# M&A Dynamic Games under the Threat of Hostile Takeovers*

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**Abstract**

This paper builds on recent advances in the domain of option games under uncertainty and looks closer at determinants that drive friendly mergers. Each firm calculates its payoff resulting from either a friendly merger or hostile takeover that then serves as a credible threat when jointly negotiating the terms of a merger. In contrast to similar papers, we show that the firms still have an incentive to delay the merger. Moreover, the results indicate that threat values are important for the asymmetric firm case, i.e. when firms have different bargaining power. The weaker firm can improve its position in the merger as uncertainty increases, i.e. its share in the new entity increases. The same holds true if synergies increase.

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

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

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## 1 Introduction

On March, 19th in 1997 Krupp-Hoesch, a German Steelmaker, launched a hostile takeover bid for its German rival Thyssen.[1] While the combined firm's steel production would catapult the new entity up to number three of world steelmaker and number one in Europe, respectively, the gained strength and competitive advantage was not the astounding fact. Rather, the M&A was interesting because of two other facts. First, hostile takeovers are very rare in Germany. Second, the bidder Krupp-Hoesch was ranked 17th in the world steel production and far smaller than the sighted target Thyssen (in 1996 Krupp-Hoesch sales were 24 billions DEM and yssen 41 billions DEM)[2]. In that sense, *David* had challenged the Philistine champion *Goliath* as described in the book of Samuel. Unlike the decent of the Old Testament, however, Krupp-Hoesch was not as unexperienced as the young sheppard David. The 1811 founded company which became one of Europe's great industrial powers by the turn of the 20th century had already a track record regarding successful hostile takeovers. Consequently, the hostile bid served as a credible threat to Thyssen's managers and the a reasonable strategy to prevent the hostile takeover was to agree to a merger between the two firms which materialized November, 4th in 1997.

To date, research on M&A strategies, their performance and important determinants has constantly received considerable attention in the finance literature. While previous literature in the domain of theoretical corporate finance has predominantly looked at the effect the means of payment has on M&A outcome, less attention has been on the negotiation tacicts. In particular, how does the threat of a hostile bid affects merger bargaining and timing? Alike, does such a threat make friendly merger more likely? And finally, how does uncertainty impact the negotiating tactics? This paper contributes to the M&A literature on dynamic bargaining under uncertainty and tries to provide answers to the aforementioned questions.

[1] New York Times, March 19, 1997 *Krupp-Hoesch Confirms Bid Of $8 Billion for Thyssen.*

[2] See e.g. Puziak and Martyniuk (2012)

The paper unfolds as follows. Section 2 provides a brief overview of recent literature while Section 3 presents the derivation of the model. Section 4 analyses the optimal strategy choices and presents numerical results based on comparative-static analysis. Finally, Section 5 concludes.

## 2 Literature review

Bargaining and negotiation are pivotal pieces of M&As and recent literature has analyzed how uncertainty affects dynamic decision making of the party's involved. In particular, several papers have used the real options approach to advance the analysis of contract design under uncertainty (Lambrecht, 2004; Morellec and Zhdanov, 2005; Alvarez and Stenbacka, 2006; Lambrecht and Myers, 2007; Thijssen, 2008; Lukas and Welling, 2012). The results have provided answers with respect to how hostile takeover negotiation and merger n,egotiation, respectively, have an impact on takeover timing and sharing of the surplus under uncertainty. Exemplary, Morellec and Zhdanov (2005) and Lambrecht (2004) model a friendly merger of two firms where the timing and terms of takeovers are endogenous and result from value-maximizing decisions. The findings reveal, that M&As are usually timed in periods of economic expansion and that competition among heterogeneous firms speeds up the acquisition process. Alike, Lambrecht and Myers (2007) show that M&As are not solely triggered by positive economic shocks but can also be efficient when industries decline. Recent papers have furthermore stressed the importance of takeover type, i.e. friendly or hostile, on timing and wealth distribution. The results indicate that hostile takeovers occur inefficiently late when compared with the friendly merger as being the first-best. However, the bidder can claim a majority stake in the new entity due to its first-mover advantage and thus improve his bargaining position (See e.g. Lambrecht, 2004; Lukas and Welling, 2012).

Yet, however, the impact of negotiation tactics and threats as in the case of ThyssenKrupp have been neglected in this literature domain so far. We expand the literature on M&A timing by explicitly allowing firms to switch to alternative tactics in case of disagreement to a friendly merger. Thus, the paper is closely related to Thijssen (2008). Here, both the bidder and the target can make a bid for the other firm at any time. The two firms maximize expected profits and face different, but correlated, risk. A friendly merger occurs, when both simultaneous bid for the other firm. In contrast, no simultaneous bids indicate a hostile takeover. There are two important results: First, if the roles the player take up, i.e. bidder or seller, are determined endogenously then the value to delay the M&A disappears due to the threat of preemption. This is in contrast to situations where the roles are assigned exogenously. Here, an incentive for the parties arise to delay the merger. Second, merger can be observed in both declining and expanding industries.

