (41) after substituting $x(t)$ for the respective trigger, $x^*_{fh,M}$. □

Proof of Proposition 12. For the big-bang case, the second branch of (25) is used to incorporate as $F_j(.)$ into (41). As before, the trigger (Equation (44)) corresponds to that of a central planner, and is the solution of the smooth-pasting condition at $x(t) = x^*_{fh,M}$:

$$\begin{aligned} &\beta_1 \left(((\omega_{ML} - \psi^*_{hh,L})K_L + (\omega_{EM} - 1)K_M)x(t) - \epsilon_{ML} T_{h,ML} - T_{f,EM} \right) \\ &\qquad = \left((\omega_{ML} - \psi^*_{hh,L})K_L + (\omega_{EM} - 1)K_M \right) x(t) \end{aligned} \tag{74}$$

where $\psi^*_{hh,L}$ is set equal to $\bar{\psi}_{fh,L}$. Equation (45) is the solution of the maximization problem (41) after substituting $x(t)$ for the respective trigger. Solving the smooth-pasting condition (74) for a generic ψ gives:

$$x^*_{fh,M}(\psi) = \frac{\beta_1}{\beta_1 - 1} \frac{T_{f,EM} + \epsilon_{ML} T_{h,ML}}{(\omega_{EM} - 1)K_M + (\omega_{ML} - \psi)K_L} \tag{75}$$

Substitute $\bar{\psi}_{fh,L}$ for ψ and $\psi_{ih,L}$ in (75) and in (64), respectivelly. Set $x^*_{fh,M}(\bar{\psi}_{fh,L}) = x^*_{ih,L}(\bar{\psi}_{fh,L})$ and solve for $\bar{\psi}_{fh,L}$. □

Proof of Proposition 13. Set Equations (42) and (44) equal and solve for ω_{ML} for finding the level of synergies that separate the sequential and the big-bang regions. □

Proof of Proposition 14. In the sequential case, the first branch of (33) is used to incorporate as $F_j(.)$ into (41). The trigger is given by Equation (48), and corresponds to that of a central planner which solves the following smooth-pasting condition at $x(t) = x^*_{ff,M}$:

$$\beta_1 \Big((\omega_{EM} - 1)K_M x(t) + A_f x(t)^{\beta_1} - T_{f,EM} \Big) = (\omega_{EM} - 1)K_M x(t) + \beta_1 A_f x(t)^{\beta_1} \tag{76}$$

where $A_f = \left(\phi_{hf} x^*_{hf,L} - \epsilon_{ML} T_{f,ML}\right) \left(\frac{1}{x^*_{hf,L}}\right)^{\beta_1}$ (see the first branch of Equation (33) and Equation (34)). Equation (49) is the solution of the maximization problem (41) after substituting $x(t)$ for the respective trigger. □

Proof of Proposition 15. For the big-bang case, the second branch of (33) is used to incorporate as $F_j(.)$ into (41). The trigger is given by Equation (48), and corresponds to that of a central planner which solves the following smooth-pasting condition at $x(t) = x^*_{ff,M}$:

$$\begin{aligned} \beta_1 \left(((\omega_{EM} - 1)K_M + \eta_{ML}(\omega_{ML} - 1)K_L)x(t) - T_{f,EM} - \eta_{ML} T_{f,ML} \right) \\ = (\omega_{EM} - 1)K_M + \eta_{ML}(\omega_{ML} - 1)K_L)x(t) \end{aligned} \tag{77}$$

Equation (51) is the solution of the maximization problem (41) after substituting $x(t)$ for the respective trigger. □

Proof of Proposition 16. Set Equations (48) and (50) equal and solve for ω_{ML} for finding the level of synergies that separate the sequential and the big-bang regions. □