Private Equity Funds and Strategic Buyers
– Effort, Debt Overhang, and Cross-subsidization

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This version: January 15, 2023

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Abstract Private equity funds and strategic buyers search for targets, in particular those with valuable growth options and in financial distress. We analyze the role of private equity funds and focus on debt overhang implications due to the target's debt. We recognize that an acquirer's strategy and valuation depend on the acquirer's type. A private equity fund has skills allowing it to obtain better information through costly effort and thus make more efficient investments. A strategic buyer aims to obtain synergies. We extend the analysis to include effects of cross-subsidization when a strategic buyer also has debt. Our model predicts that private equity funds are more active when the likelihood of a successful growth option is moderate. In contrast, strategic buyers are more active when a growth option is likely to be successful and synergies are possible, and cross-subsidization effects play a central role in the attractiveness of the target.

Keywords: Acquisition Strategy, Growth Opportunities, Synergy Effects, Information Advantage, Risky Debt

JEL subject codes: G24, G32, G34

1 Introduction

Acquisitions are a common phenomenon in the market of corporate control. In the corporate landscape, there is a specific category of financial buyers that seek to profit from acquisitions: private equity funds. Private equity funds play an active role by acquiring target firms that are often associated with valuable growth opportunities, but the target firms are not able to easily follow a growth strategy because they are in financial distress. Private equity funds can offer at least two valuable elements. First, they both have committed capital available, thus mitigating financing frictions, and second, they have build up skills allowing them to make special value creation plans to undertake growth opportunities (e.g., Kaplan and Strömberg, 2009; Gompers et al., 2016). However, target firms can as well attract other types of buyers. We pay attention to so-called strategic buyers—a firm with similar operational structure as the target firm—which due to existing assets see potential for creating synergies when acquiring the target's assets. Hence, strategic buyers are inherently very different from private funds both in relation to the underlying basis for acquisitions, but also in their strategies of how they plan to gain from them (e.g., Malenko and Malenko, 2015).

In this paper, we make a normative assessment of when a target becomes more attractive to either a private equity fund or a strategic buyer based on their different characteristics. Private equity funds usually acquire targets through a leveraged buyout using a significant amount of debt (e.g., Axelson et al., 2009, 2013). To focus our analysis, we abstract from tax benefits of debt and thus assume that each buyer can issue equity to acquire the target. The acquisition price depends on the target's growth opportunities because such opportunities affect the interests of potential buyers and hence the target's bargaining power (Margsiri et al., 2008). We let a buyer's valuation of a target be the value that this type of buyer can generate from acquiring the target. We then use this to make predictions related to the premiums paid. While we do not consider the detailed bargaining game between a buyer and the target, our analysis is related to research addressing the premium paid. Acquisitions by private equity fund are often associated with lower premiums than the premiums paid by strategic buyers, e.g., Bargeron et al. (2008) and Gorbenko and Malenko (2014). The latter study suggests that this is because private equity funds and strategic buyers value targets differently.

To facilitate our analysis, we develop a discrete-time framework in which we consider a target firm with growth opportunities. These are modelled as two mutually exclusive growth options. The target's growth options are represented by a no-risk project or a volatile project. Both projects require a two-stage investment cost. However, once a project is initiated by payment of the first-stage investment it lays out a track for that specific project. We treat the target as a firm being in financial distress because of its risky debt which implies that a growth option can typically not be implemented by the target as a stand-alone firm. Therefore, the target's debt gives rise to a debt overhang problem that a potential buyer needs to take into account. As a potential buyer, we first consider a strategic buyer who has a firm with productive assets in place and debt. This setup implies that a strategic buyer in addition to the aforementioned debt overhang friction must consider a subsidization channel that benefits debt holders but not the strategic buyer's equity holders. An advantage of the strategic buyer is that it has a positive probability of generating synergy effects when investing in the volatile project. The other type of buyer is a private equity fund which is equipped with committed capital to initiate the value creating process, i.e., first-stage investment, if it acquires the target. The fund has an advantage in the form of its skills to obtain information that facilitates better decision making, and thus more efficient value creation plans. Moreover, the fund has some reputation available that can be used in the acquired target and, in a more general context, makes it easier to raise later debt financing (e.g., Ivashina and Kovner, 2011). Thus, if a target acquired by a private equity fund becomes financially distressed, then the fund is faster at either resolving financial distress or the fund more swiftly decides that the target is abandoned (e.g., Hotchkiss et al., 2012; Huang et al., 2016). However, it requires costly effort to exploit skills. The amount of effort follows as the outcome of the contractual agreements with the fund's limited partners (e.g., Chung et al., 2012; Metrick and Yasuda, 2010).

