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Financial Synergy in M&A

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Abstract This paper develops a continuous model to examine financial synergy when M&A timing is determined endogenously. In the first-best setting, the optimal capital structure after M&A is determined to maximize the total firm value. However, because the decision on M&A is made by equityholders, first-best results cannot be realized without restrictions on equityholders' behavior, such as debt covenants. Instead, equityholders maximize the sum of equity value and newly issued debt value to determine the optimal capital structure; that is, the existing debt value is ignored. Such a situation is called the second-best setting. We find that, when operational synergy is zero, purely financial synergy can motivate M&A in both the first-best and second-best settings. However, the optimal M&A timing is delayed and the financial synergy is smaller in the second-best setting, which reflects the existence of inefficiency. On the other hand, when operational synergy is negative, even if financial synergy is positive, its magnitude is insufficient to motivate M&A.

Keywords: Financial synergy; Optimal Capital structure; Optimal M&A timing

JEL classification: G32; G34

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1 Introduction

Recently, M&A has seen explosive growth. In 2007, M&A activity totaled a record $4.38 trillion globally, up 21 percent from 2006. More and more firms are considering M&A as a firm value creation strategy instead of internal growth. Furthermore, M&A has been the subject of considerable research in financial economics. Most studies have focused on positive or negative operational synergy, e.g., economies of scale, market power, and managerial benefits.[1] However, financial synergy has rarely been analyzed.

The Modigliani-Miller (1958) theorem states that, without tax benefits and default costs, capital structure is irrelevant to total firm value. As a result, there is no financial synergy. However, in the real world with tax benefits and default costs, capital structure does matter. Therefore, changing the optimal capital structure through M&A can create financial synergy. Although some empirical papers relate firms' incentive of M&A to capital structure motives based on tax benefits, financial slack, wealth transfers, etc., they do not have an explicit model to demonstrate the financial synergy realized in M&A. On the other hand, with the exception of Leland (2007) and Morellec and Zhdanov (2008), M&A related theoretical works do not focus on optimal capital structure by taking tax benefits and default costs into consideration.

This paper develops a continuous model to examine financial synergy when M&A timing is determined endogenously by equityholders. The main questions are as follows. (i) Can M&A be motivated by purely financial synergy, i.e., without operational synergy? How large is the financial synergy? (ii) How is financial synergy distributed between equityholders and debtholders? Related to the first question, Lewellen (1971) asserts that the financial benefits of mergers are always positive. However, Leland (2007) suggests that financial synergy by itself is insufficient to justify M&A in many cases. Related to the second question, Scott (1977) and Shastri (1990) report that, while total firm value may increase through mergers because of lower risk, debtholders may gain at the expense of equityholders. On the other hand, Ghosh and Jain (2000) argues that equityholders can appropriate the benefits from debtholders by financing the merger with debt and increasing financial leverage of the merged firm.

In this paper, we examine financial synergy in both the first-best and second-best settings. By first-best, we mean that the optimal capital structure after M&A is determined to maximize the total firm value. Because the M&A decision is made by equityholders, they choose second-best rather than first-best. That is, they maximize the sum of equity value and newly issued

[1] Lambrecht (2004) analyzes the timing of mergers motivated by economies of scale.

debt value to determine the optimal capital structure, ignoring the existing debt value. We find that when operational synergy is zero, purely financial synergy can motivate M&A in both the first-best and second-best settings. However, the optimal M&A timing is delayed and the financial synergy is smaller in the second-best setting, which reflects the existence of inefficiency. On the other hand, when operational synergy is negative, even if financial synergy is positive, its magnitude is insufficient to motivate M&A.

We show that the distribution of financial synergy between equityholders and debtholders is different in the first-best and second-best settings. In the first-best setting, a part of the value created from exercising the M&A option goes to the existing debtholders, irrespective of the fact that the cost of M&A is fully borne by equityholders. This *ex post* wealth transfer leads equityholders to choose the second-best setting, which reduces the total firm value. In the second-best setting, equityholders may issue a significant amount of new debt, which results in higher default risk. Such actions that transfer wealth from existing debtholders to equityholders are similar to the risk-shifting problem discussed in Jensen and Meckling (1976). Furthermore, the inefficiency of second-best is similar to the debt overhang problem discussed in Myers (1977), which may delay or prevent an investment decision to improve the total firm value because of the existing debt. Actually, the first-best setting corresponds to a situation where debt is issued with covenants protecting the existing debtholders. On the other hand, the second-best setting provides a clear rationale for a leveraged buyout (LBO), where the acquirer issues a significant amount of debt to pay for M&A and then uses the cash flows of the target firm to pay off the debt over time..

The study most related to our paper is Leland (2007), which develops a one-period model to examine purely financial synergy. However, our paper differs from Leland (2007) in that, we provide a continuous model to examine financial synergy with endogeneous M&A timing, which is exogenously given in Leland's discrete model. By taking the optimal M&A timing into consideration endogeneously, our paper analyzes the interaction between financing and investment decisions, and obtain different results from Leland (2007).[2] That is, we find that financial synergy can motivate M&A without operational synergy, whereas Leland (2007) concludes that financial synergy by itself is insufficient to justify M&A in many cases. This discrepancy stems exactly from the difference in modelling mentioned above.

[2]Leland (1994) used firstly a contingent claims approach to study the optimal capital structure in corporate finance. Dixit and Pindyck (1994) is a standard textbook on the real options approach to investment under uncertainty.

The remainder of this paper is organized as follows. Section 2 describes the model's setup. Section 3 examines the determination of optimal M&A timing in both the first-best and second-best settings. Section 4 measures the financial synergy and provides the model implications of our results through some numerical examples. Section 5 concludes. Some detailed proofs can be found in Appendix.

2 Model setup

The model is set in a continuous-time framework. Consider an industry with more than two risk-neutral firms.[3] Among them, there are a potential acquiring firm and a potential target firm.[4] That is, we do not consider competition when there are several potential acquiring firms. The determination of which firm is the acquirer and which is the target is exogenous.

Let the price of the product produced by the firms be $(X_s)_{s\geq 0}$, which is given by the following geometric Brownian motion process:

$$\mathrm{d}X(s) = \mu X(s)\mathrm{d}t + \sigma X(s)\mathrm{d}W(s), \quad X(0) = x_0,$$

where μ and σ (> 0) are constant parameters and $W(s)$ is a standard Brownian motion. The initial value $X(0) = x_0$ is sufficiently low. As in most real options model, we assume the risk-free interest rate $r > \mu$. The quantity produced by firm j ($\in \{a, tar\}$) is Q_j, where the subscripts "a" and "tar" stand for the acquiring firm and the target firm, respectively.