We deviate from this paper in certain ways. First, we do not make the assumption that the terms of a merger and hostile takeover, respectively, are set only by one player. As in Lambrecht (2004); Morellec and Zhdanov (2005) and Lukas and Welling (2012), among others we allow both the bidder and the target to determine the terms by which wealth is distributed and when to close the deal. Second, and more importantly, we allow both firms to threaten the other firm to conduct a hostile takeover in the second stage should a friendly merger negotiation fail. Our findings reveal that parties' have still an incentive to postpone the merger. Regarding the endogenous roles of the player, we find that firm 1 will choose to become a target (bidder) if it has low (high) bargaining power. Hence, if firms are symmetric with respect to bargaining then both end up in a friendly merger. Also, the smaller, weaker (larger, stronger) firm's position in the merger is positively (negatively) affected by uncertainty, i.e. the higher the uncertainty the higher (lower) his share in the new entity. This result is a direct consequence of the threat imposed in the subsequent stages. Alike, the weaker (stronger) firm's position in friendly merger is also improved should synergies increase (decrease). These results are in contrast with the findings of Lambrecht (2004) and Morellec and Zhdanov (2005).

## 3 The Model

Consider two firms active in the market labeled as $i$ and $j$. In the merging process two roles $B$ and $T$ can be assumed by the firms, where $B$ stand for bidder and $T$ for target. For the sake of simplicity, we will assume that each firm is endowed with a capital stock

$K_{i,j}$ and subject to an industry wide shock modeled by means of a geometric Brownian motion, i.e.:

$$dx(t) = \alpha x(t)dt + \sigma x(t)dW \quad (1)$$

where $\alpha \in \mathbb{R}$ denotes the instantaneous drift, $\sigma \in \mathbb{R}^+$ denotes the instantaneous variance and $dW$ denotes the standard Wiener increment. Under risk-neutrality we set $\alpha = r - \delta$, where $r$ is the risk-free rate and $\delta$ is a return shortfall. Additionally, we will assume that:

$$V_{i,j}(t) = K_{i,j}x(t) \quad (2)$$

were $V_{i,j}(t)$ approximates the firms' individual stand-alone values.

Upon merging, the value of the new entity $M$ is give by:

$$V_M(t) = (\omega + K_B + K_T)x(t) \quad (3)$$

where $\omega > 0$ denote synergies arising from the merger.

Our merger game unfolds as follows. At the outset, and before start negotiating the terms of the merger, each of the firms ($i$ and $j$) assess in what position it would end up if the negotiations fail. This *pre-assessment* stage seems to be relevant in situations where the interest in the M&A process is not restricted to friendly mergers, and when firms can move to a hostile takeover if cooperation breaks. In other words, before starting the negotiation, each firm considers the alternative (hostile) option to merge, evaluating its own position in this scenario.

In technical terms, the alternative for the hostile takeover is an outside option, which will emerge in the case of disagreement. If credible, the alternative position of each firm acts as a threat value. These are known as disagreement points (the values each plays expect to obtain in the case of a break down of the negotiations) which should be considered for finding the terms of the friendly merger. In fact, the firms play a threat game, by choosing the role (hostile bidder or target) that maximizes their own position in the cooperative negotiation. The optimal roles to be played by each firm will depend, as we will see, on the their relative bargaining power. By considering, realistically, the existence of a hostile outside option for both parties, we depart from the existing dynamic M&A literature, where a null threat value is assumed (Thijssen, 2008).

Then, the players move to the second stage which refers to setting the cooperative game, accounting for the existence of the disagreement points. Given each firm's bargaining power the game is solved by means of the Nash bargaining solution.

### 3.1 Hostile takeover

In order to model the acquisition process, we will rely on a non-cooperative bargaining solution following Lukas and Welling (2012), where the bidder firm offers a premium $\psi > 0$ and the target times the acquisition. Let $\epsilon_B Y$ and $\epsilon_T Y = (1 - \epsilon_B)Y$ denote the transaction costs assigned to each party where $\epsilon_B \in (0, 1)$ indicates the fraction of the irreversible transaction costs $(Y)$ assigned to the bidder.

Consequently, the target firm $T$ receives a premium $\psi K_T x(t)$ in exchange for its asset worth $K_T x(t)$ and has to bear transaction cost of size $(1 - \epsilon_B)Y$. Following standard real option reasoning, for any given premium level, $\psi$, $T$'s timing decision to sell the company solves the following optimization problem:

$$f(x) = \max_{\tau} \left[ \mathbf{E} \left[ \left( (\psi - 1) K_T x(t) - (1 - \epsilon_B) T \right) e^{-r\tau} \right] \right], \tag{4}$$

$$= \max_{x_h^*(\psi)} \left[ \left( (\psi - 1) K_T x_h^*(\psi) - (1 - \epsilon_B) T \right) \left( \frac{x(t)}{x_h^*(\psi)} \right)^{\beta_1} \right] \tag{5}$$