Our model involves several trade-offs which we analyze using extensive numerical analyses. Here, we examine the role of private equity funds jointly with the effect of debt overhang and the effect of cross-subsidization with a strategic buyer's existing firm. We show that not only does the target's debt give rise to debt overhang frictions, but so does the strategic buyer's debt which is even worse with more risky debt. Thus, our analysis implies that a strategic buyer's acquisition activity is sensitive in its leverage. In particular, without any synergy effects, our model predicts that a private equity fund is more likely to win over a strategic buyer when the fund exerts effort to gain an information advantage. As a result, a private equity fund will be able to acquire the target for a lower premium since a strategic buyer with risky debt will find the target less attractive. When a strategic buyer can create synergy effects by acquiring a target, then such an acquisition is more likely when the target's growth opportunity has a high success probability. In contrast, a private equity fund is more likely to acquire a target with a growth option having a more moderate success probability. In this case the fund expects that effort substantially increases value. This is consistent with existing empirical literature that private equity funds often undertake major changes to acquired target and improve operational performance (e.g., Norbäck et al., 2013; Biesinger et al., 2020).

Our paper is related to studies that analyze the interactions between strategic and financial buyers (e.g., Hege et al., 2018; Martos-Vila et al., 2019; Clausen-Jørgensen and Flor, 2021). In particular, our framework mostly relates to Flor and Sørensen (2021) as their approach also involves an information advantage of a private equity fund. Instead of assuming that the fund has an information advantage due to its commitment to a loss-cutting strategy, we assume that it is an outcome of exerting effort so that learning takes place and the fund can make more efficient decisions. Further, we consider frictions stemming from cross-subsidization.

The remainder of the paper is organized as follows. Section 2 sets up the model. Section 3 analyzes the basics of the model with a focus on debt overhang. Section 4 elaborates on implications of subsidization and effort. We conclude in Section 5. Technical details are postponed to the appendix.

2 Model

Our model consists of three players: the target firm, the strategic buyer, and the private equity (PE) fund. All players are risk-neutral and the risk-free interest rate is zero. The target firm has productive assets in place that returns a cash-flow, X, at time $t = 2$. The cash flow is either high or low depending on which state prevails. Specifically, $X \in \{x_{2H}, x_{2L}\}$ where $x_{2H} > x_{2L} \geq 0$. All players share the same prior belief $p = \Pr(X = x_{2H})$, where $0 < p < 1$.

The target's assets also provide embedded growth opportunities, i.e., growth options. These growth options involve undertaking either a no-risk project N or a volatile project V. The projects are mutually exclusive and they are both characterized by requiring a two-stage investment. The first-stage investment, I_0, is made at the initial time $t = 0$ and determines which growth strategy is pursued. At time $t = 1$ the second-stage investment,

I_1, needs to be made in order to continue the project. Thus, the joint investment cost is $I_0 + I_1$. It is possible not to proceed with the project at time $t = 1$; however, at this stage the other growth option is not available any more. Investing in the no-risk project N returns the payoff $(1 + r)(I_0 + I_1)$ at time $t = 3$, so that the payoff from the no-risk project is independent of the target's productive assets. Thus, the net present value (NPV) of the no-risk project is:

$$\mathrm{NPV}_N = r(I_0 + I_1), \tag{1}$$

for $r > 0$. In contrast, the volatile project V returns either a high-state or a low-state payoff at time $t = 3$: $V \in \{v_H, v_L\}$, where $v_H > I_0 + I_1 > v_L \geq 0$. Upon observing the target's cash flow at time $t = 2$, all players update their beliefs according to Bayes' rule: $\Pr(V = v_H | X = x_{2H}) = q_H$ and $\Pr(V = v_H | X = x_{2L}) = q_L$. This implies that the net present value of investing in project V is

$$\begin{aligned} \mathrm{NPV}_V &= p(q_H v_H + (1 - q_H) v_L) + (1 - p)(q_L v_H + (1 - q_L) v_L) - (I_0 + I_1), \\ &= p(q_H - q_L)(v_H - v_L) - q_L(v_H - v_L) + v_L - (I_0 + I_1). \end{aligned} \tag{2}$$

Below we outline the setting for each type of player and we provide a timeline and an overview in Figure 1.