Both the acquirer and the target have already been financed (either by all-equity or by both equity and debt) to start their firms respectively. For simplicity, we assume that the issued debt has infinite maturity and the contractual continuous coupon payment of the perpetual debt issued by firm j is c_j. Then, if there is no variable production cost, the instantaneous profit of firm j at time t before M&A is $(1-\tau)(Q_j X(t) - c_j)$, where τ represents the corporate tax rate. Although issuing debt can obtain tax benefits, it is also accompanied by default costs. As

[3]If there are only two firms in the industry, then a monopoly can be formed through M&A and the merged firm may have market power to determine the price of the product. We assume that firms are price-takers; therefore, monopoly is not considered.

[4]During the1960s and the early 1970s, most mergers were motivated by the diversification effect. That is, when activities' cash flows are imperfectly correlated, risk can be lowered via mergers. However, because business circumstances become more and more competitive, it is inefficient to manage different activities as a conglomerate. Instead of the diversification effect, the specialization effect is more important nowadays. Rhodes-Kropf and Robinson (2004) find empirical evidence that similar firms merge. That is why we consider M&A to be in the same industry and not correlated across two industries.

in Leland (1994), we consider a stock-based definition of default whereby equityholders inject funds in the firm as long as the equity value is positive. In other words, equityholders default on their debt obligations the first time the equity value is equal to zero. Let x_j^d denote the default threshold of firm j before M&A. At the default threshold, we assume that the total firm value is given by the fraction $(1-\alpha)$ of the unlevered firm value $\Pi_j(x_j^d)$, where $\Pi_j(x) \equiv \frac{1-\tau}{r-\mu} Q_j x$. The fraction $\alpha \in [0,1]$ measures the inefficiency because of default costs.

We assume that firms can only receive the M&A option unexpectedly. If either the acquirer or target defaults before the optimal M&A timing arrives, M&A can never be realized. If the price process $(X(s))_{s>0}$ is sufficiently high to hit the optimal M&A threshold before each firm's default threshold, then the acquirer exercises the M&A option by paying the fixed M&A cost I.[5] After M&A, the instantaneous profit of the merged firm is $(1-\tau)(Q_m x - c_m)$, where the subscript "m" stands for the merged firm. Let $Q_m \equiv (1+\xi)(Q_a + Q_{tar})$, where $\xi > -1$ is the parameter of operational synergy. If $\xi > (<)\ 0$, then the operational synergy is positive (negative). The coupon $c_m \equiv c_a + c_{tar} + c_n$ reflects the adjustment of capital structure through M&A, where $c_n \geq 0$ denotes the coupon of the newly issued debt by assuming that firms cannot call back their existing debt when exercising the M&A option. The default threshold of the merged firm is denoted by x_m^d.

3 Model solution

Through our paper, we assume that firms behave in the interests of equityholders.[6] We solve the model using backward induction. Section 3.1 examines the default policy after M&A and the coupon of newly issued debt, which depends on M&A timing. Section 3.2 analyzes the optimal M&A timing before M&A, taking the possibility of default before M&A into consideration.

3.1 After M&A

We start with the valuation of the combined firm after M&A. The first step is to determine the default threshold for the merged firm, x_m^d, and values after M&A. Let T_m^i and T_m^d denote the endogenously chosen time for M&A investment and default of the merged firm. According to

[5]The M&A cost here refers to the due diligence cost paid to the third party.

[6]We abstract from potential agency conflicts between managers and equityholders by assuming that the incentives of these two groups are perfectly aligned. See Zwiebel (1996) and Morellec (2004) for an analysis of the relation between agency conflicts, financing decisions, and control transactions.

our model setup, for $T_m^i \le t \le T_m^d$, the equity value and debt value after M&A are expressed as follows:

$$E_m(x) = \mathbb{E}\left[\int_t^{T_m^d} \mathrm{e}^{-r(s-t)}(1-\tau)(Q_m X(s) - c_m)\mathrm{d}s \Big| X(t) = x\right],$$

$$D_m(x) = \mathbb{E}\left[\int_t^{T_m^d} \mathrm{e}^{-r(s-t)} c_m \mathrm{d}s + \mathrm{e}^{-r(T_m^d - t)}(1-\alpha)\Pi_m(X(T_m^d)) \Big| X(t) = x\right],$$

where $\Pi_m(x) \equiv \frac{1-\tau}{r-\mu} Q_m x$ is the unlevered firm value after M&A.

The instantaneous change in the equity value after M&A satisfies the following ordinary differential equation (ODE):

$$rE_m(x) = (1-\tau)(Q_m x - c_m) + \mu x E_m'(x) + \frac{1}{2}\sigma^2 x^2 E_m''(x), \quad x \ge x_m^d. \tag{3.1}$$

Once process $(X(s))_{s>t}$ hits the threshold x_m^d, the merged firm defaults. The following boundary conditions ensure that the optimal default threshold is chosen by equityholders:

$$\begin{cases} E_m(x_m^d) = 0, \\ E_m'(x_m^d) = 0, \\ \lim_{x\to\infty} E_m(x) = \frac{(1-\tau)x}{r-\mu} - \frac{c_m}{r}. \end{cases} \tag{3.2}$$

Here, the first condition is the value-matching condition. Following the stock-based definition of default, at the default threshold x_m^d, the equity value equals 0. The second condition is the smooth-pasting condition. Because the default decision is made by equityholders, we require this condition to ensure that x_m^d is chosen to maximize the equity value. The third condition is the no-bubbles condition. In the absence of bubbles, the equity value must approach the expected present value of the future cash flows when x goes to infinity.

Solving the above ODE with these boundary conditions, we obtain the equity value after M&A as follows:[7]

$$E_m(x) = \Pi_m(x) - \frac{(1-\tau)c_m}{r} - \left[\Pi_m(x_m^d) - \frac{(1-\tau)c_m}{r}\right]\left(\frac{x}{x_m^d}\right)^\gamma, \tag{3.3}$$

where

$$x_m^d = \frac{\gamma}{\gamma-1}\frac{r-\mu}{r}\frac{c_m}{Q_m}, \tag{3.4}$$

and γ is the negative root of the quadratic equation $\frac{1}{2}\sigma^2 y^2 + (\mu - \frac{1}{2}\sigma^2)y - r = 0$, i.e.,

$$\gamma = \frac{1}{\sigma^2}\left[-(\mu - \frac{\sigma^2}{2}) - \sqrt{(\mu - \frac{\sigma^2}{2})^2 + 2\sigma^2 r}\right] < 0. \tag{3.5}$$

[7] See Appendix A for details.

The equity value after M&A has two components: (i) the unlevered firm value minus the present value of the contractual coupon payment paid to the debtholders, and plus the present value of tax benefits; (ii) the value of the default option, which is the product of savings from default and the risk-neutral probability of default, given by $(x/x_m^d)^\gamma$.

The debt value after M&A can be obtained as

$$D_m(x) = \frac{c_m}{r} - \Big[\frac{c_m}{r} - (1-\alpha)\Pi_m(x_m^d)\Big]\Big(\frac{x}{x_m^d}\Big)^\gamma. \tag{3.6}$$

It also has two components: (i) the present value of perpetual coupon payments; (ii) the present value of the loss in the event of default. Similarly, we can get the economic interpretation for the firm value. Note that the default threshold x_m^d depends on the ratio c_m/Q_m.