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 bidder anticipates the reaction function of the target and grants an optimal premium such that it maximizes its objective function, i.e.:

$$\max_{\psi} \left[ \left( \left( (\omega + K_B + K_T) - K_B - \psi K_T \right) x_h^*(\psi) - \epsilon_B Y \right) \left( \frac{x(t)}{x_h^*(\psi)} \right)^{\beta_1} \right] \tag{6}$$

Solving both objective functions recursively leads to the following result:

**Proposition 1.** *The hostile takeover of firm $j$ by firm $i$ takes place, if firm $j$ receives an* *optimal premium $\psi^*$ and waits until $x(t)$ hits the optimal trigger value $x(t) = x_h^*$ where $\psi^*$ and $x_h^*$ are given by:*

$$\psi^* = 1 + \frac{(\beta_1 - 1)(1 - \epsilon_B)}{\beta_1 - \epsilon_B} \frac{\omega}{K_T} \tag{7}$$

$$x_h^*(K_B, K_T, \epsilon_B) \equiv x_h^*(\psi^*) = \frac{\beta_1}{(\beta_1 - 1)^2} \frac{(\beta_1 - \epsilon_B)Y}{\omega} \tag{8}$$

*Option values:*

$$B(K_B, K_T, \epsilon_B)x^{\beta_1} = \frac{(\beta_1 - \epsilon_B)Y}{(\beta_1 - 1)^2} \left( \frac{x}{x_h^*(K_B, K_T, \epsilon_B)} \right)^{\beta_1} \tag{9}$$

$$T(K_B, K_T, \epsilon_B)x^{\beta_1} = \frac{(1 - \epsilon_B)Y}{\beta_1 - 1} \left( \frac{x}{x_h^*(K_B, K_T, \epsilon_B)} \right)^{\beta_1} \tag{10}$$

*Proof.* See Appendix. □

A higher uncertainty (higher $\sigma$, lower $\beta_1$) induces the bidder to offer a lower premium and to wait for a higher level of the state variable $x$. If the merger produces more synergies, it will occur sooner with a higher premium (Corollary 1).

**Corollary 1.** *The sensitivities of the optimal solution are as follows: $\partial\psi^*/\partial\sigma < 0$, $\partial x_h^*/\partial\sigma > 0$, $\partial\psi^*/\partial\omega > 0$, $\partial x_h^*/\partial\omega < 0$.*

### 3.2 Friendly merger

Let us start by considering a friendly merger between firm 1 and 2. In particular, let us assume that after the merger, each firm holds an equity stake $\gamma_i$ in the new firm. Each firm will give up his stand-alone value $V_i = K_i x(t)$ and receives upon paying the transaction cost $\epsilon_i Y$ a stake in the new venture thereby profiting from the synergies $\omega$ that arise out of the merger. Hence, firm $i$'s net gain becomes:

$$(\gamma_i(\omega + K_1 + K_2) - K_i)x(t) - \epsilon_i Y \tag{11}$$

where $\omega + K_1 + K_2$ denotes the size of the merged firm.

Assuming that both firms possess a certain amount of bargaining power, $\eta_1$ for firm 1 and $\eta_2 = 1 - \eta_1$ for firm 2, then the optimal share each firm has in the new venture solves the following optimization problem:

$$\max_{\gamma_i} \Big[ \Big( \gamma_i(\omega + K_1 + K_2) - K_1) x(t) - \epsilon_i Y - A_i x^{\beta_1} \Big)^{\eta_i} \Big( ((1-\gamma_i)(\omega + K_1 + K_2) - K_2) x(t) - (1-\epsilon_i) Y - A_j x^{\beta_1} \Big)^{1-\eta_i} \Big] \qquad i, j \in \{1, 2\}, i \neq j \tag{12}$$

The terms $A_i x^{\beta_1}$ and $A_j x^{\beta_1}$ represent, in generic terms, the disagreement points of $i$ and $j$ respectively. Notice that the constants $A_i$ and $A_j$ will reflect, as we will see, the concrete position each firm will assume by playing the threat game.

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 $x_f^*$ from below:*

$$x_f^* = \frac{\beta_1}{\beta_1 - 1} \frac{Y}{\omega} \tag{13}$$

*Firm $i$'s optimal stake $\gamma_i^*(x_f^*)$ in the merger amounts to:*

$$\gamma_i(x_f^*) = \frac{K_i}{\omega + K_1 + K_2} + \left( \frac{(\beta_1 - 1)\epsilon_i + \eta_i}{\beta_1} + \theta_i \right) \frac{\omega}{\omega + K_1 + K_2} \tag{14}$$

*where*

$$\theta_i = \frac{\beta_1 - 1}{\beta_1} \times \frac{(1-\eta_i) A_1 - \eta_i A_2}{Y} {x_f^*}^{\beta_1} \tag{15}$$

*Proof.* See Appendix. □

Now that we have derived the optimal policy for the two firms to merge, we can deduce firm $i$'s ex-ante option value for the friendly merger, i.e.:

$$F_i(x) = \begin{cases} \Big( (\gamma_i^*(\omega + K_1 + K_2) - K_i) \, x_f^* - \epsilon_i Y \Big) \left( \dfrac{x(t)}{x_f^*} \right)^{\beta_1} & x(t) < x_f^* \\ (\gamma_i^*(\omega + K_1 + K_2) - K_i) \, x(t) - \epsilon_i Y & x(t) \geqslant x_f^* \end{cases} \tag{16}$$

where $\gamma_i^* \equiv \gamma_i(x_f^*)$.

