The Interaction Between Capital Structure and Merger Decisions*

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Abstract

This paper presents a new model for analyzing the interplay between capital structure and merger decisions, incorporating both operational and financial synergies. The model posits that operational and financial synergies are inversely correlated. Although leverage tends to increase following a merger, the proposed model suggests that this outcome may not always be the case. The paper also examines the impact of exogenous and endogenous leverage decisions on merger timing, leverage ratios, and credit spreads. The model suggests that firms with the option to merge may have lower or higher leverage ratios than other firms depending on whether they adjust leverage in anticipation of the merger.

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JEL codes: G32; G34

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1 Introduction

Mergers and acquisitions (M&As) can be motivated by a variety of factors, including the potential to achieve operational and financial synergies. Operational synergies refer to the potential benefits that can be gained through combining the operations of two companies, such as economies of scale or increased market power. Financial synergies, on the other hand, refer to the potential benefits that can be gained through financial arrangements, such as coinsurance or value transfers.

The empirical literature on the usage of debt capacity prior to mergers has provided mixed evidence. According to studies by Bruner (1988) and Blomkvist et al. (2022), bidders are typically less leveraged than a control sample of firms, indicating the presence of unused debt capacity. However, other research by Ghosh and Jain (2000) and Harford et al. (2009) found weak evidence of unused debt capacity in the pre-merger years.

Uysal (2011) found that firms that are over-leveraged relative to their target debt ratios are less likely to make acquisitions. Additionally, they found that under-leverage has an insignificant effect on the acquisition probability. The study also observed that over-leveraged firms tend to reduce their leverage deficits and issue equity in an effort to move closer to their target capital structures.

Harford et al. (2009) also found that acquirers are more likely to engage in a leverage-increasing acquisition transaction if their target debt ratio also increases as a result of the transaction. On average, acquirers incorporate more than two-thirds of the change to the merged firm's new target leverage through the structure of the acquisition financing. Furthermore, Blomkvist et al. (2022) found that pre-bid underleveraging increases with bidding competition, synergies offered by targets, investment type, industry concentration, and with firms actively adjusting their capital structure in advance of bidding. They also found consistent evidence that strategic underleveraging conditional on the acquisition outlook is an important determinant of capital structure dynamics.

After the merger, the bidders' leverage rises significantly, as evidenced by previous studies (e.g. Bruner, 1988; Ghosh and Jain, 2000; Agliardi et al., 2016). This increase in leverage can be attributed to a number of factors, including the coinsurance effect, where existing bondholders are made better off as debt becomes relatively safer. Additionally, shareholders may appropriate part or all of the benefits from bondholders by financing the merger with debt, thereby increasing the financial leverage of the merged firm. Furfine and Rosen (2011) show that mergers increase default risk, as a result of aggressive managerial actions affecting risk enough to outweigh the strong risk-reducing asset diversification expected from a typical merger.

It has been established through previous research that the relationship between a bidder's leverage and its financing decisions for an acquisition is noteworthy. Specifically, when a bidder's leverage exceeds its targeted level, the likelihood of financing the acquisition with debt diminishes, and the likelihood of financing the acquisition with equity increases. Additionally, after debt-financed acquisitions, managers tend to actively work towards returning the firm to its target leverage, thereby reversing the increase in leverage (Harford et al., 2009).

Most M&A dynamic real option models used to evaluate the potential value of a merger or acquisition, have typically assumed that the firms involved are unlevered (e. g. Lambrecht, 2004; Alvarez and Stenbacka, 2006; Leland, 2007; Morellec and Zhdanov, 2008). However, there have been a few exceptions to this, including the studies by Morellec and Zhdanov (2008), Tian et al. (2010), and Tarsalewska (2015), which have considered the impact of leverage on the value of M&As.

Morellec and Zhdanov (2008) study the impact of a bidder's leverage on their ability to win an auction and acquire a target company. They find that, in most cases, the bidder with the lowest leverage is more likely to win the auction, and their leverage ratio is typically lower than the tax shields – default costs trade-off ratio. However, while they consider the interaction of leverage decisions between two bidding firms, they ignore the interaction of financing strategies between bidders and targets.

Tarsalewska (2015) examines the timing of vertical mergers and their associated synergies. The author finds that during economic upturns, vertical mergers tend to occur for operational reasons, such as to gain market power. Conversely, during economic downturns, vertical mergers occur for financial reasons, such as to avoid bankruptcy. The study ignores any strategic default interaction between the two firms.

The interaction between bidder and target financing decisions is considered in Tian et al. (2010). The focus of the paper is on financial synergies, and the authors argue that these synergies alone are sufficient to motivate mergers. The paper assumes that leverage prior to the merger is exogenous, that the target has no bargaining power and the merger option is modeled as a decision made by a central planner (equity and bond holders).

This paper presents a novel model for analyzing the interplay between capital structure and merger decisions, incorporating both operational and financial synergies. The model allows for the interaction between financing strategies of the two firms involved in a merger (as in Tian et al. (2010)), rather than focusing solely on the financing strategies of the bidder firm as is in Morellec and Zhdanov (2008). Unlike Tian et al. (2010), the model accounts for both firms to have bargaining power in the merger and examines the case of endogenous leverage decisions. Furthermore, the study provides a detailed analysis of how operational and financial synergies interact in a merger. With a more comprehensive model setting, this paper aims to answer some important questions regarding financing decisions in the context of a merger, including if firms increase leverage after a merger, how operational and financial synergies interact, and how firms with an option to merge make leverage decisions prior to the merger.

Previous literature has suggested that leverage tends to increase following a merger, however, the proposed model posits that this outcome may not always be the case. The model suggests that operational and financial synergies are inversely correlated, with low operational synergies promoting mergers due to greater financial synergies, and high operational synergies deterring merger activity due to decreased financial synergies.

Furthermore, the paper evaluates whether firms with the option to merge have lower leverage than other firms. The model suggest that when a merger is driven solely by operational synergies, there is a notable difference between the cases of exogenous and endogenous leverage. When leverage decisions are exogenous, a merger motivated solely by operational synergies leads to a reduction in default thresholds, leverage ratios, and credit spreads. However, if equityholders adjust leverage prior to the merger, these effects can be mitigated, making debt more appealing to them, thus firms with the option to merge may have lower or higher leverage ratios than other firms depending on whether they adjust leverage in anticipation of the merger.

In summary, the proposed model provides a comprehensive understanding of the relationship between capital structure and merger decisions, and the factors that influence leverage decisions before and after a merger. It highlights the inverse correlation between operational and financial synergies, examines the implications of exogenous and endogenous leverage decisions, and the impact of mergers on leverage ratios, credit spreads, and default thresholds.

The remainder of this paper is structured as follows: In Section 2, the model is presented. Section 3 conducts a thorough examination of the model, including the adjustment of leverage by merged firms post-merger, pre-merger leverage decision-making, and the interaction and impact of operational and financial synergies on merger timing, leverage ratios, and credit spreads of merging firms. Finally, Section 4 concludes the paper.

2 The model

2.1 The value of firms without the option to merge

Let firms 1 and 2 be endowed with a capital stock K_1 and K_2, respectively, which allow them to generate a continuous stream of cash flows that are subject to an industry-wide shock modeled by a geometric Brownian motion, given by the following equation:

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

where α represents the instantaneous risk-neutral drift, σ represents the instantaneous variance, and dW denotes the standard Wiener increment.

The instantaneous after-tax profit of firm i, where $i \in 1, 2$, can be expressed as:

$$\pi_i(t) = (K_i \; x(t) - c_i) \, (1 - \tau) \tag{2}$$

where c_i is the perpetual coupon payment and τ is the corporate tax rate.

The merger of the two firms create a new firm m with the following profit flow:

$$\pi_m(t) = (K_m\ x(t) - c_m)\,(1-\tau) \tag{3}$$

where $K_m = \omega + K_1 + K_2$, ω denotes the operational synergies arising from the merger, and c_m is the coupon of the merged firm.