The firm value $V_m(x)$ is the sum of equity value and debt value as follows:

$$V_m(x) = E_m(x) + D_m(x) = \Pi_m(x) + \frac{\tau c_m}{r} - \Big[\alpha\Pi_m(x_m^d) + \frac{\tau c_m}{r}\Big]\Big(\frac{x}{x_m^d}\Big)^\gamma. \tag{3.7}$$

The second step is to determine the coupon payment of newly issued debt. We assume that the existing debt and newly issued debt have equal priority at the default threshold.[8] Then, the existing debt value after M&A is $D_m^e(x) = [(c_a + c_{tar})/c_m]D_m(x)$ and the newly issued debt value after M&A is $D_m^n(x) = (c_n/c_m)D_m(x)$. For analytical convenience, we suppose that the merged firm can change its financing policy immediately after M&A, i.e., M&A and the adjustment of the optimal capital structure occur at the same time.

We consider the determination of newly issued debt in both the first-best and second-best settings. In the first-best setting, equityholders choose c_n^* to maximize the total firm value $V_m(x)$ at the optimal M&A threshold x_m^{i*}, which is endogenously determined later. The superscript "$*$" stands for the solution corresponding to the first-best setting. In the second-best setting, equityholders choose c_n^{**} at the optimal M&A threshold x_m^{i**} to maximize $V_m^n(x)$, which represents the sum of equity value $E_m(x)$ and newly issued debt value $D_m^n(x)$. That is:

$$V_m^n(x) = \Pi_m(x) + \frac{\tau c_m - c_a - c_{tar}}{r} + \Big[\Big((1-\alpha)\frac{c_n}{c_m} - 1\Big)\Pi_m(x_m^d) + \frac{c_a + c_{tar} - \tau c_m}{r}\Big]\Big(\frac{x}{x_m^d}\Big)^\gamma. \tag{3.8}$$

The superscript "$**$" stands for the solution corresponding to the second-best setting. The distinction between $V_m(x)$ and $V_m^n(x)$ is essential, because equityholders no longer care about the existing debt value when exercising the M&A option and issuing new debt. This creates the differences between the first-best and second-best settings. Taking the first-order conditions of $V_m(x)$ and $V_m^n(x)$ in (3.7) and (3.8), respectively, we have the following results.

[8] A number of papers, including Weiss (1990), report that the priority of claims is frequently violated in bankruptcy.

The coupon of the newly issued debt in the first-best setting is:

$$c_n^* = -c_a - c_{tar} + \frac{r}{r-\mu}\frac{\gamma-1}{\gamma}\frac{Q_m}{h}x_m^{i*}, \tag{3.9}$$

provided that the right hand side of (3.9) is nonnegative and

$$h = \left[1 - \gamma(1-\alpha+\frac{\alpha}{\tau})\right]^{\frac{-1}{\gamma}} > 1. \tag{3.10}$$

The coupon of the newly issued debt in the second-best setting c_n^{**} satisfies the following implicit function:

$$c_n^{**} = -c_a - c_{tar} + \frac{r}{r-\mu}\frac{\gamma-1}{\gamma}\frac{Q_m}{h}x_m^{i**}\left[1 - \frac{\gamma}{\gamma-1}\left(\frac{\tau^{-1}-\gamma(1-\alpha+\alpha/\tau)}{1-\gamma(1-\alpha+\alpha/\tau)}\right)\frac{c_a+c_{tar}}{c_n^{**}+c_a+c_{tar}}\right]^{\frac{1}{\gamma}}, \tag{3.11}$$

provided that the right hand side of (3.9) is nonnegative. Comparing c_n^* and c_n^{**} in (3.9) and (3.11), respectively, we find that they depend on different optimal M&A thresholds x_m^{i*} and x_m^{i**} and there is an additional coefficient in the last term of c_n^{**}.

3.2 Before M&A

To analyze the situation before M&A in the third step, we consider two cases: Case 1 (an all-equity firm acquires a leveraged firm) and Case 2 (a leveraged firm acquires an all-equity firm). For each case, we first analyze the first-best setting and then the second-best setting. Because the main point here is that there exists difference in firms' default thresholds before M&A, we omit the case in which both the acquirer and the target are leveraged firms, which can also be analyzed by an extension of this model but with unchanged implications.

3.2.1 Case 1: all-equity firm acquires leveraged firm

For Case 1, because the acquiring firm is an all-equity firm, default of the acquiring firm before M&A never occur. Therefore, the acquiring equityholders only determine the upper boundary x_{m1}^i, where the subscript "1" stands for Case 1. Howerver, if the process $(X(s))_{s>0}$ hits the lower boundary x_{tar}^d before M&A, which is determined by the target equityholders, then M&A can never be realized.

Let E_{am} denote the equity value of the acquiring firm with an M&A option.[9] In the first-best

[9]Note that $V_{am}(x) = E_{am}(x)$ in Case 1, because the acquiring firm is an all-equity firm.

setting, the boundary conditions are given as follows:

$$\begin{cases} E_{am}(x_{m1}^{i*}) + V_{tarm}(x_{m1}^{i*}) = V_m(x_{m1}^{i*}) - I, \\ E'_{am}(x_{m1}^{i*}) + V'_{tarm}(x_{m1}^{i*}) = V'_m(x_{m1}^{i*}), \\ E_{am}(x_{tar}^{d}) = \Pi_a(x_{tar}^{d}), \end{cases} \tag{3.12}$$

where the subscripts "am" and "$tarm$" differs from "a" and "tar" in that they represent values with an M&A option.

Here, the first condition is the value-matching condition at x_{m1}^{i*}. After M&A, the acquiring equityholders internalize the tax benefits and default costs of the merged firms. By paying cost I to exercise the M&A option at x_{m1}^{i*}, the acquiring equityholders collect the surplus from the merged firm value substracting the value paid to the target firm.[10] The second condition is the smooth pasting condition at x_{m1}^{i*}. This condition ensures that x_{m1}^{i*} is chosen to maximize the total firm value. The third condition is the value-matching condition at x_{tar}^{d}. Because the acquiring equityholders do not select the default threshold x_{tar}^{d}, this value-matching condition is not associated with a smooth-pasting condition.

On the other hand, in the second-best setting, the value-matching and smooth-pasting conditions at the M&A threshold are given as follows:

$$\begin{cases} E_{am}(x_{m1}^{i**}) = V_m^n(x_{m1}^{i**}) - E_{tar}(x_{m1}^{i**}) - I, \\ E'_{am}(x_{m1}^{i**}) = V_m^{n'}(x_{m1}^{i**}) - E'_{tar}(x_{m1}^{i**}). \end{cases} \tag{3.13}$$

Note that $V_m^n(x) - E_{tar}(x) = V_m(x) - D_{tarm}(x) - E_{tar}(x) = V_m(x) - V_{tarm}(x)$, i.e., the value-matching condition in the second-best setting is exactly the same with that in the first-best setting.