The threat values do not impact the timing, but only the sharing rule ($\gamma_i^*$) and, therefore, the option value $F_i$. Choosing the highest option value is the same as choosing the highest share in the merged firm.

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

$$\begin{aligned} G(x) &= \max_{\tau} \left[ \mathbf{E} \left[ (\omega x(t) - Y) \, e^{-r\tau} \right] \right] \\ &= \max_{x_f^*} \left[ \left( \omega x_f^* - Y \right) \left( \frac{x(t)}{x_f^*} \right)^{\beta_1} \right] \end{aligned} \tag{17}$$

**Proposition 3.** *The trigger for merging of the individual firms is the same as that of a central planner maximizing the overall payoff* $\omega x(t) - Y$.

*Proof.* See Appendix. □

The two firms bargain the share of a constant merger surplus or, equivalently, the share of the overall option to merge.

### 3.3 The threat game

Let us now move to the initial stage where the firms make a pre-assessment of their individual positions in the case of a negotiation failure. The firms play a threat game, by choosing the role (hostile bidder or target) that maximizes their own position in the cooperative negotiation, which naturally influences the outcome of the game.

Let us present the possible combinations of the roles (bidder and target) each firm can threat to assume.

#### Case 1: both bidders (null threat)

Consider the case where both firm threaten to assume the role of a hostile bidder if the negotiations breakdown. Naturally, the threat reveals not credible in this context and so a null disagreement point is assumed, as no serious outside option emerges in this context. Accordingly, under a null threat value we set $A_1 = A_2 = 0$. Substituting in equation 14, we obtain the following solutions for the optimal sharing rule and for option value in the continuation region:

$$\gamma_i^{BB} = \frac{K_i}{\omega + K_1 + K_2} + \frac{(\beta_1 - 1)\epsilon_i + \eta_i}{\beta_1} \times \frac{\omega}{\omega + K_1 + K_2} \tag{18}$$

$$F_i^{BB}(x) = \eta_i \frac{Y}{\beta_1 - 1} \left( \frac{x(t)}{x_f^*} \right)^{\beta_1}, \qquad x(t) < x_f^* \tag{19}$$

**Case 2: both targets**

If both plays threaten to assume the target position, both passively waiting for the hostile bidding from the other party, the disagreement points are as follows:

$$A_1 = T(K_2, K_1, 1 - \epsilon_1)$$
$$A_2 = T(K_1, K_2, \epsilon_1)$$

and following solutions arise for the sharing rule:

$$\gamma_i^{TT} = \frac{K_i}{\omega + K_1 + K_2} + \left( \frac{(\beta_1 - 1)\epsilon_i + \eta_i}{\beta_1} + \theta_i^{TT} \right) \frac{\omega}{\omega + K_1 + K_2} \tag{20}$$

where

$$\theta_i^{TT} = \frac{(1 - \eta_i)\epsilon_i}{\beta_1} \left( \frac{\beta_1 - 1}{\beta_1 - (1 - \epsilon_i)} \right)^{\beta_1} - \frac{\eta_i(1 - \epsilon_i)}{\beta_1} \left( \frac{\beta_1 - 1}{\beta_1 - \epsilon_i} \right)^{\beta_1} \tag{21}$$

and for the option to merge:

$$F_i^{TT}(x) = \left( (1 - \eta_i)\epsilon_i \left( \frac{\beta_1 - 1}{\beta_1 - (1 - \epsilon_i)} \right)^{\beta_1} - \eta_i(1 - \epsilon_i) \left( \frac{\beta_1 - 1}{\beta_1 - \epsilon_i} \right)^{\beta_1} + \eta_i \right) \times$$
$$\times \frac{Y}{\beta_1 - 1} \left( \frac{x(t)}{x_f^*} \right)^{\beta_1}, \qquad x(t) < x_f^* \tag{22}$$