The dynamic real options setting for firms with leverage has inspired multiple models for determining an optimal capital structure. One influential contribution in this area is the work of Leland (1994), who applied the contingent claims approach to extend the static trade-off theory. This work has served as a foundation for a significant body of literature that uses contingent claims analysis to address capital structure decisions (see Strebulaev et al. (2012) for a review). While subsequent developments have added greater realism to this model, the present analysis will focus on the impact of leverage in the context of a firm's option to merge, while abstracting from more complex features.

According to Leland (1994), equityholders in the model have "deep pockets". There are no emission costs in this model, and all profits are distributed to shareholders as dividends. If the firm experiences a loss, it is compensated for through the issuance of new equity. If the firm defaults, debtholders receive a portion of the unlevered firm and incur a proportional default cost b.

Proposition 1. *The value of equity of firm $i \in \{1,2,m\}$ is:*

$$E_i^o(x,c_i) = \left(\frac{K_i\ x}{r-\alpha} - \frac{c_i}{r}\right)(1-\tau) + A_{2,i}^o(c_i)x^{\beta_2} \tag{4}$$

where

$$A_{2,i}^o(c_i) = \left(\frac{K_i\ \underline{x}_i^o(c_i)}{r-\alpha} - \frac{c_i}{r}\right)(1-\tau)\left(\frac{1}{\underline{x}_i^o(c_i)}\right)^{\beta_2} > 0, \tag{5}$$

$$\beta_2 = \frac{1}{2} - \frac{\alpha}{\sigma^2} - \sqrt{\left(-\frac{1}{2}+\frac{\alpha}{\sigma^2}\right)^2 + \frac{2r}{\sigma^2}} < 0 \tag{6}$$

and $\underline{x}_i^o(c_i)$ is the default threshold:

$$\underline{x}_i^o(c_i) = \frac{\beta_2}{\beta_2 - 1}\left(\frac{r-\alpha}{K_i}\right)\frac{c_i}{r} \tag{7}$$

The value of debt is:

$$D_i^o(x,c_i) = \frac{c_i}{r} + B_{2,i}^o(c_i)x^{\beta_2} \tag{8}$$

where

$$B_{2,i}^o(c_i) = \left((1-b)\frac{K_i\ \underline{x}_i^o(c_i)}{r-\alpha}(1-\tau) - \frac{c_i}{r}\right)\left(\frac{1}{\underline{x}_i^o(c_i)}\right)^{\beta_2} < 0 \tag{9}$$

2.2 The value of firms with an option to merge

When the two firms have the option to merge, it is assumed that the firms cooperatively determine the timing and terms of the merger.[1] One approach to modeling the outcome of the merger is to assume that the firms define the terms and timing in two rounds, as in Lambrecht (2004) and Morellec and Zhdanov (2005, 2008). Instead, in this paper, the outcome is modeled as the result of a Nash bargaining game, as in Alvarez and Stenbacka (2006), Thijssen (2008), and Lukas et al. (2019).

It is assumed that after the merger, each firm holds an equity stake γ_i in the new firm m. The equityholders of each firm give up their stand-alone value $E_i^o(x, c_i)$ and receive a stake in the new venture, after paying an irreversible merger cost Y_i. Additionally, the merger may create an opportunity to optimize the capital structure, in which case it is assumed that the debt is recalled at the market value and new debt is issued.

The merger creates the following total synergy for the equityholders of both firms:

$$\begin{aligned} &E_m^o(x, c_m) + D_m^o(x, c_m) - D_m^o(x, c_i + c_j) - (E_1^o(x, c_1) + E_2^o(x, c_2)) - (Y_1 + Y_2) \\ &\quad = \frac{\omega\ x}{r - \alpha}(1 - \tau) + \left(A_{2,m}^o(c_1 + c_2) - A_{2,1}^o(c_1) - A_{2,2}^o(c_2)\right) x^{\beta_2} \\ &\quad + \left(A_{2,m}^o(c_m) - A_{2,m}^o(c_1 + c_2) + B_{2,m}^o(c_m) - B_{2,m}^o(c_1 + c_2)\right) x^{\beta_2} \\ &\quad\quad + \frac{c_m - c_1 - c_2}{r}\tau \\ &\quad - (Y_1 + Y_2) \end{aligned} \tag{10}$$

The second line captures the effect of the operational synergy ω: the first term is the pure operational synergy and the second term its negative impact on the value of equity ($A_{2,m}^o(c_1 + c_2) - A_{2,1}^o(c_1) - A_{2,2}^o(c_2) < 0$). When $\omega > 0$, there is a coinsurance effect, with the risk of debtholders decreasing because default becomes less likely, resulting in a transfer of value from equityholders to debtholders.[2] The pure financial synergies that result from the opportunity to rebalance the capital structure are shown in the second and third lines and include the effects on equity value and the procceds to equityholders from the adjustment in leverage from $c_1 + c_2$ to c_m. When leverage is increased after the merger the financial synergy is positive. In summary, the merger can create pure operational synergies, pure financial synergies ($\omega = 0$) and a value transfer from equityholders to debtholders.

Proposition 2. *Before the merger, the value of equity must consider not only the option to merge but also the option to default. Therefore, it is:*

$$\left(\frac{K_i\ x}{r - \alpha} - \frac{c_i}{r}\right)(1 - \tau) + A_{1,i}\ x^{\beta_1} + A_{2,i}\ x^{\beta_2} \tag{11}$$

[1] A non-cooperative solution has been used to model takeovers (Lambrecht, 2004; Lukas et al., 2019).

[2] When the two firms are exposed to two correlated sources of uncertainty, the coinsurance effect may also result from the reduced portfolio uncertainty.

where $A_{1,i}\ x^{\beta_1}$ and $A_{2,i}\ x^{\beta_2}$ represent the two option values.

In the bargaining game the equityholders of firm i are entitled to the following net payoff:

$$\gamma_i \left(E^o_m(x, c_m) + D^o_m(x, c_m) - D^o_m(x, c_i + c_j)\right) - Y_i \tag{12}$$

Further details on the determination of γ_i through the Nash bargaining game and the agreement to merge at a threshold $\bar{x}$ can be found in Appendix B. The outcome of the bargaining game for firm i, with a bargaining power η_i, is that its value of the option to merge is a share η_i of the merger surplus given the default policies ($A_{2,i}$, and $A_{2,j}$) of the two firms:

$$A_{1,i}\ \bar{x}^{\beta_1} = \eta_i \left(\frac{\omega\ \bar{x}}{r-\alpha}(1-\tau) + \left(A^o_{2,m}(c_m) - A_{2,i} - A_{2,j} + B^o_{2,m}(c_m) - B^o_{2,m}(c_i + c_j)\right) \bar{x}^{\beta_2} + \frac{c_m - c_i - c_j}{r}\tau - Y_i - Y_j \right) \tag{13}$$

With the option to merge now available, the value of $A_{2,i}$ differs from the "myopic" value $A^o_{2,i}$. The default policy of the shareholders of each firm changes, as they must now consider both the option to merge and the decision of the other firm's shareholders. Because the default of one firm terminates the option to merge, it becomes optimal to default at a later time and potentially wait for the other firm's default.

As a result, four cases are possible: Firm 1(2) defaults first, followed by firm 2(1) defaulting at the myopic threshold $\underline{x}^o_2(\underline{x}^o_1)$, or firm 2(1) defaults immediately when firm 1(2) defaults at $\underline{x}_1(\underline{x}_2)$. The latter cases occur when both firms have myopic default thresholds above the new default threshold, meaning that if they had been the second firm to default, they would have defaulted when the first firm defaults, but now must wait for it to happen.