Let $\mathcal{H}(x; y, z)$ denote the present value of a claim that pays \$1 contingent on x reaching the upper threshold y before reaching the lower threshold z. In addition, let $\mathcal{L}(x; y, z)$ denote the present value of a claim that pays \$1 contingent on x reaching the lower threshold z before reaching the upper threshold y. In Appendix B, we show that:

$$\begin{cases} \mathcal{H}(x; y, z) = \frac{z^\gamma x^\beta - z^\beta x^\gamma}{z^\gamma y^\beta - z^\beta y^\gamma}, \\ \mathcal{L}(x; y, z) = \frac{x^\gamma y^\beta - x^\beta y^\gamma}{z^\gamma y^\beta - z^\beta y^\gamma}, \end{cases} \tag{3.14}$$

[10] Because the target firm has no decision power on M&A in our model, it will agree on M&A if the acquiring firm provides its stand-alone firm value.

where β is the positive root of the quadratic equation $\frac{1}{2}\sigma^2 y^2 + (\mu - \frac{1}{2}\sigma^2)y - r = 0$, i.e.,

$$\beta = \frac{1}{\sigma^2}\left[-(\mu - \frac{\sigma^2}{2}) + \sqrt{(\mu - \frac{\sigma^2}{2})^2 + 2\sigma^2 r}\right] > 1. \tag{3.15}$$

According to the above boundary conditions, the equity value of the acquiring firm with the M&A option for Case 1 can be written as:

$$E_{am}(x) = \Pi_a(x) + e^i_{a1}\mathcal{H}(x; x^i_{m1}, x^d_{tar}), \tag{3.16}$$

where

$$e^i_{a1} = V_m(x^i_{m1}) - V_{tarm}(x^i_{m1}) - I - \Pi_a(x^i_{m1}) = V^n_m(x^i_{m1}) - E_{tar}(x^i_{m1}) - I - \Pi_a(x^i_{m1}). \tag{3.17}$$

The value given in (3.16) is the sum of the unlevered equity value without an M&A option and the present value of the M&A option. The latter is given by the product of conditional probability $\mathcal{H}(x; x^i_{m1}, x^d_{tar})$ and the net payoff e^i_{a1} from exercising the M&A option.

Taking into consideration the possibility of an M&A offered by the acquiring firm, the firm value of the target is:

$$\begin{aligned} V_{tarm}(x) &= E_{tar}(x) + D_{tarm}(x) \\ &= \Pi_{tar}(x) - \frac{(1-\tau)c_{tar}}{r} - \left[\Pi_{tar}(x^d_{tar}) - \frac{(1-\tau)c_{tar}}{r}\right]\left(\frac{x}{x^d_{tar}}\right)^{\gamma} \\ &+ \frac{c_{tar}}{r} + e^i_{tar1}\mathcal{H}(x; x^i_{m1}, x^d_{tar}) + e^d_{tar1}\mathcal{L}(x; x^i_{m1}, x^d_{tar}), \end{aligned} \tag{3.18}$$

where

$$\begin{cases} e^i_{tar} = \frac{c_{tar}}{c_m} D_m(x^i_{m1}) - \frac{c_{tar}}{r}, \\ e^d_{tar} = (1-\alpha)\Pi_{tar}(x^d_{tar}) - \frac{c_{tar}}{r}. \end{cases} \tag{3.19}$$

Because we assume that the acquiring equityholders only provide the stand-alone target equity value in the M&A, it has the same form as (3.3). However, the target debt value with the M&A option is different from the stand-alone value, i.e., $D_{tarm}(x) \neq D_{tar}(x)$, because of the assumption that the existing debt cannot be called back after the M&A. The target debt value is passively affected by the acquiring equityholders' M&A option and therefore has three components: (i) the present value of perpetual coupon payments; (ii) the present value of the M&A option, which is given by the product of conditional probability $\mathcal{H}(x; x^i_{m1}, x^d_{tar})$ and the net payoff e^i_{tar} from the acquiring equityholders exercising the M&A option; (iii) the present value of the default option, which is given by the product of the conditional probability $\mathcal{L}(x; x^i_{m1}, x^d_{tar})$ and the net payoff e^d_{tar} from the target equityholders exercising the default option.

By arranging the smooth-pasting condition at x_{m1}^{i*} in the first-best setting, we obtain:

$$\frac{1-\tau}{r-\mu}\xi(Q_a+Q_{tar})x_{m1}^{i*}+\nu_1\gamma(x_{m1}^{i*})^{\gamma}= \frac{\beta[(e_{a1}^i+e_{tar1}^i)(x_{tar}^d)^{\gamma}-e_{tar1}^d(x_{m1}^{i*})^{\gamma}](x_{m1}^{i*})^{\beta}-\gamma[(e_{a1}^i+e_{tar1}^i)(x_{tar}^d)^{\beta}-e_{tar1}^d(x_{m1}^{i*})^{\beta}](x_{m1}^{i*})^{\gamma}}{(x_{tar}^d)^{\gamma}(x_{m1}^{i*})^{\beta}-(x_{tar}^d)^{\beta}(x_{m1}^{i*})^{\gamma}}, \tag{3.20}$$

where

$$\nu_1=-\Big[\alpha\Pi_m(x_m^d)+\frac{\tau c_{m1}^*}{r}\Big](x_m^d)^{-\gamma}+\Big[\Pi_{tar}(x_{tar}^d)-\frac{(1-\tau)c_{tar}}{r}\Big](x_{tar}^d)^{-\gamma}. \tag{3.21}$$

Therefore, we have two equations, (3.9) and (3.20) to determine the two unknowns in the first-best setting: x_{m1}^{i*} and c_{n1}^*.

On the other hand, the smooth-pasting condition at x_{m1}^{i**} in the second-best setting implies:

$$\frac{1-\tau}{r-\mu}\xi(Q_a+Q_{tar})x_{m1}^{i**}+\nu_2\gamma(x_{m1}^{i**})^{\gamma}=\frac{\beta e_{a1}^i(x_{tar}^d)^{\gamma}(x_{m1}^{i**})^{\beta}-\gamma e_{a1}^i(x_{tar}^d)^{\beta}(x_{m1}^{i**})^{\gamma}}{(x_{tar}^d)^{\gamma}(x_{m1}^{i**})^{\beta}-(x_{tar}^d)^{\beta}(x_{m1}^{i**})^{\gamma}}, \tag{3.22}$$

where

$$\nu_2=\Big[\Big((1-\alpha)\frac{c_{n1}^{**}}{c_{m1}^{**}}-1\Big)\Pi_m(x_m^d)+\frac{c_{tar}-\tau c_{m1}^{**}}{r}\Big](x_m^d)^{-\gamma}+\Big[\Pi_{tar}(x_{tar}^d)-\frac{(1-\tau)c_{tar}}{r}\Big](x_{tar}^d)^{-\gamma} \tag{3.23}$$

Then, we have (3.11) and (3.22) to determine the two unknowns in the second-best setting: x_{m1}^{i**} and c_{n1}^{**}.