**Case 3: $i$ the bidder, and $j$ the target**

Consider the outside options for one firm is to be a hostile bidder and for the other is to assume a target position. For this case, the threat values take the form:

$$A_i = B(K_i, K_j, \epsilon_i)$$

$$A_j = T(K_i, K_j, \epsilon_j)$$

and the sharing rule become:

$$\gamma_i^{BT} = \frac{K_i}{\omega + K_1 + K_2} + \left( \frac{(\beta_1 - 1)\epsilon_i + \eta_i}{\beta_1} + \theta_i^{BT} \right) \frac{\omega}{\omega + K_1 + K_2} \tag{23}$$

where

$$\theta_i^{BT} = \frac{(1 - \eta_i)(\beta_1 - \epsilon_i) - \eta_i(\beta_1 - 1)(1 - \epsilon_i)}{\beta_1(\beta_1 - 1)} \left( \frac{\beta_1 - 1}{\beta_1 - \epsilon_i} \right)^{\beta_1} \tag{24}$$

and the options value is as follows:

$$F_i^{BT}(x) = \left( (1 - 2\eta_i)(1 - \epsilon_i) \left( \frac{\beta_1 - 1}{\beta_1 - \epsilon_i} \right)^{\beta_1} + \eta_i \right) \frac{Y}{\beta_1 - 1} \left( \frac{x(t)}{x_f^*} \right)^{\beta_1}, \qquad x(t) < x_f^* \tag{25}$$

Figure 1 shows the possible combinations for the roles of firms 1 and 2, with respective equity stake.

| | | Firm 2 | |
|---|---|---|---|
| | | bidder | target |
| Firm 1 | bidder | $(\gamma_1^{BB}, 1 - \gamma_1^{BB})$ | $(\gamma_1^{BT}, 1 - \gamma_1^{BT})$ |
| | target | $(1 - \gamma_2^{BT}, \gamma_2^{BT})$ | $(\gamma_1^{TT}, 1 - \gamma_1^{TT})$ |

**Figure 1:** The threat game

Since $1 - \gamma_2^{BT} \geqslant \gamma_1^{TT}$ and $1 - \gamma_1^{BT} \geqslant 1 - \gamma_1^{TT}$ Firm $i$ always prefers to threat to be the hostile bidder when $j$ opts for the hostile target threat. Therefore the two firm will never use as threat values the hostile target values simultaneously.

When firm 2 opts for the bidder threat, Firm 1 prefers the bidder threat when $\gamma_1^{BB} \geqslant 1 - \gamma_2^{BT}$, which occurs when

$$\eta_1 \geqslant \eta_1^L = \frac{(\beta_1 - 1)\epsilon_1}{\beta_1 - 1 + \beta_1\epsilon_1} \tag{26}$$

If firm 2 has not enough bargaining power, it will opt for the target threat when $1 - \gamma_1^{BT} \geqslant 1 - \gamma_1^{BB}$, which occurs when

$$\eta_1 \geqslant \eta_1^H = \frac{\beta_1 - \epsilon_1}{\beta_1 - 1 + \beta_1(1 - \epsilon_1)} \tag{27}$$

**Proposition 4.** *Nash equilibrium in pure strategies is the following:*

*(i) Firm 1 chooses target and firm 2 chooses bidder if the bargaining power of firm 1 is small* $\left(0 \leqslant \eta_1 < \eta_1^L\right)$*;*

*(ii) Firm 1 choose bidder and firm 2 chooses target if the bargaining power of firm 2 is small* $\left(\eta_1^H < \eta_1 \leqslant 1\right)$*;*

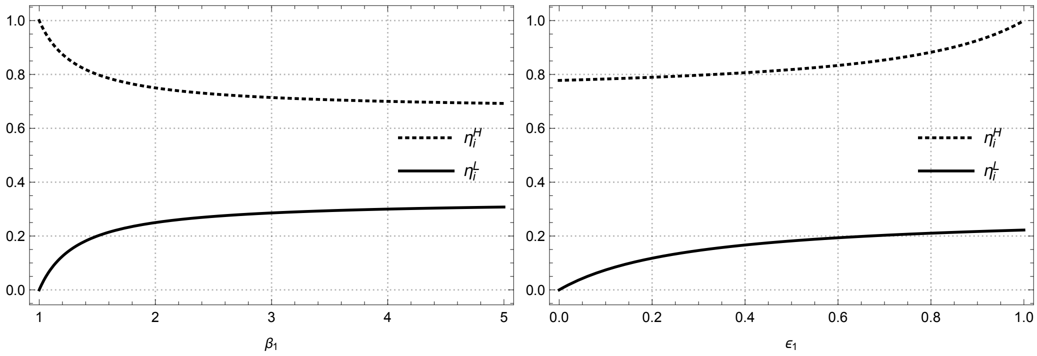
*(iii) For intermediate bargaining powers the two firms want to threaten being hostile bidders, and end up with zero threat value (non-credible threat)* $\left(\eta_1^L \leqslant \eta_1 < \eta_1^H\right)$*.*

# 4 Comparative statics

In this section we present a comparative statics of the main drivers of merger timing and terms.

From Equations (26) and (27), the choice of the optimal strategy for the threat game is only determined by the level of uncertainty and the merger costs incurred by each firm.