In the event that two firms default sequentially, with firm j defaulting first at $\underline{x}_j$ and firm i defaulting optimally last at $\underline{x}^o_i$, the equityholders of firm j receive zero upon default, while the equityholders of firm i receive the stand-alone equity value of $E^o_i(c_i)$. However, if $\underline{x}^o_i > \underline{x}_j$, the equityholders of firm i choose to default simultaneously with firm j at $\underline{x}_j$, waiting for j's default, in which case they too will receive zero upon default.

Proposition 3. *When firm i has an option to merge with firm j, and the default policy for the two firms is sequential, with firm j defaulting before firm i, the values of the six unknown variables $(A_{1,i}, A_{1,j}, A_{2,i}, A_{2,j}, \underline{x}_j, \overline{x})$ can be found by numerically solving the following set of nonlinear equations:*

$$A_{1,i} = \eta_i \left(\frac{\omega\ \bar{x}}{r-\alpha}(1-\tau) + (A^o_{2,m}(c_m) - A_{2,i} - A_{2,j} + B^o_{2,m}(c_m) - B^o_{2,m}(c_i+c_j))\bar{x}^{\beta_2} + \frac{c_m - c_i - c_j}{r}\tau - Y_i - Y_j \right) \bar{x}^{-\beta_1} \tag{14}$$

$$A_{2,i} = A^o_{2,i}(c_i) - A_{1,i}\ \ \underline{x}_j^{\beta_1} \underline{x}_j^{-\beta_2} \tag{15}$$

$$A_{1,j} = \frac{1-\eta_i}{\eta_i} A_{1,i} \tag{16}$$

$$A_{2,j} = -\left(A_{1,j}\ \underline{x}_j^{\beta_1} + \left(\frac{K_j\ \underline{x}_j}{r-\alpha} - \frac{c_j}{r} \right)(1-\tau) \right) \underline{x}_j^{-\beta_2} \tag{17}$$

$$(\beta_1 - \beta_2)\, A_{1,j}\ \underline{x}_j^{\beta_1} - (\beta_2 - 1)\, \frac{K_j\ \underline{x}_j}{r-\alpha}(1-\tau) + \beta_2 \frac{c_j}{r}(1-\tau) = 0 \tag{18}$$

$$(\beta_1 - \beta_2)\left(A^o_{2,m}(c_m) - A_{2,i} - A_{2,j} + B^o_{2,m}(c_m) - B^o_{2,m}(c_i+c_j) \right) \bar{x}^{\beta_2} + (\beta_1 - 1)\, \frac{\omega\ \bar{x}}{r-\alpha}(1-\tau) + \beta_1 \left(\frac{c_m - c_i - c_j}{r}\tau - Y_i - Y_j \right) = 0 \tag{19}$$

When firm i defaults simultaneously with j, Equation 15 is replaced by:

$$A_{2,i} = -\left(A_{1,i}\ \underline{x}_j^{\beta_1} + \left(\frac{K_i\ \underline{x}_j}{r-\alpha} - \frac{c_i}{r} \right)(1-\tau) \right) \underline{x}_j^{-\beta_2} \tag{20}$$

The first four equations are the simplified value-matching conditions, while the last two equations are the simplified smooth-pasting conditions at the two thresholds. The values of the options to merge, represented by $A_{1,i}$ and $A_{1,j}$, are proportional to the firms' bargaining power.

The value of debt is determined by the actions of the equityholders, specifically their default and merger policies (thresholds). Debtholders behave passively, receiving the benefits and incurring the costs associated with the merger and default. Upon default, they incur a default cost, while upon merger they benefit from the coinsurance effect. The behavior of the equityholders directly impacts the value of debt through their decisions regarding default and merger.

Proposition 4. *When firms have an option to merge, the value of debt of both firms is given by:*

$$D_i(x, c_i, c_j) = \frac{c_i}{r} + B_{1,i} x^{\beta_1} + B_{2,i} x^{\beta_2} \tag{21}$$

When the two firms default sequentially (j being the first) the four unknowns are:

$$B_{1,i} = \left(\frac{c_i}{c_i+c_j} B^o_{2,m}(c_i+cj) - B^o_{2,i}(c_i)\right) \underline{x}_j^{\beta_2} \frac{\bar{x}^{\beta_2}}{\underline{x}_j^{\beta_2}\bar{x}^{\beta_1} - \underline{x}_j^{\beta_1}\bar{x}^{\beta_2}} \tag{22}$$

$$B_{2,i} = B^o_{2,i}(c_i) - B_{1,i} \tag{23}$$

$$B_{1,j} = \left(\frac{c_j}{c_i+c_j}\left(\frac{c_i+c_j}{r} + B^o_{2,m}(c_i+cj)\ \underline{x}_j^{\beta_2}\right) - (1-b)\frac{K_j\ \underline{x}_j}{r-\alpha}(1-\tau)\right) \times \frac{\bar{x}^{\beta_2}}{\underline{x}_j^{\beta_2}\bar{x}^{\beta_1} - \underline{x}_j^{\beta_1}\bar{x}^{\beta_2}} \tag{24}$$

$$B_{2,j} = -\left(\frac{c_j}{c_i+c_j} B^o_{2,m}(c_i+cj)\ \underline{x}_j^{\beta_1}\right) \frac{\bar{x}^{\beta_2}}{\underline{x}_j^{\beta_2}\bar{x}^{\beta_1} - \underline{x}_j^{\beta_1}\bar{x}^{\beta_2}} - \left(\frac{c_j}{r} - (1-b)\frac{K_j\ \underline{x}_j}{r-\alpha}(1-\tau)\right) \frac{\bar{x}^{\beta_1}}{\underline{x}_j^{\beta_2}\bar{x}^{\beta_1} - \underline{x}_j^{\beta_1}\bar{x}^{\beta_2}} \tag{25}$$

When i defaults at the same time as j at $\underline{x}_j$, the first two equations become:

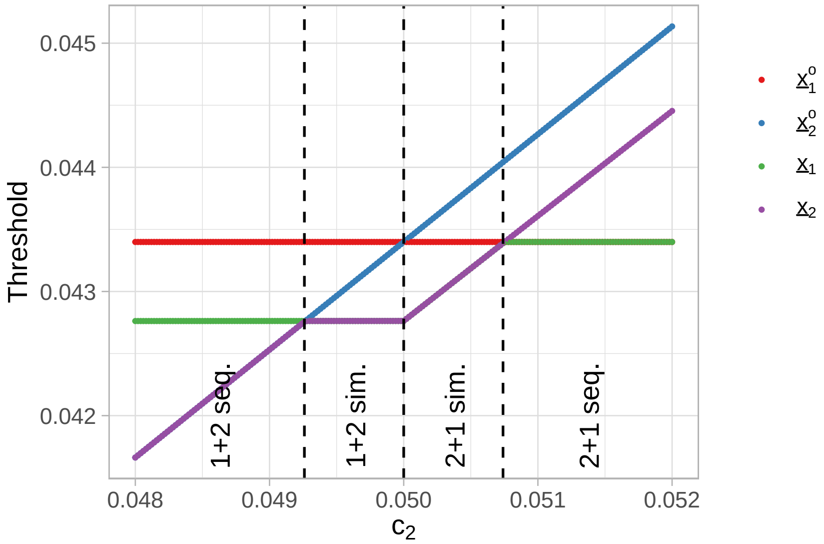
$$B_{1,i} = \left(\frac{c_i}{c_i+c_j}\left(\frac{c_i+c_j}{r} + B^o_{2,m}(c_i+cj)\ \underline{x}_j^{\beta_2}\right) - (1-b)\frac{K_i\ \underline{x}_j}{r-\alpha}(1-\tau)\right) \times \frac{\bar{x}^{\beta_2}}{\underline{x}_j^{\beta_2}\bar{x}^{\beta_1} - \underline{x}_j^{\beta_1}\bar{x}^{\beta_2}} \tag{26}$$

$$B_{2,i} = -\left(\frac{c_i}{c_i+c_j} B^o_{2,m}(c_i+cj)\ \underline{x}_j^{\beta_1}\right) \frac{\bar{x}^{\beta_2}}{\underline{x}_j^{\beta_2}\bar{x}^{\beta_1} - \underline{x}_j^{\beta_1}\bar{x}^{\beta_2}} - \left(\frac{c_i}{r} - (1-b)\frac{K_i\ \underline{x}_j}{r-\alpha}(1-\tau)\right) \frac{\bar{x}^{\beta_1}}{\underline{x}_j^{\beta_2}\bar{x}^{\beta_1} - \underline{x}_j^{\beta_1}\bar{x}^{\beta_2}} \tag{27}$$

The default costs, represented by the constants $B_{2,i}$ and $B_{2,j}$, are smaller than their myopic counterparts, $B^o_2(c_i)$ and $B^o_2(c_j)$, due to the presence of the option to merge. This is true even for firm i when it defaults optimally at the myopic threshold $\underline{x}^o_i$.