3.2.2 Case 2: leveraged firm acquires all-equity firm

For Case 2, because the acquiring firm is a leveraged firm, the acquiring equityholders determine both the upper and lower boundaries: x_{m2}^i and x_{am}^d. Note that the default threshold with the M&A option is represented by x_{am}^d ($\neq x_a^d$). In the first-best setting, the boundary conditions are given as follows:

$$\begin{cases} V_{am}(x_{m2}^{i*})+E_{tar}(x_{m2}^{i*})=V_m(x_{m2}^{i*})-I, \\ V_{am}'(x_{m2}^{i*})+E_{tar}'(x_{m2}^{i*})=V_m'(x_{m2}^{i*}), \\ E_{am}(x_{am}^{d*})=0, \\ E_{am}'(x_{am}^{d*})=0. \end{cases} \tag{3.24}$$

The first and the second conditions are value-matching and smooth-pasting conditions at x_{m2}^{i*}, respectively, which are similar to those in Case 1. The third and the fourth conditions are value-matching and smooth-pasting conditions at x^{d*}_{am}, respectively, because the acquiring equityholders optimally choose to default when the equity value equals 0.

According to the above boundary conditions, the equity value of the acquiring firm with an M&A option for Case 2 can be written as:

$$E_{am}(x) = \Pi_a(x) - \frac{(1-\tau)c_a}{r} + \hat{e}^i_{a2}\mathcal{H}(x; x^i_{m2}, x^d_{am}) + \hat{e}^d_{a2}\mathcal{L}(x; x^i_{m2}, x^d_{am}), \tag{3.25}$$

where

$$\begin{cases} \hat{e}^i_{a2} = V^n_m(x^i_{m2}) - E_{tar}(x^i_{m2}) - I - \left[\Pi_a(x^i_{m2}) - \frac{(1-\tau)c_a}{r}\right], \\ \hat{e}^d_{a2} = -\left[\Pi_a(x^d_{am}) - \frac{(1-\tau)c_a}{r}\right]. \end{cases} \tag{3.26}$$

The total firm value of the acquiring firm with the M&A option is

$$\begin{aligned} V_{am}(x) &= E_{am}(x) + D_{am}(x) \\ &= \Pi_a(x) + \frac{\tau c_a}{r} + e^i_{a2}\mathcal{H}(x; x^i_{m2}, x^d_{am}) + e^d_{a2}\mathcal{L}(x; x^i_{m2}, x^d_{am}), \end{aligned} \tag{3.27}$$

where

$$\begin{cases} e^i_{a2} = V_m(x^i_{m2}) - E_{tar}(x^i_{m2}) - I - [\Pi_a(x^i_{m2}) + \frac{\tau c_a}{r}], \\ e^d_{a2} = -\left[\alpha\Pi_a(x^d_{am}) + \frac{\tau c_a}{r}\right]. \end{cases} \tag{3.28}$$

By arranging the smooth-pasting condition at x^{i*}_{m2} and x^{d*}_{am} in the first-best setting, we obtain:

$$\begin{aligned} &\frac{1-\tau}{r-\mu}\xi(Q_a + Q_{tar})x^{i*}_{m2} + \nu_3\gamma(x^{i*}_{m2})^{\gamma} = \\ &\frac{\beta[e^i_{a2}(x^{d*}_{am})^{\gamma} - e^d_{a2}(x^{i*}_{m2})^{\gamma}](x^{i*}_{m2})^{\beta} - \gamma[e^i_{a2}(x^{d*}_{am})^{\beta} - e^d_{a2}(x^{i*}_{m2})^{\beta}](x^{i*}_{m2})^{\gamma}}{(x^{d*}_{am})^{\gamma}(x^{i*}_{m2})^{\beta} - (x^{d*}_{am})^{\beta}(x^{i*}_{m2})^{\gamma}}, \end{aligned} \tag{3.29}$$

where

$$\nu_3 = -\left[\alpha\Pi_m(x^d_m) + \frac{\tau c^*_{m2}}{r}\right](x^d_m)^{-\gamma}, \tag{3.30}$$

and

$$\Pi_a(x^{d*}_{am}) + \frac{\beta[\hat{e}^i_{a2}(x^{d*}_{am})^{\gamma} - \hat{e}^d_{a2}(x^{i*}_{m2})^{\gamma}](x^{d*}_{am})^{\beta} - \gamma[\hat{e}^i_{a2}(x^{d*}_{am})^{\beta} - \hat{e}^d_{a2}(x^{i*}_{m2})^{\beta}](x^{d*}_{am})^{\gamma}}{(x^{d*}_{am})^{\gamma}(x^{i*}_{m2})^{\beta} - (x^{d*}_{am})^{\beta}(x^{i*}_{m2})^{\gamma}} = 0. \tag{3.31}$$

Therefore, we have three equations (3.9), (3.29), and (3.31) to determine the three unknowns in the first-best setting: x^{i*}_{m2}, x^{d*}_{am}, and c^*_{n2}.

On the other hand, the smooth-pasting condition at x^{i**}_{m} in the second-best setting implies:

$$\begin{aligned} &\frac{1-\tau}{r-\mu}\xi(Q_a + Q_{tar})x^{i**}_{m2} + \left[\left((1-\alpha)\frac{c^{**}_{n2}}{c^{**}_{m2}} - 1\right)\Pi_m(x^d_m) + \frac{c_a - \tau c^{**}_{m2}}{r}\right]\gamma\left(\frac{x^{i**}_{m2}}{x^d_m}\right)^{\gamma} = \\ &\frac{\beta[\hat{e}^i_{a2}(x^{d**}_{am})^{\gamma} - \hat{e}^d_{a2}(x^{i**}_{m2})^{\gamma}](x^{i**}_{m2})^{\beta} - \gamma[\hat{e}^i_{a2}(x^{d**}_{am})^{\beta} - \hat{e}^d_{a2}(x^{i**}_{m2})^{\beta}](x^{i**}_{m2})^{\gamma}}{(x^{d**}_{am})^{\gamma}(x^{i**}_{m2})^{\beta} - (x^{d**}_{am})^{\beta}(x^{i**}_{m2})^{\gamma}}. \end{aligned} \tag{3.32}$$

Therefore, we have have three equations (3.11), (3.31) (x_{m2}^{i**} and x_{am}^{d**} instead of x_{m2}^{i*} and x_{am}^{d*}), and (3.32) to determine the three unknows in the second-best setting: x_{m2}^{i**}, x_{am}^{d**}, and c_{n2}^{**}.

4 Model implications

Because the above equations are nonlinear in the thresholds, analytical solutions in closed forms are impossible. In this section, we conduct numerical examples to analyze the characteristics of the solutions. In particular, we measure financial synergy (without or with operational synergy) when the M&A option is exercised optimally.