**Corollary 2.** *A higher the uncertainty increases the bargaining power wedge over which firms prefer to chose the bidder threat value* ($\partial\eta_i^L/\partial\beta_1 < 0$ *and* $\partial\eta_i^H/\partial\beta_1 > 0$)*. The choice of the target (bidder) threat is more likely for firms with a low (high) bargaining power the lower the uncertainty is.*




(a) (b)

$\epsilon_i = 0.5$, $\beta_1 = 1.4$

**Figure 2:** Sensitivity of the threat values to $\beta_1$ and $\epsilon_i$

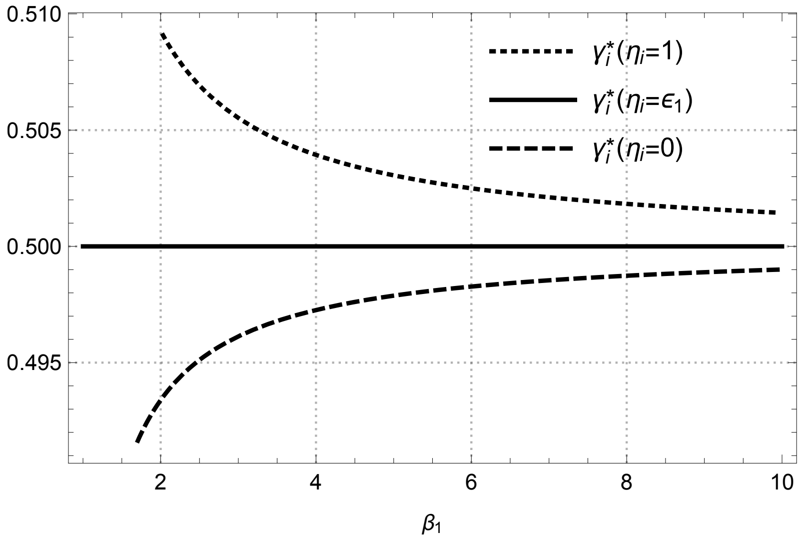
**Corollary 3.** *The choice of the target (bidder) threat is more (less) likely for firms with a low (high) bargaining power when the fraction of the merger costs incurred increases* $(\partial\eta_i^L/\partial\epsilon_i > 0$ *and* $\partial\eta_i^H/\partial\epsilon_i > 0)$*.*

Figure 2 illustrates these effects. Notice that size can impact the strategy choice if the fraction of the merger costs paid by each firm is not independent of size.

**Corollary 4.** *A higher uncertainty deters mergers* $\left(\partial x_f^*/\partial\sigma > 0\right)$ *and induces a higher (lower) share for the firm with a bargaining power higher (lower) than its fraction in the merger costs* $(\partial\gamma_i/\partial\sigma > 0,$ *if* $\eta_i > \epsilon_i)$*. If the bargaining power is proportional to the merger costs, uncertainty has no effect on the merger terms.*

Figure 3 illustrates the effect of uncertainty on the merger terms, stated in Corollary 4. The Figure plots three cases: a base-case where $n_1 = \epsilon_i$ and the limiting cases of a full ($\eta_i = 1$) and a null ($\eta_i = 0$) bargaining power. The Figure shows that the effect of uncertainty on the merger terms is more pronounced for high levels of uncertainty (low $\beta_1$).

The bargaining power of each firm in the merger negotiation determines the merger terms. Our model suggests that a higher bargaining power allows a firm to capture a higher share of the merged firm, but also increases the negotiation power of those firms that can credible commit to a bidder role in a subsequent hostile takeover.



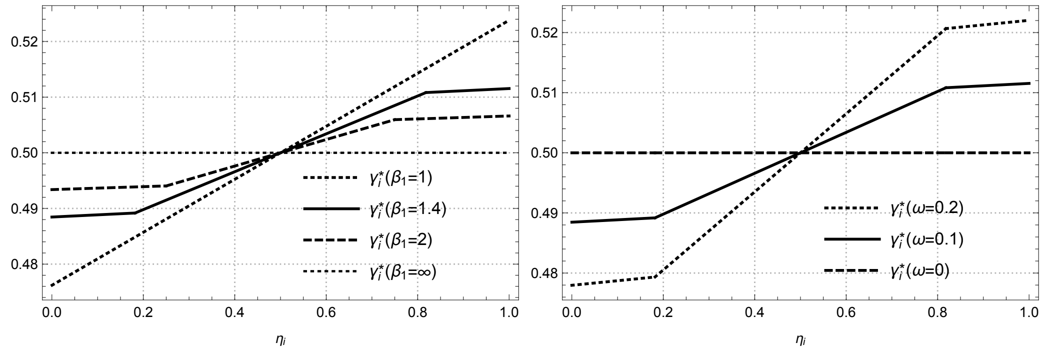

$K_i = 1$, $K_j = 1$, $\omega = 0.1$, $Y = 0.1$, $\epsilon_i = K_i/(K_i + K_j)$, $\beta_1 = 1.4$

**Figure 3:** Sensitivity of the merger terms to $\beta_1$

**Corollary 5.** *The bargaining power of firms has no effect on the timing of mergers* $\left(\partial x_f^*/\partial \eta_i = 0\right)$ *but induces higher shares for firms with a higher bargaining power* $(\partial \gamma_i/\partial \eta_i > 0)$*. This effect is augmented by the level of synergies and mitigated by uncertainty.*