Figure 1 illustrates the four possible scenarios that can occur for different levels of the firm 2 coupon, c_2. When c_2 is low, firm 2 defaults sequentially after firm 1 at its myopic default threshold $\underline{x}^o_i$, and firm 1 defaults at the threshold $\underline{x}_1$. In this case, only the default policy of firm 1 is influenced by the merger option, as the merger option is no longer available once firm 1 defaults. As the coupon c_2 increases, firm 2 becomes increasingly willing to default sooner. In the second region, firm 2 would prefer to default sooner if firm 1 had already defaulted, but must wait until firm 1 defaults before doing so, resulting in simultaneous default. At $c_2 = 0.05$, the two firms optimally default at the same time. Beyond this point, it is now firm 1 that must wait for firm 2 to default before it becomes optimal for firm 1 to default sequentially at its myopic trigger $\underline{x}^o_1$.

How would a central planner acting on behalf of the equityholders of both firms choose the default policy? Is is known that when leverage is ignored, a cooperative solution of the option to merge is the same as the central planner's optimization (e.g.: Lambrecht, 2004;



The parameter values are as in Table 1.

Figure 1: Default policies without leverage adjustment

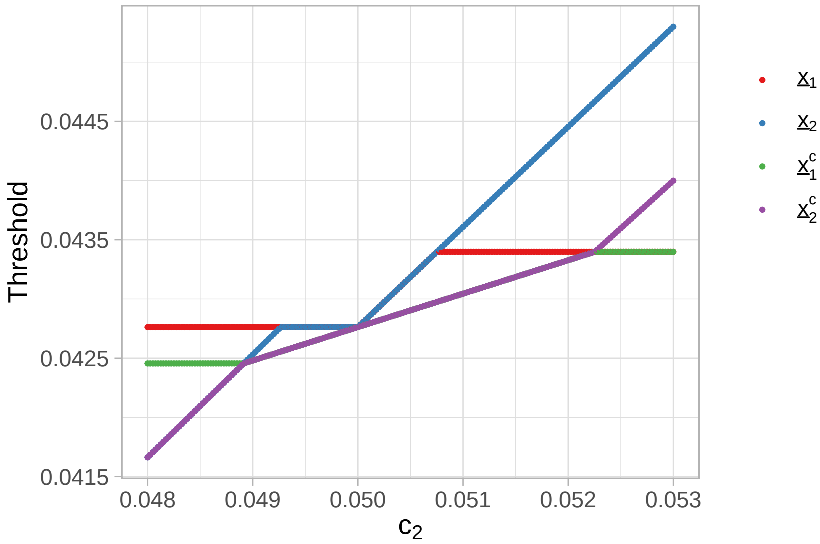
Morellec and Zhdanov, 2008; Lukas et al., 2019). However, when firms issue debt, the central planner solution is not achieved, because equityholders would also have to cooperate in defaulting, which is not in their best interest, unless there is common ownership of the two firms. Figure 2 shows that comparing with the individual strategic default, default would occur later to keep the option to merge alive as much as possible. It is still possible a sequential default or a simultaneous default, with the latter occurring optimally at the same time. The solution of the central planner can be found in Appendix C.

2.3 Adjusting leverage after the merger

Without leverage adjustment after the merger, the debt coupons remain at $c_m = c_1 + c_2$. The merger creates the opportunity to adjust leverage, as the merged firm has no longer to consider the effects of the merger and the strategic value of debt ceases (Morellec and Zhdanov, 2008). The equityholders of the merged firm maximize the equity value considering the new debt issued. When it is not possible to retire existing debt, possibly because of covenants protecting debtholders, the following proposition states how leverage is optimally chosen.

Proposition 5. *The optimal debt coupon after merger, c_m^*, is the solution to the following optimization problem:*

$$c_m^* = \arg\max_{c_m} \left[E_m^o(\bar{x}, c_m) + D_m^o(\bar{x}, c_m) - D_m^o(\bar{x}, c_1 + c_2)\right] \tag{28}$$



The parameter values are as in Table 1.

Figure 2: Default policies without leverage adjustment: central planner

which yields:

$$c_m^* = h\left(\frac{\bar{x}}{\underline{x}_m^o(c_m)}\right) \tag{29}$$

$$h = \left(1 - \beta_2\left(1 - b + \frac{b}{\tau}\right)\right)^{1/\beta_2} < 1 \tag{30}$$

This solution is equivalent to maximization of the total firm value as the existing debt is protected against the (possible) increased leverage of the merged firm. The case where that does not occur, with debtholders (partially) expropriated of the coinsurance effect created by the merger, as in Tian et al. (2010), can also be considered.

2.4 Endogenous optimal leverage

So far, it was assumed the security values incorporate both the option to default and the option to merge for a given leverage. As in Morellec and Zhdanov (2008), leverage, i.e. the coupon level, can also be determined endogenously by each firm's equityholders. Let us assume that at time 0 (when $\underline{x}_j < x < \bar{x}$) they simultaneously choose the coupon to maximize their firm value:

$$\hat{c}_i(c_j) = \arg\max_{c_i}\left[E_i(x, c_i, c_j, c_m) + D_i(x, c_i, c_j)\right] \tag{31}$$

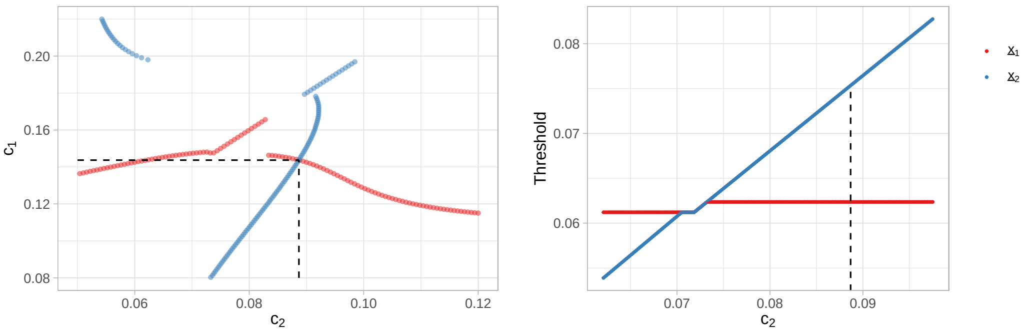
$$\hat{c}_j(c_i) = \arg\max_{c_j}\left[E_j(x, c_i, c_j, c_m) + D_j(x, c_i, c_j)\right] \tag{32}$$

Since the value of securities and the default and merger policies depend on both firms' leverage, each firm's equityholders have to consider the other firm's equitholders actions. Therefore, the solution is:

$$c_i^* = \hat{c}_i(c_j^*) \tag{33}$$

$$c_j^* = \hat{c}_j(c_i^*) \tag{34}$$

Figure 3 depicts the case when x is close to the merger threshold and there is no leverage adjustment after the merger. The best-response functions are shown in Figure 3(a). Figure 3(b) shows the default policies for different levels of c_2, when firm 1 chooses the optimal coupon c_1^*. For this case the equilibrium is a sequential default, with firm 2 defaulting first and firm 1 defaulting at the myopic threshold.