2.1 Target as a stand-alone firm

The target has existing debt with a face value $F_T > 0$ which is due at time $t = 2$. We assume that the target has no liquid funds and that its debt is risky:

Assumption 1 *The target firm's cash flow satisfies $x_{2H} - F_T = 0$ and $x_{2L} - F_T < 0$.*

This assumption implies that the target defaults if it gets the low cash flow. Furthermore,

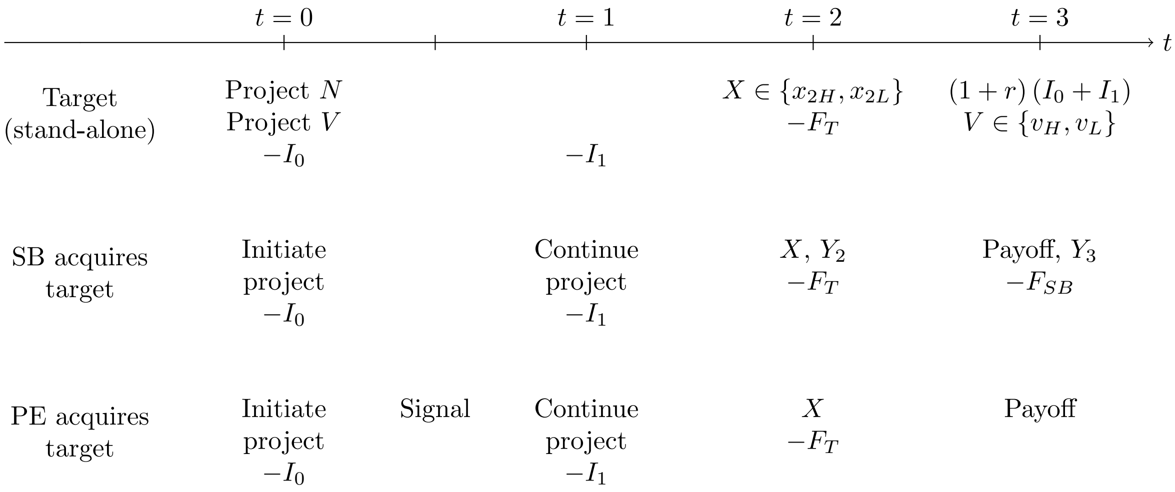


Figure 1: **Timeline of the model.**

to focus on effects of debt overhang frictions, we restrict the no-risk project's return:

Assumption 2 *The target as a stand-alone firm is unable to make a risk-free investment in project N: $r < (F_T - x_{2L}) / (I_0 + I_1)$.*

With the above assumptions, the target is in financial distress due to existing debt and growth opportunities are unlikely to be exploited.

2.2 Strategic buyer

The strategic buyer is a firm with productive assets in place that provide the cash flows $Y_t \in \{y_{tH}, y_{tL}\}$ at time $t = 2, 3$. We assume that the strategic buyer's cash flows at time $t = 2$ and $t = 3$ are perfectly correlated, that is, if the cash flow at time $t = 2$ is high then the cash flow at time $t = 3$ is also high. The strategic buyer has existing debt with a face value, F_{SB}, that matures at time $t = 3$. If the strategic buyer acquires the target, the two firms are merged. In our analysis we focus on a base case in which the strategic buyer as a stand-alone firm does not have risky debt. Furthermore, we assume a perfect positive correlation between the target's and the strategic buyer's cash flows. In particular, x_{2H} and y_{2H} occur at the same time.

Assumption 3 *The strategic buyer's cash-flow from its productive assets is sufficient to pay down its existing debt* $y_{2H} = F_{SB}$ *and* $y_{2L} + y_{3L} = F_{SB}$ *where* $y_{2L} = F_T - x_{2L}$.

This assumption implies that the target's debt becomes risk free. That is, if the strategic buyer takes over the target, then the cash flow at time $t = 2$ from productive assets, Y_2, is sufficient to meet the target's debt obligation, F_T. Hence, the strategic buyer's NPV as a stand-alone firm is

$$SB = p\,y_{3H}. \tag{3}$$

The NPV from acquiring the target with an investment in project V or project N:

$$N_{SB} = r\left(I_0 + I_1\right) - (1-p)\,y_{2L} + py_{2H}, \tag{4}$$

$$V_{SB} = p\left(\left(q_H - q_L\right)\left(v_H - v_L\right) + y_{3H}\right) + q_L\left(v_H - v_L\right) + v_L - (1-p)\,y_{2L} - \left(I_0 + I_1\right). \tag{5}$$

The above assumes that there are no synergy gains from combining the target with the strategic buyer. However, we will introduce that possibility later as follows: If the target's assets returns a high cash flow and investment in project V yields the high returns, then there is a synergy net gain rate of g. This provides the value

$$\begin{aligned} V_{SB} =& p\left(q_H\left((1+g)v_H - v_L\right) - q_L\left(v_H - v_L\right) + y_{3H}\right) + q_L\left(v_H - v_L\right) + v_L \\ & - (1-p)\,y_{2L} - \left(I_0 + I_1\right). \end{aligned} \tag{6}$$

Hence, the strategic buyer's optimal strategy yields

$$\max\left\{SB, N_{SB}, V_{SB}\right\}. \tag{7}$$

If the target is acquired, the above reflects the strategic buyer's maximum willingness to pay.