Figure 4 shows the effect of the bargaining power on the merger terms for different levels of uncertainty (Figure 4(a)) and synergies (Figure 4(b)). As stated in Corollary 5, a higher bargaining power increases the share captured by the firm. Figure 4(a) illustrates the the effect of uncertainty also shown in Figure 3, but additionally suggests that the effect of the bargaining power on the merger terms is smaller when one of the firms can credibly threat with an hostile takeover (both for low and high values of $\eta_i$). The higher the uncertainty, the less pronounced is the effect of the bargaining power on the merger terms up to limit of not having any effect ($\beta_1 = 1$). Another interesting result suggested by this Figure is that for low levels of uncertainty ($\beta \to \infty$) the effect of the bargaining power is maximum and the threat of hostile takeovers is not credible. Figure 4(b) illustrates how the effect of the bargaining power is augmented by synergies. As in Figure 4(a) the effect of the bargaining power is smaller for a low and a high bargaining power.

**Corollary 6.** *Holding the bargaining power constant, bigger firms capture higher shares in mergers* $(\partial \gamma_i/\partial K_i > 0)$*.*




(a) (b)

$K_i = 1$, $K_j = 1$, $\omega = 0.1$, $Y = 0.1$, $\epsilon_i = K_i/(K_i + K_j)$, $\beta_1 = 1.4$

**Figure 4:** Sensitivity of the merger terms to $\eta_i$

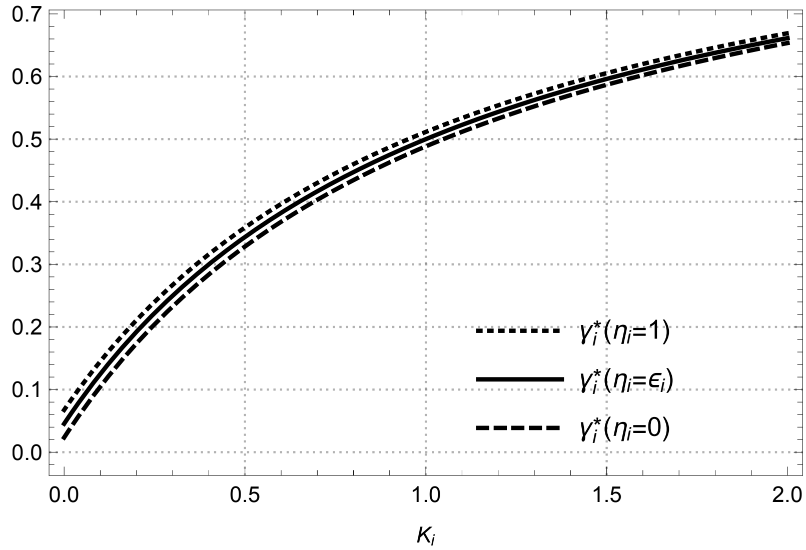
Figure 5 illustrates the effect of firm size on the merger terms.

**Corollary 7.** *Holding the bargaining power constant, firms incurring in higher relative costs capture higher shares in mergers* ($\partial\gamma_i/\partial\epsilon_i > 0$).

Figure 6 illustrates the effect of the merger costs on the merger terms. The effect is mitigated by uncertainty (Figure 6(a)) and augmented by synergies (Figure 6(b)).

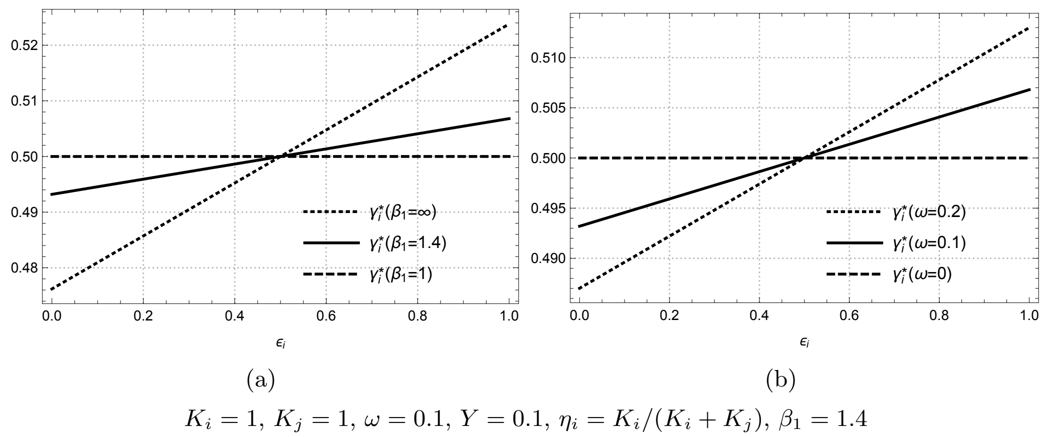
# 5 Conclusions

Given the increasing prominence of M&A deals in today's global economy, their increasing valuation levels, and their strategic importance for firms' competitiveness it is surprising how little about their trends and in particular their dynamics has been explored in depth. The paper at hand builds on recent advances in the domain of option games under uncertainty and looks closer at determinants that drive friendly mergers. In particular, the model considers two firms that independently commit themselves to grow by means of M&A. Given that the outcome is uncertain, each firm calculates its payoff resulting from either a friendly merger or hostile takeover. The value-maximizing strategy then serves as a credible threat when jointly negotiating the terms of a merger. Consequently, the paper advances recent literature by explicitly considering threat values during negotiation. In contrast to similar papers, we show that the firms still have an incentive to delay the