(a) Best response functions (b) Default thresholds

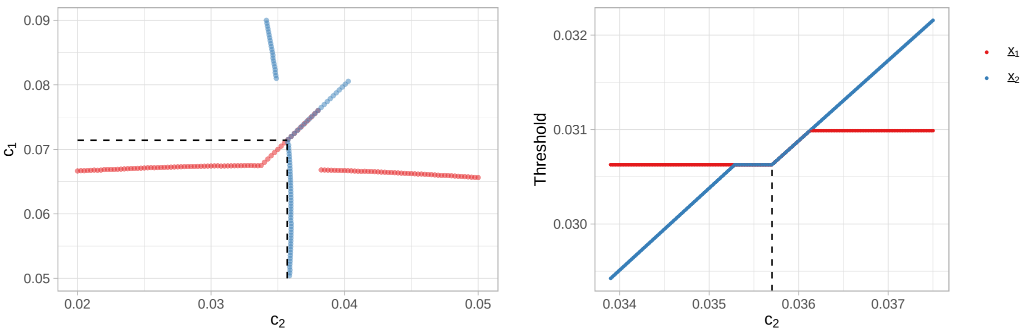
The parameter values are as in Table 1, except $x = 0.2$.

Figure 3: Endogenous leverage without leverage adjustment: case 1

Figure 4 shows the case of a smaller x. For this case the equilibrium has and indeterminacy, as multiple combinations of c_1^* and c_2^* are possible. However, both firms are better off choosing the lowest possible c as the firm value is maximized if they do so. The equilibrium is a simultaneous optimal default (Figure 4(b)).

3 The effect of operational and financial synergies

In this section, a numerical analysis is conducted to examine the impact of various model configurations associated with a merger that generates operational and/or financial synergies, including the timing of the merger, default policies, leverage ratios, and credit spreads. The base-case parameter values are outlined in Table 1. It is assumed that the bargaining powers, merger costs and relative debt coupons are proportional to the firms' capital stock. This assumption implies that in the absence of a merger, the firms would exhibit similar levels of leverage and would default at the same time.



(a) Best response functions (b) Defaults thresholds

The parameter values are as in Table 1, except $x = 0.11$.

Figure 4: Endogenous leverage without leverage adjustment: case 2

3.1 Do firms always increase leverage after a merger?

Most of previous empirical studies have demonstrated that merged firms tend to adjust leverage upwards, taking advantage of the financial synergies created by the merger. Similarly, the few real options models that address financing decisions within the context of a merger have also suggested that increasing leverage is optimal. The model presented in this paper, however, does not take a stance on this matter and allows for both optimal increases and reductions in leverage.

The model explores whether both outcomes are possible in equilibrium, by adjusting the debt coupon to its optimal level c_m^* ($\neq c_1 + c_2$). The model presents two possible solutions: one with a higher leverage adjustment and another with a lower leverage adjustment, with the latter occurring sooner. The two solutions are depicted in Figure 5 for different operational synergies.

It is important to note that solution 1 is always preferred by the equityholders, making solution 2 a second-best option. The question of whether this solution implies always a leverage increase is then relevant. While Figure 5(b) may suggest that this is the case, a closer examination of the model's results as presented in Figure 6 reveals that it is possible for a reduction in leverage to become optimal. This occurs when operational synergies are sufficiently large and, unexpectedly, for the case of a low *ex-ante* leverage (Figure 6(a)). Despite this reduction in leverage, equityholders are still better off due to the large effects of the operational synergies. It is important to acknowledge, however, that the scenario where an optimal reduction in leverage occurs is relatively less likely in the model compared to the scenario of a leverage increase.

Table 1: The base-case parameter values.

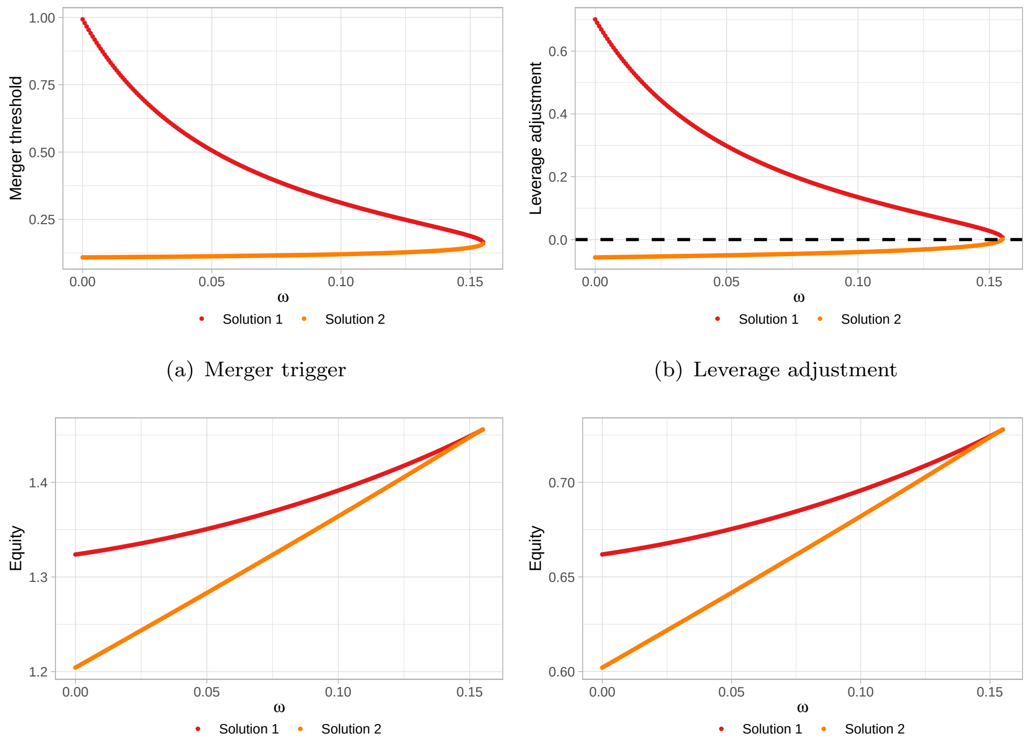
Parameter	Description	Value
x	Current level of x	0.15
K_1	Capital stock of firm 1	1.0
K_2	Capital stock of firm 2	0.5
c_1	Perpetual debt coupon of firm 1	0.10
c_2	Perpetual debt coupon of firm 2	0.05
τ	Corporate tax rate	0.15
b	Bankruptcy cost	0.4
η	Bargaining power of firm 1	2/3
ω	Synergy factor	0.1
Y_1	Merger costs of firm 1	0.10
Y_2	Merger costs of firm 2	0.05
σ	Volatility	0.25
r	Risk-free interest rate	0.06
α	Risk-neutral drift rate	0.01

3.2 The interaction between operational and financial synergies

This section explores the relationship between operational and financial synergies and its impact on the merger timing, default policies, leverage ratios, and credit spreads of the participating firms. To this end, the examination employs Figures 7 and 8 to illustrate the effects of operational synergies on exogenous and endogenous leverage scenarios, respectively. The figures present a comparison between cases that incorporate leverage adjustments post-merger and those that do not, as well as a scenario in which the merger option is not available.

It is important to note that operational and financial synergies are inversely correlated. Specifically, when operational synergies are low, financial synergies tend to be greater (Figures 7(b) and 8(b)), which accelerates the merger (Figures 7(a) and 8(a)). However, as operational synergies increase, financial synergies tend to decrease, thereby deterring mergers. Furthermore, mergers solely motivated by financial synergies ($\omega = 0$) are possible, confirming the result of Tian et al. (2010) and, obviously, mergers with neither synergies do not occur: when $\omega = 0$ and there is no leverage adjustment after the merger, the merger threshold tends to infinity (Figure 7(a)).