The basic parameter values are set as follows: $\mu = 0.01,\ \sigma = 0.25,\ r = 0.06,\ \tau = 0.4,\ \alpha = 0.4,\ I = 10,\ x = 2.5$. The parameter values c and Q for the acquirer and target are different: $c_a = 0,\ c_{tar} = 5,\ Q_a = 1.1,\ Q_{tar} = 1$ for Case 1, and $c_a = 5,\ c_{tar} = 0,\ Q_a = 1,\ Q_{tar} = 1.1$ for Case 2. In Case 1, the acquirer is an all-equity firm with relatively efficient production but financial slack, and the target is a leveraged firm with enough capital but relatively inefficient production. Case 2 corresponds to an adverse situation.

4.1 Financial synergy without operational synergy

If there is no operational synergy (i.e., $\xi = 0$), the financial synergy of M&A is measured by the difference between the value of the optimally levered merged firm, and the sum of the stand-alone acquirer value and target value. The discounted financial synergy at time t is:

$$FS(x_m^i) = [V_m(x_m^i) - V_a(x_m^i) - V_{tar}(x_m^i)](x/x_m^i)^\beta = \left[\Delta TB(x_m^i) - \Delta DC(x_m^i)\right](x/x_m^i)^\beta, \quad (4.1)$$

where

$$\Delta TB(x_m^i) = \tau\frac{c_m}{r}\left[1 - \left(\frac{x_m^i}{x_m^d}\right)^\gamma\right] - \tau\frac{c_j}{r}\left[1 - \left(\frac{x_m^i}{x_j^d}\right)^\gamma\right], \quad (4.2)$$

$$\Delta DC(x_m^i) = \alpha(1-\tau)\frac{Q_m x_m^d}{r-\mu}\left(\frac{x_m^i}{x_m^d}\right)^\gamma - \alpha(1-\tau)\frac{Q_j x_j^d}{r-\mu}\left(\frac{x_m^i}{x_j^d}\right)^\gamma, \quad (4.3)$$

$j = tar$ for Case 1, and $j = a$ for Case 2. The financial synergy can be decomposed into two components, which are directly related to changes in financial structure through M&A. The first component ΔTB denotes the change in the present value of tax benefits from the optimally levered merged firm versus separate firms. The second component ΔDC denotes the change in the present value of default costs at the optimal M&A timing.

The credit spread and leverage are measured using the following definition.

$$CS_j(x_m^i) = \frac{c_j}{D_j(x_m^i)} - r, \quad (4.4)$$

$$L_j(x_m^i) = \frac{D_j(x_m^i)}{V_j(x_m^i)}, \tag{4.5}$$

where $j \in \{m, a, tar\}$.

Table 1 shows the results of both Case 1 and Case 2 in the first-best (FB) and second-best (SB) settings, when there is no operational synergy.

Table 1: Results without operational synergy.

Case 1	x_{tar}^d	x_m^i	FS	ΔTB	ΔDC	c_m	ΔE	ΔD_{tar}	CS_{tar}	CS_m	L_{tar}	L_m
FB	2.17	5.26	4.93	5.92	0.99	10.08	4.62	0.30	0.027	0.025	0.72	0.70
SB	2.17	7.53	3.49	5.64	2.15	18.17	5.52	-2.03	0.016	0.037	0.59	0.79
Case 2	x_{am}^d	x_m^i	FS	ΔTB	ΔDC	c_m	ΔE	ΔD_a	CS_a	CS_m	L_a	L_m
FB	2.09	4.76	5.43	6.23	0.80	9.11	4.11	1.32	0.032	0.025	0.76	0.70
SB	1.88	7.61	3.49	5.61	2.13	18.32	5.50	-2.01	0.016	0.037	0.58	0.79

First, consider the default threshold before M&A (column 2). We find $x_{am}^d < x_{tar}^d = 2.17$. Because default involves the loss of the M&A option and tax benefits from issuing new debt in the future, equityholders are less willing to exercise the default option, compared with the setting without the M&A option.

Second, consider the M&A timing and financial synergy (columns 3-6). We find that financial synergy can be positive in both the first-best and second-best settings. In other words, purely financial synergy itself can motivate M&A. However, the optimal M&A timing is delayed and the financial synergy is smaller in the second-best setting, compared with those in the first-best setting. The inefficiency stems from the action that the equityholders choose c_n to maximize the sum of equity value $E_m(x)$ and newly issued debt value $D_m^n(x)$, not $V_m(x)$. Both tax benefits and default costs increase; however, the increase in tax benefits is much larger than that in default costs.

Claim 4.1. *When operational synergy is zero, purely financial synergy can motivate M&A in both the first-best and second-best settings.*

Third, consider the coupon and value changes after M&A (columns 7-9). In the first-best setting, although the coupon after M&A increases a little, the ratio of c_m/Q_m in (3.4) decreases. Therefore, default risk decreases and the existing debt value increases. Irrespective of the fact that the M&A cost is fully borne by equityholders, a part of the increase in the total firm value accrues to the existing debtholders. This wealth transfer discourages equityholders from exercising the M&A option at the first-best timing, although it can maximize the total firm value after M&A. This reflects the debt-overhang problem discussed in Myers (1977) and Sundaresan and Wang (2006), which may delay or prevent an investment decision to improve the total firm value. In the second-best setting, default risk increases and the existing debt value decreases. The reason is that equityholders appropriate the benefits from existing debtholders by issuing a significant amount of new debt and increasing the leverage of the merged firm.[11] That is the so-called risk-shifting problem discussed in Jensen and Meckling (1976). Equity value increases in both the first-best and second-best settings, which ensures the participation constraint of equityholders in M&A.

Fourth, consider the changes in the leverage and credit spread (columns 10-13). In the first-best setting, although the coupon after M&A increases a little, the default risk decreases. Therefore, both the leverage and credit spread decrease. On the other hand, in the second-best setting, because the coupon increases significantly and the default risk increases, both the leverage and credit spread increase. In fact, the first-best setting corresponds to a situation where debt is issued with covenants protecting the existing debtholders, and the second-best setting corresponds to the case of an LBO. In an LBO, an acquirer issues a significant amount of debt to pay for an acquisition and then uses the cash flows of the target firm to pay off the debt over time. After an LBO, firms usually have high leverage, and the debt usually is not investment grade. From the perspective of existing debtholders, an LBO represents a fundamental shift in the firm's risk profile and results in a decrease in debt value.[12] Note that the optimal leverage and credit spread after M&A are the same for both Case 1 and Case 2 in the first-best setting, although the optimal M&A thresholds are different. According to Proposition 1 and equation (3.9), the optimal debt coupon after M&A, the optimal debt value and firm value are proportional to x_m^i in the first-best setting. Thus, the leverage and credit spread are invariant to x_m^i.