$K_j = 1$, $\omega = 0.1$, $Y = 0.1$, $\eta_i = \epsilon_i = 0.5$, $\beta_1 = 1.4$

**Figure 5:** Sensitivity of the merger terms to $K_i$




$K_i = 1$, $K_j = 1$, $\omega = 0.1$, $Y = 0.1$, $\eta_i = K_i/(K_i + K_j)$, $\beta_1 = 1.4$

**Figure 6:** Sensitivity of the merger terms to $\epsilon_i$

merger. Moreover, the results indicate that threat values are important for the asymmetric firm case, i.e. when firms have different bargaining power. Here, the weaker firm can improve its position in the merger as uncertainty increases, i.e. its share in the new entity increases. The same holds true if synergies increase.

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# A Proofs of propositions

# B Proofs of corollaries

*Proof of Corollary 5.*

$$\frac{\partial x_f^*}{\partial \eta_i} = 0 \tag{28}$$

$$\frac{\partial(1-\gamma_j^{BT})}{\partial \eta_i} = \left(\frac{1}{\beta_1} - \frac{(\beta_1-1)+\beta_1\epsilon_i}{\beta_1(\beta_1-1)}\left(\frac{\beta_1-1}{\beta_1-(1-\epsilon_i)}\right)^{\beta_1}\right)\frac{\omega}{\omega+K_i+K_j} > 0 \tag{29}$$

$$\frac{\partial \gamma_1^{BB}}{\partial \eta_i} = \frac{1}{\beta_1}\frac{\omega}{\omega+K_i+K_j} > 0 \tag{30}$$

$$\frac{\partial \gamma_i^{BT}}{\partial \eta_i} = \left(\frac{1}{\beta_1} - \frac{(\beta_1-1)+\beta_1(1-\epsilon_i)}{\beta_1(\beta_1-1)}\left(\frac{\beta_1-1}{\beta_1-\epsilon_i}\right)^{\beta_1}\right)\frac{\omega}{\omega+K_i+K_j} > 0 \tag{31}$$

From Equation (26) and $\eta_i < 1$, $(\beta_1-1)+\beta_1\epsilon_i > (\beta_1-1)\epsilon_i$, and given $\beta_1-1 < \beta_1-(1-\epsilon_i)$ and $\epsilon_i < 1$, the additional part in $1-\gamma_j^{BT}$ relative to $\gamma_i^{BB}$ is smaller than $1/\beta_1$, and therefore $\partial(1-\gamma_j^{BT})/\partial\eta_i > 0$.

From Equation (27) and $\eta_i < 1$, $(\beta_1-1)+\beta_1(1-\epsilon_i) > \beta_1-\epsilon_i$, and given $\beta_1-1 < \beta_1-\epsilon_i$, the additional part in $\gamma_1^{BT}$ relative to $\gamma_i^{BB}$ is smaller than $1/\beta_1$, and therefore $\partial\gamma_i^{BT}/\partial\eta_i > 0$. □

*Proof of Corollary 6.*

$$\frac{\partial x_f^*}{\partial K_i} = 0 \tag{32}$$

$$\frac{\partial(1-\gamma_j^{BT})}{\partial K_i} = -\frac{K_i}{(\omega+K_i+K_j)^2} - \left(\frac{(\beta_1-1)\epsilon_i+\eta_i}{\beta_1} - \theta_j^{BT}\right)\frac{\omega}{(\omega+K_i+K_j)^2} < 0 \tag{33}$$

$$\frac{\partial \gamma_1^{BB}}{\partial K_i} = -\frac{K_i}{(\omega+K_i+K_j)^2} - \frac{(\beta_1-1)\epsilon_i+\eta_i}{\beta_1} \times \frac{\omega}{(\omega+K_i+K_j)^2} < 0 \tag{34}$$

$$\frac{\partial \gamma_i^{BT}}{\partial K_i} = -\frac{K_i}{(\omega+K_i+K_j)^2} - \left(\frac{(\beta_1-1)\epsilon_i+\eta_i}{\beta_1} + \theta_i^{BT}\right)\frac{\omega}{(\omega+K_i+K_j)^2} < 0 \tag{35}$$

Given $\eta_i < \eta_i^L$ and $\theta_j^{BT} < 0$, therefore, $\partial(1-\gamma_j^{BT})/\partial K_j < 0$. Given $\eta_i > \eta_i^H$ and $\theta_i^{BT} > 0$, therefore, $\partial\gamma_i^{BT}/\partial K_j < 0$. □