The effects of operational and financial synergies on leverage ratios and credit spreads vary depending on whether leverage decisions are exogenous or endogenous. In the exogenous leverage case, operational synergies reduce leverage ratios and concurrent financial synergies reduce them further for low operational synergies. However, as operational synergies increase, the effect of financial synergies on credit spreads is diminished, eventually



(a) Merger trigger (b) Leverage adjustment

(c) Equity 1 (d) Equity 2

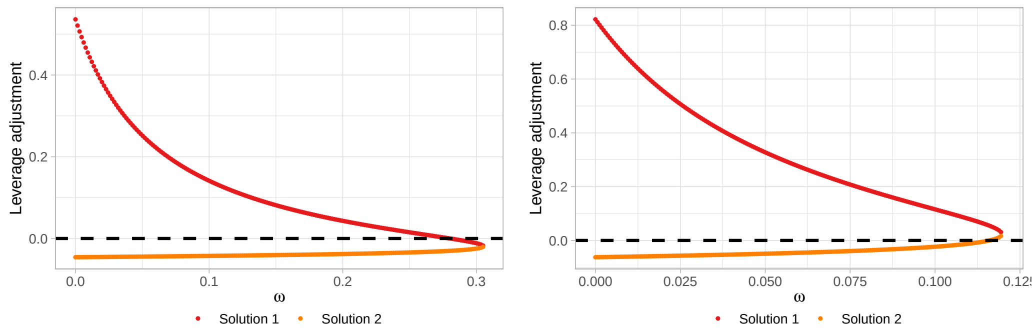
The parameter values are as in Table 1.

Figure 5: Model solutions with leverage adjustment

increasing them (Figures 7(d)).[3] In contrast, for the endogenous leverage case, mergers motivated solely by operational synergies increase leverage and credit spreads of both firms (Figures 8(e) and 8(f)). As with exogenous leverage, for moderate operational synergies, concurrent financial synergies mitigate the effects of operational synergies on leverage ratios and credit spreads. However, as operational synergies increase, the (lower) financial synergies can increase both leverage ratios and credit spreads.

Additionally, given the different firm sizes, equityholders optimally choose different debt coupons (Figure 8(c)), and in cases of low operational synergies and high financial synergies, both firms have the same leverage ratios and credit spreads (Figures 8(e) and 8(f). However, in mergers motivated solely by (very) large operational synergies, the largest firm chooses a lower leverage and has lower credit spreads.

[3]Please note that since for the base-case parameter values leverage is proportional to the capital stock, these effects are identical for the two firms.



(a) $c_1 = 0.06; c_2 = 0.03$ (b) $c_1 = 0.13; c_2 = 0.065$

The remaining parameter values are as in Table 1.

Figure 6: Leverage adjustment for different *ex-ante* leverage ratios

3.3 The effect of uncertainty

The figures 9 and 10 illustrate the impact of uncertainty for the exogenous and endogenous cases respectively. It is a common phenomenon in real options models that uncertainty deters the exercise of the option to merge, as depicted in figures 9(a) and 10(a). This deterrent effect results in the creation of greater financial synergies, as seen in figures 9(b) and 10(b). Consequently, this accelerates the merger process. In the case of exogenous leverage, an increased level of uncertainty reduces leverage ratios (Figure 9(d)) and raises credit spreads (Figure 9(e)), as debt becomes riskier. While the default thresholds decrease, the likelihood of default increases, thereby deterring the coinsurance effect for higher levels of uncertainty. In the case of endogenous leverage, the effects are similar when firms opt to choose identical leverage levels. This occurs when firms take advantage of financial synergies or when uncertainty is high. When there is no adjustment of leverage following a merger, i.e. there are no financial synergies, an increase in uncertainty from a low level to a higher level (above 0.25) may result in the larger firm (1) increasing leverage to match the other firm's leverage level, from a starting point where the two firms make asymmetric choices (figures 10(c) and 10(e)). Regardless, credit spreads consistently increase with uncertainty, indicating that debt becomes riskier, as demonstrated in Figure 10(f).

3.4 Do firms with an option to merge have lower leverage?

The preceding figures demonstrate that when a merger is driven solely by operational synergies, there is a marked difference between the cases of exogenous and endogenous leverage. Table 2 summarizes the effects of the merger and its interaction with synergy level (as shown in figures 7 and 8), uncertainty (as depicted in figures 9 and 10), and the relative size of firm 1, where it is assumed that the relative size of capital stocks, relative

Table 2: Summary of the effect of the merger with operational synergies

This table shows the effects of the merger with operational synergies as the parameter values change, comparing the case of the merger without leverage adjustment with the case without the merger.

Panel A: Exogenous leverage

Parameter	$\underline{x}_1$	$\underline{x}_2$	LR_1	LR_2	CS_1	CS_2
Relative size 1	−	−	−	−	−	−
Synergy ω	−	−	−	−	−	−
Uncert. σ	−	−	−	−	−	−

Panel B: Endogenous leverage

Parameter	c_1^*	c_2^*	$\underline{x}_1$	$\underline{x}_2$	LR_1	LR_2	CS_1	CS_2
Relative size 1	+	+	+	+	+	+	+	+
Synergy ω	+	+	+	+	+	+	+	+
Uncert. σ	+	+	+	+	+	+	+	+

exogenous debt coupons, relative merger costs, and relative bargaining power are equal ($K_1/K_2 = c_1/c_2 = Y_1/Y_2 = \eta_1$). When leverage is exogenous, a merger motivated solely by operational synergies reduces default thresholds, leverage ratios, and credit spreads. The operational synergies created by the merger make debt more appealing to debtholders, but not to equityholders, as without financial synergies, there is a transfer of value from equityholders to bondholders. However, if equityholders adjust leverage prior to the merger, these effects can be mitigated, making debt more appealing to them. They do this by increasing leverage when a merger option is available, making debt riskier. Firms with the option to merge may have lower or higher leverage ratios than other firms depending on whether they adjust leverage in anticipation of the merger.

Mergers also generate financial synergies. Table 3 summarizes the incremental effects of financial synergies by comparing the cases with and without leverage adjustment. While financial synergies may have a non-monotonic impact on merger timing, deterring or accelerating mergers, the incremental effect on leverage ratios is consistently negative. When firms take advantage of financial synergies by adjusting leverage after the merger, leverage ratios are even lower than in the exogenous case and their increase can be reversed in the endogenous case. The combination of operational and financial synergies when firms endogenously choose their leverage may result in firms with the option to merge having lower leverage ratios than other firms. This occurs when operational synergies are insufficient to overcome the correlated high financial synergies. Debt becomes safer, as credit spreads are reduced when financial synergies exist for the case of endogenous leverage. However, debt may become riskier if firms do not adjust leverage prior to the merger.

In summary, firms that have the option to merge will have lower leverage ratios and safer debt only if they endogenously choose to lower leverage before the merger and can

Table 3: Summary of the effect of financial synergies

This table shows the incremental effects of the financial synergies as the parameter values change, comparing the case of the merger with leverage adjustment with the case without leverage adjustment.

Panel A: Exogenous leverage

Parameter	$\bar{x}$	$\underline{x}_1$	$\underline{x}_2$	LR_1	LR_2	CS_1	CS_2
Relative size 1	$+$	$-$	$-$	$-$	$-$	$+$	$+$
Synergy ω	$-/+$	$-$	$-$	$-$	$-$	$-/+$	$-/+$
Uncert. σ	$-/+$	$-$	$-$	$-$	$-$	$+$	$+$

Panel B: Endogenous leverage

Parameter	$\bar{x}$	c_1^*	c_2^*	$\underline{x}_1$	$\underline{x}_2$	LR_1	LR_2	CS_1	CS_2
Relative size 1	$+$	$-$	$-$	$-$	$-$	$-$	$-$	$-$	$-$
Synergy ω	$-/+$	$-$	$-$	$-$	$-$	$-$	$-$	$-$	$-$
Uncert. σ	$+$	$-$	$-$	$-$	$-$	$-$	$-$	$-$	$-$

take advantage of large financial synergies created by the merger. This is only possible when operational synergies are not the primary motivation for the merger.