To examine the effect of uncertainty on optimal M&A timing, Figure 1 plots the M&A

[11] Although we assumed both the existing debt and the newly issued debt have equal priority at the default threshold, even with seniority provisions, the existing debtholders lose value when new debt is issued. Ziegler (2004) demonstrates that seniority provisions do protect existing debtholders against losing value to new debtholders; however, they do not protect existing debtholders against wealth transfers driven by changes in the timing and probability of default.

[12] The famous example of an LBO is that KKR acquired RJR-Nabisco in the late 1980s and this illustrates the wealth transfer from the existing debtholders to equityholders.

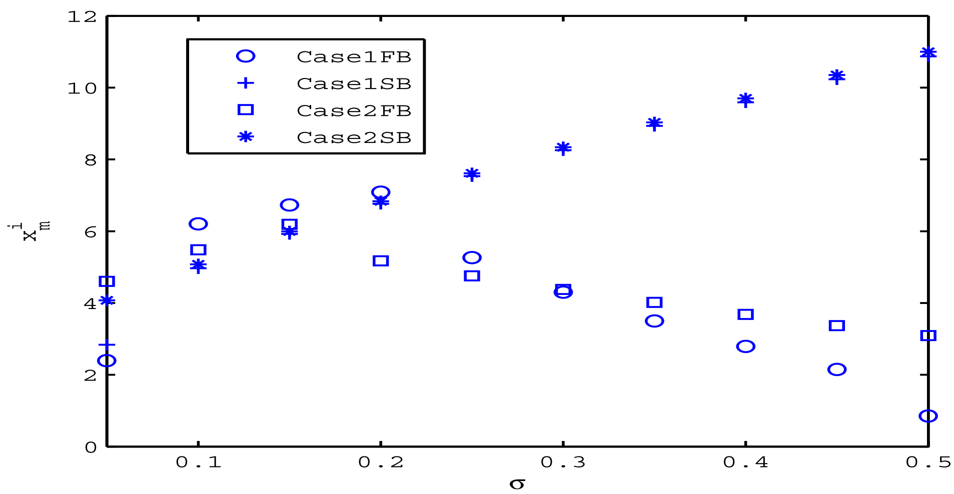

Figure 1: The effects of volatility on M&A threshold.

threshold x_m^i for varying volatilities of the price process. As σ increases, x_m^i in the second-best setting increases. However, x_m^i in the first-best setting increases at first, and then decreases. The intuition is as follows. Volatility has two countervailing effects on the optimal M&A threshold. One is the usual positive effect explained in the standard real options model (all-equity firm without default). Higher volatility implies a larger option value of waiting to exercise the M&A option. Therefore, the M&A threshold increases with volatility. The other is a negative effect because of the existence of the lower default boundary before M&A. As σ increases, the probability of hitting the default boundary before M&A increases. Therefore, there is an incentive for equityholders to exercise M&A earlier, which induces a lower M&A threshold. In the second-best setting, the positive effect dominates, because x_m^i is chosen to maximize the sum of equity value and newly issued debt value, ignoring the existing debt value. However, in the first-best setting, x_m^i is chosen to maximize the total firm value, which is different from the standard real options (all-equity firm) model. The negative effect becomes stronger as σ increases and begins to dominate the positive effect when σ increases by a certain degree.

4.2 Financial synergy with operational synergy

From (4.2) and (4.3), we find that the operational synergy parameter, Q_m ($\equiv (1+\xi)(Q_a + Q_{tar})$) entered into the finanacial adjustment terms ΔTB and ΔDC. Therefore, when there is operational synergy ($\xi \neq 0$), we cannot divide financial synergy and operational synergy simply.

However, it is unquestionable that the interaction between financial synergy and operational synergy stems from the additional consideration of financial structure adjustment.

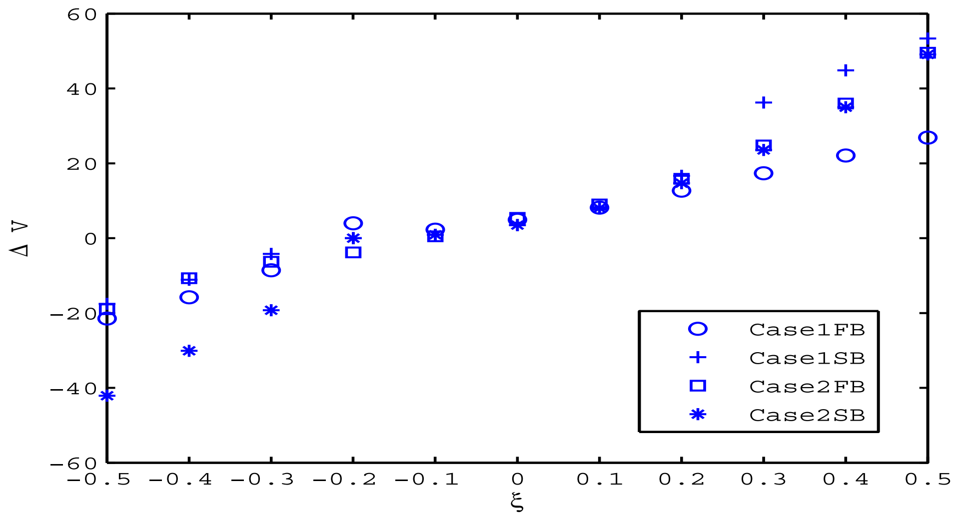

Figure 2: The effects of operational synergy in change of total firm value.

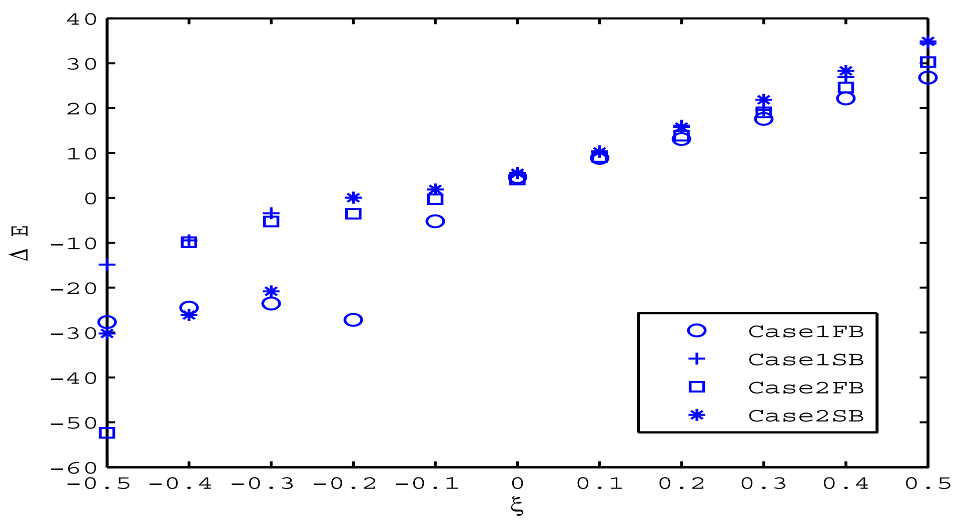

Figure 3: The effects of operational synergy in change of equity value.