4 Conclusion

This study presents a new model for analyzing the interplay between capital structure and merger decisions, incorporating both operational and financial synergies. Previous empirical studies and real options models have suggested that leverage tends to increase following a merger. However, the proposed model allows for both optimal increases and reductions in leverage, though it must be noted that the scenario of a leverage reduction is less likely than the scenario of leverage increase.

The model posits that operational and financial synergies are inversely correlated, with low operational synergies, which deter mergers, resulting in greater financial synergies and thus promoting mergers. Conversely, as operational synergies increase, financial synergies tend to decrease, deterring merger activity. Additionally, the study notes that mergers motivated solely by financial synergies are possible. The impact of operational and financial synergies on leverage ratios and credit spreads is contingent on whether leverage decisions are exogenous or endogenous, which has significant implications for the distribution of value among equityholders and bondholders.

The study also evaluates whether firms with the option to merge have lower leverage than other firms. When a merger is driven solely by operational synergies, there is a notable difference between the cases of exogenous and endogenous leverage. When leverage decisions are exogenous, a merger motivated solely by operational synergies leads to a reduction in default thresholds, leverage ratios, and credit spreads. This is because the operational synergies generated by the merger make debt more attractive to debtholders, but not to equityholders, resulting in a transfer of value from equityholders to bondholders. However, if equityholders adjust leverage prior to the merger, these effects can be mitigated, making debt more appealing to them. Thus, firms with the option to merge may have lower or higher leverage ratios than other firms depending on whether they adjust leverage in anticipation of the merger.

In conclusion, this study presents a novel model that provides a comprehensive understanding of the relationship between capital structure and merger decisions, and the factors that influence leverage decisions before and after a merger. The model highlights the inverse correlation between operational and financial synergies. Additionally, it examines the implications of exogenous and endogenous leverage decisions, and the impact of mergers on leverage ratios, credit spreads, and default thresholds. The findings of this study have important implications that can be tested through further empirical research.

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A Proofs of propositions

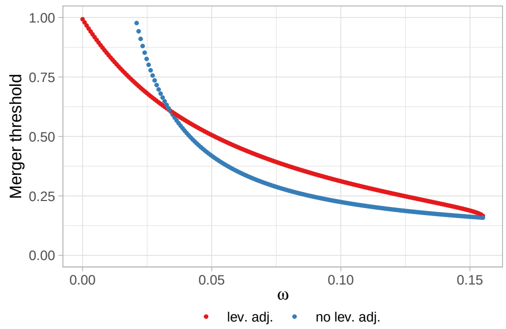
To be added.

B The Nash bargaining solution

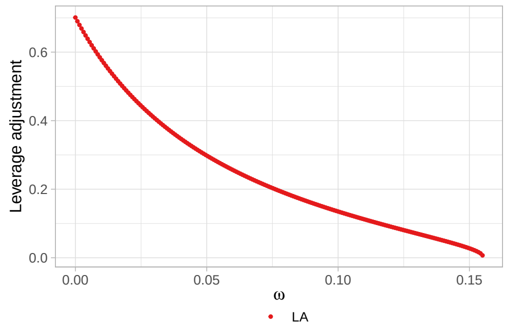
To be added.

C The central planner solution

To be added.



(a) Merger trigger



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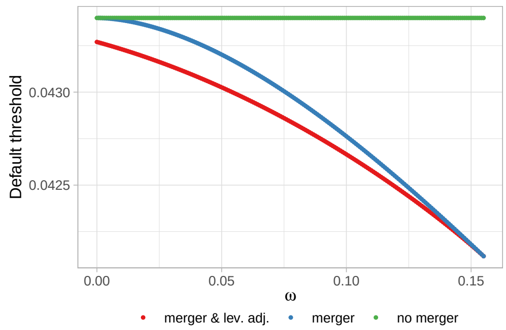
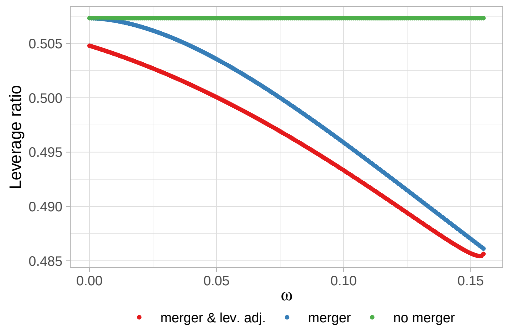
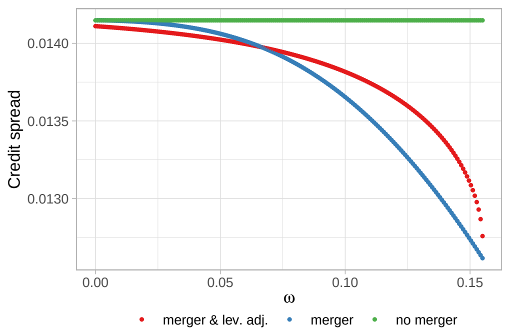


(c) Default trigger



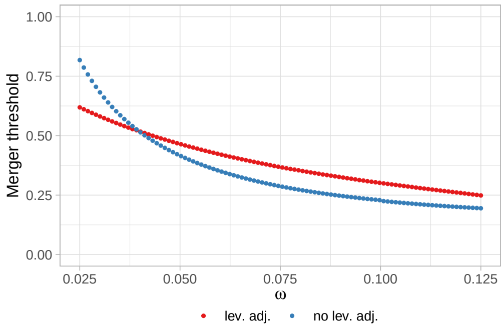
(d) Leverage



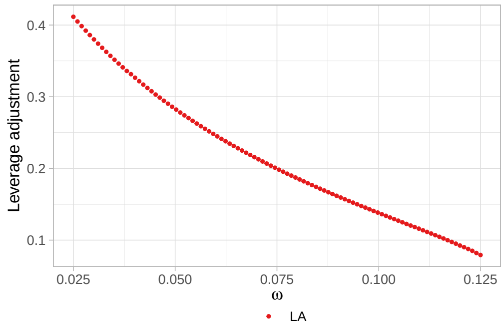
(e) Credit spread

The remaining parameter values are as in Table 1. The default thresholds, leverage ratios, and credit spreads are the same for the two firms because the debt coupons c_i are proportional to the capital stocks K_i.

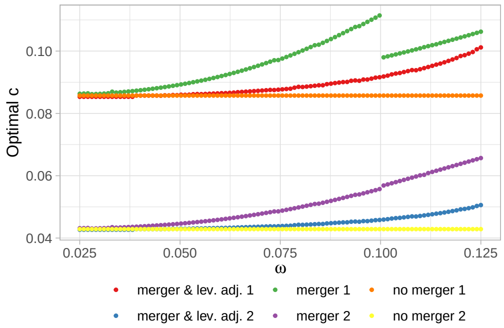
Figure 7: The impact of operational synergies (ω) with exogenous leverage



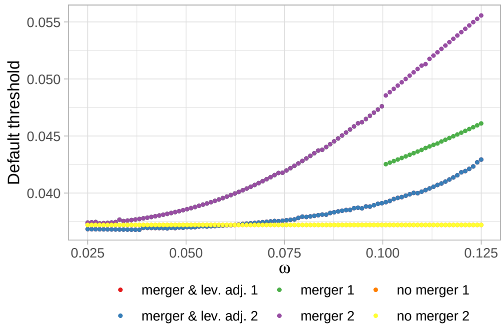
(a) Merger trigger



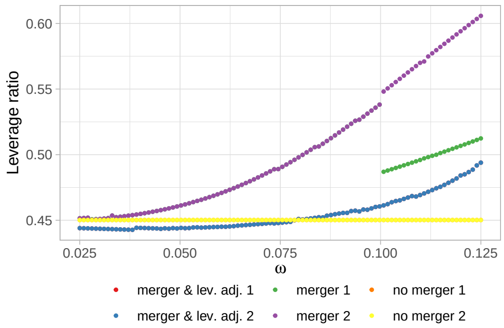
(b) Leverage adjustment



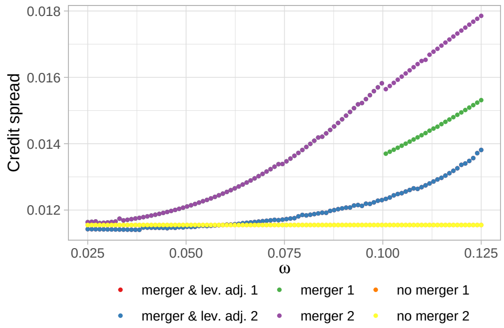
(c) Debt coupon



(d) Default trigger



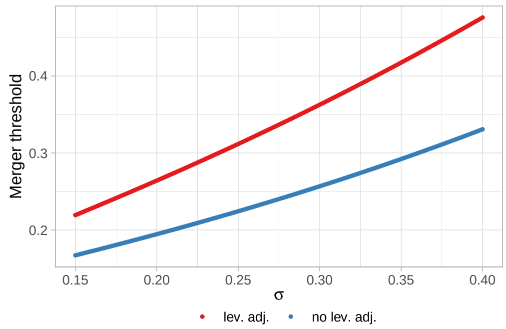
(e) Leverage



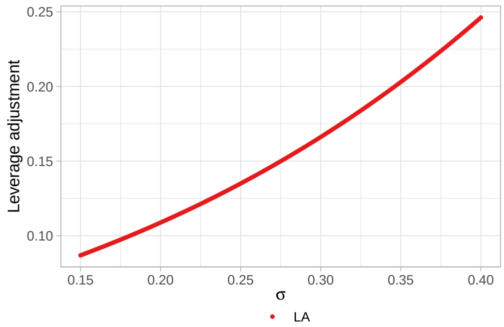
(f) Credit spread

The remaining parameter values are as in Table 1.

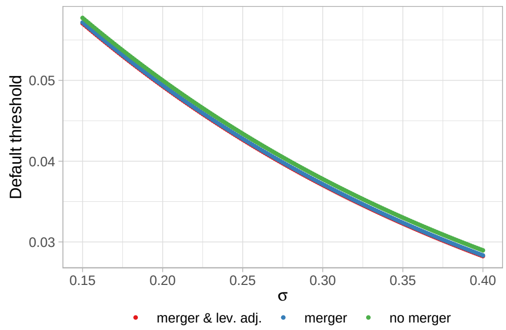
Figure 8: The impact of operational synergies (ω) with endogenous leverage



(a) Merger trigger



(b) Leverage adjustment



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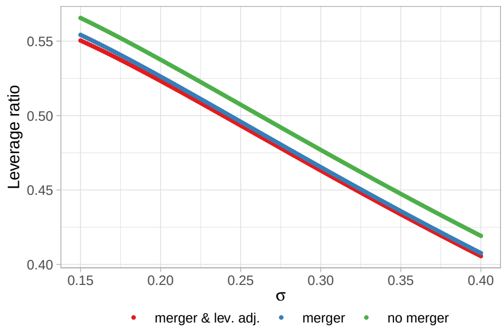
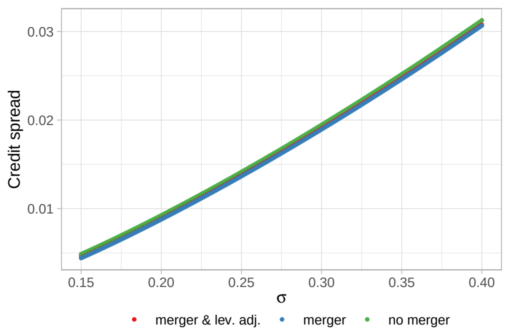


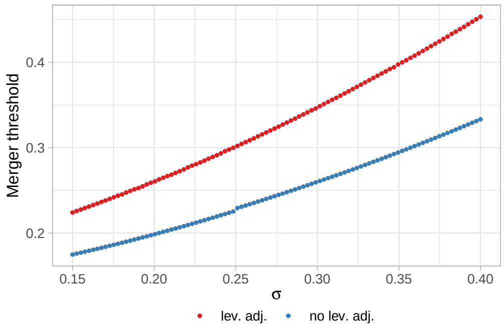
(d) Leverage



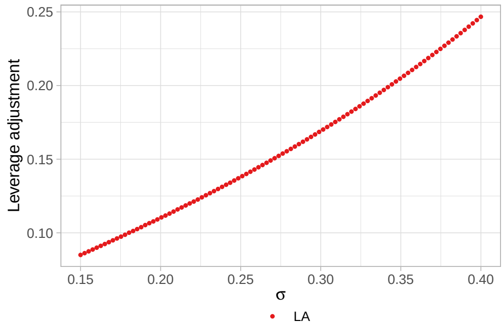
(e) Credit spread

The remaining parameter values are as in Table 1. The default thresholds, leverage ratios, and credit spreads are the same for the two firms because the debt coupons c_i are proportional to the capital stocks K_i.

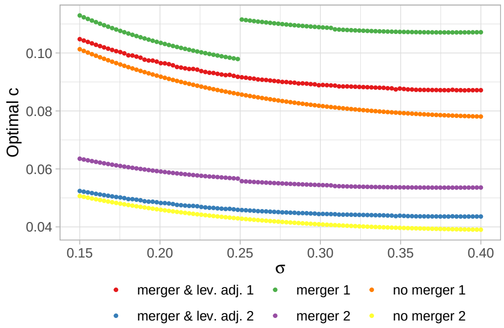
Figure 9: The impact of uncertainty (σ) with exogenous leverage



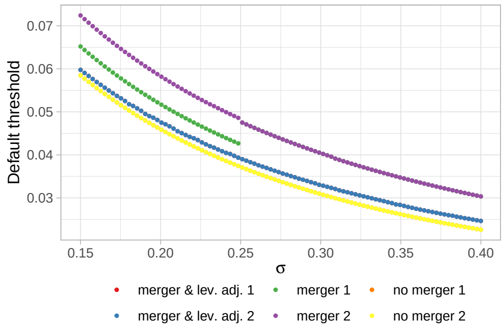
(a) Merger trigger



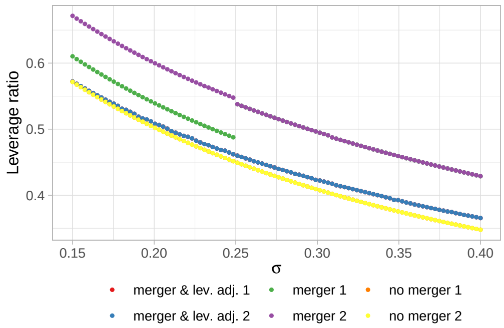
(b) Leverage adjustment



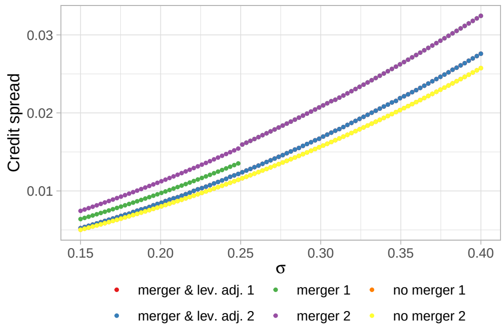
(c) Debt coupon



(d) Default trigger



(e) Leverage



(f) Credit spread

The remaining parameter values are as in Table 1.

Figure 10: The impact of uncertainty (σ) with endogenous leverage