Figures 2 and 3 depicts the value changes when ξ varies.[13] We find that even if $\xi < 0$, there exist situations where $\Delta V > 0$. However, because the decision of exercising the M&A option is

[13]If the optimal M&A threshold x_m^i is lower than the initial value x_0, then the M&A option is exercised immediately. In that case, the corresponding values are calculated at x_0.

made by equityholders, whose value decreases ($\Delta E < 0$) when $\xi < 0$, M&A cannot be realized. Therefore, we conclude as follows.

Claim 4.2. *When operational synergy is negative, even if financial synergy is positive, its magnitude is insufficient to motivate M&A.*

Figure 4 plots M&A thresholds with varying operational synergies. Comparing M&A thresholds for Case 1 and Case 2 in the first-best setting, we find that x_m^i is lower for Case 2 than for Case 1. In other words, Case 2 in the first-best setting is more likely to occur. The reason is that, in Case 2, where the acquirer is a leveraged firm, the incentive to take the existing debt value into consideration is more necessary than in Case 1. On the other hand, comparing M&A thresholds for Case 1 and Case 2 in the second-best setting, we find that x_m^i is lower for Case 1 than for Case 2. In other words, Case 1 in the second-best setting is more likely to occur. This result also reflects the debt overhang problem. The M&A option is exercised later in the second-best setting because of the presence of existing debt in the acquiring firm. Therefore, the less the existing debt, the earlier M&A occurs.

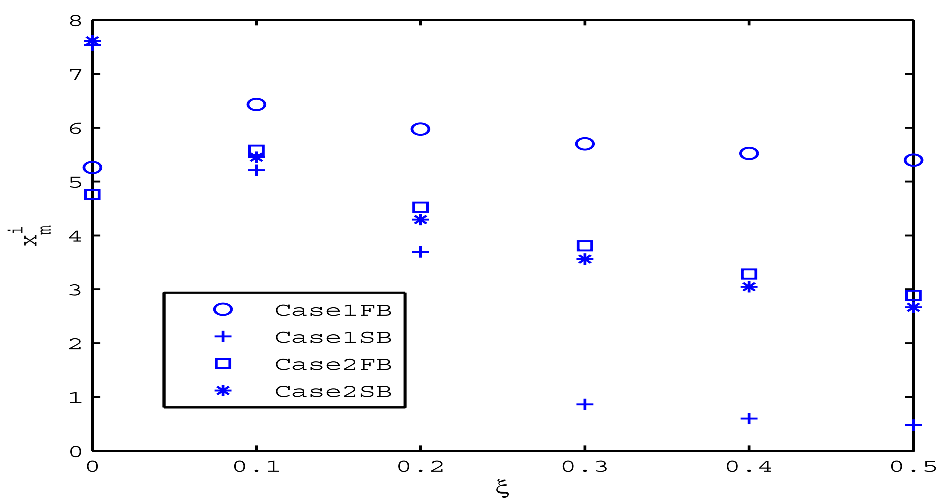

Figure 4: The effects of operational synergy on the M&A threshold.

5 Conclusions

This paper developed a continuous model to examine the financial synergy when M&A timing is determined endogenously. We showed that, when operational synergy is zero, purely financial synergy can motivate M&A in both the first-best and second-best settings. However, the optimal M&A timing is delayed and the financial synergy is smaller in the second-best setting, which reflects the existence of inefficiency. On the other hand, when operational synergy is negative, even if financial synergy is positive, its magnitude is insufficient to motivate M&A.

The analysis in this paper with exogenously given debt is suitable for settings where the firm receives a new growth option (like M&A) unexpectedly. Our theoretical model generates implications that are consistent with results in corporate finance. First, the debt overhang problem. While total firm value increases through M&A because of lower risk, a part of the value created from exercising the M&A option goes to the existing debtholders. This *ex post* wealth transfer discourages equityholders from exercising the M&A option at the first-best timing, because the cost of the M&A is fully borne by equityholders. Second, the risk-shifting problem. The existence of debtholders already in place creates an incentive for equityholders to issue a significant amount of new debt which results in higher default risk. Furthermore, the financial leverage increases significantly and the existing debt value decreases after M&A, which corresponds to an LBO.

Our results also have implications for empirical works that examine the sourses of M&A synergies. Those parameters mentioned above, such as the tax rate and default costs, which can create substantial financial synergy, should be included as possible explanatory variables.

Lastly, we should point out some important but difficult topics for future research. First, considering competition among multiple acquirers is more realistic. Competition will affect both the optimal M&A timing and the subsequent financial synergy. A discussion of an acquisition premium for the target is necessary during the competition process. Second, while our paper considered the situation where firms receive an M&A option unexpectedly, the analysis when firms can anticipate a future growth option can endogenously derive the initial capital structure to defer *ex post* inefficiency. We will consider these questions in the future.

Appendix A

The general solution of ODE (3.1) is:

$$E_m(x) = A_- x^\gamma + A_+ x^\beta + \frac{(1-\tau)Q_m x}{r-\mu} - \frac{c_m}{r}, \tag{A.1}$$

where

$$\gamma = \frac{1}{\sigma^2}\left[-(\mu - \frac{1}{2}\sigma^2) - \sqrt{(\mu - \frac{1}{2}\sigma^2)^2 + 2\sigma^2 r}\right]. \tag{A.2}$$

From the no-bubbles condition, when x goes to infinity, x^β is explosive, A_+ must equal zero. From the value-matching and smooth-pasting conditions, we know that:

$$\begin{cases} A_-(x_m^d)^\gamma + \frac{(1-\tau)Q_m x_m^d}{r-\mu} - \frac{c_m}{r} = 0, \\ A_-\gamma(x_m^d)^{\gamma-1} + \frac{(1-\tau)Q_m}{r-\mu} = 0. \end{cases} \tag{A.3}$$

Solving the above equations, we obtain default threshold x_m^d and the equity value. The debt value can be obtained similarly.

Appendix B

Because $\mathcal{H}(x; y, z)$ is a claim that receives no dividend, we know from (A.1) that $\mathcal{H}(x; y, z)$ is of the form:

$$\mathcal{H}(x; y, z) = A_- x^\gamma + A_+ x^\beta. \tag{A.4}$$

Substituting in the boundary conditions:

$$\mathcal{H}(y; y, z) = 1, \quad \mathcal{H}(z; y, z) = 0,$$

into (A.4), we find:

$$\mathcal{H}(x; y, z) = \frac{z^\gamma x^\beta - z^\beta x^\gamma}{z^\gamma y^\beta - z^\beta y^\gamma}.$$

Smilarly, $\mathcal{L}(x; y, z)$ can be obtained as:

$$\mathcal{L}(x; y, z) = \frac{x^\gamma y^\beta - x^\beta y^\gamma}{z^\gamma y^\beta - z^\beta y^\gamma}.$$

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