2.3 Private equity fund

The PE fund has committed capital available. The capital is sufficient to pay for the initial investment, I_0, and to pay down the target's debt at time $t = 2$. Thus, the fund still relies on debt financing to undertake the investment in the target's growth option. In the event of an acquisition, and if the fund initiates the volatile project, it generates a signal, S, which is informative about the outcome of the project's payoff: $S \in \{s_H, s_L\}$. However, the signal contains noise and is thus not fully informative. The fund can exert effort and by that learn more about its investment in the volatile project. Specifically, effort implies that the signal becomes more informative. Thus, we assume that effort results in a reduction of the signal's dispersion of size $z \in [0, 0.5]$. No effort corresponds to $z = 0$, full effort corresponds to $z = 0.5$. In the latter case, the signal is perfectly informative. For simplicity, we directly denote z as the effort provided. We provide the details in the Appendix. It is costly for the PE fund to exert effort. We assume that the cost of effort takes the form

$$\kappa(z) = k\left((1+z)^n - 1\right) + c, \qquad z \in [0, 0.5], \tag{8}$$

where k is a scaling effect, c is a level effect, and $n > 1$ is a marginal effect. The cost function in (8) implies that exerting more effort is more costly and the cost is also marginally increasing.

Exerting effort provides the PE fund with an advantage over the strategic buyer regarding the volatile project. By getting an informative signal, the fund can make better decisions as its posteriors get more precise. This is valuable per se, but the PE fund's value of effort also depends on the distribution of the investment costs. Indeed, the gain of effort only pertains to the late-stage investment decision because this happens after receiving the signal. Since there is no uncertainty related to the no-risk project, the fund does not gain any specific advantage by having committed capital to finance the first-stage investment, I_0. The fund considers an acquisition of the target with an investment in either project N or project V, and it takes into account that it also has to pay back the target's debt. This is only done, if the ex ante value of an acquisition is positive. The NPV from acquiring the target and investing in project N is:

$$N_{PE} = r\left(I_0 + I_1\right) - (1-p)\left(F_T - x_{2L}\right). \tag{9}$$

The NPV when investing in project V and exerting effort z is:

$$\begin{aligned} V_{PE}(z) = \Big(& \Pr(s_H)\left\{\Pr(v_H|s_H)\, v_H - \left(I_1 - \Pr(v_L|s_H)\, v_L\right) - \Pr(x_L|s_H)\left(F_T - x_{2L}\right)\right\} \\ & + \Pr(s_L)\max\Big\{ \Pr(v_H|s_L)\, v_H - \left(I_1 - \Pr(v_L|s_L)\, v_L\right) \\ & \qquad - \Pr(x_L|s_L)\left(F_T - x_{2L}\right), 0 \Big\}\Big) - \kappa(z) - I_0. \end{aligned} \tag{10}$$

Let z^* be the level of effort that yields the highest possible value, conditional on exerting effort. Then the optimal strategy results in the PE fund's maximum willingness to pay

$$\max\left\{N_{PE}, V_{PE}(z=0), V_{PE}(z=z^*), 0\right\}. \tag{11}$$

3 Numerical analysis

To get a better understanding of the mechanisms in the model we proceed with a numerical analysis. We normalize our analysis to a base case with parameters given in Table 1. The first set of parameters concerns the probabilities for the sequence of events in the models, see Figure 7. We normalize the probability that the target's cash flow is high at time $t = 2$ as $p = \frac{1}{2}$. Henceforth, we will commonly vary p as a key parameter, and we will also denote it as the high-state probability or similar. We also assume that the probability of a high return from the volatile project is higher, if a high cash flow, x_2, is received. The next set of parameters provides the setup of the target's asset in place. Clearly, the target

Base case parameters	
Likelihood of outcome	
Probability of high state	$p = 0,5$
Probability of high project return in high state	$q_H = 0.35$
Probability of high project return in low state	$q_L = 0.25$
Target	
Cash-flow	$x_{2H} = 40$
	$x_{2L} = 10$
Principal of debt	$F_T = 40$
Investment opportunity	
Investment cost	$I_0 + I_1 = 75$
Project V	$v_H = 220$
	$v_L = 40$
Project N	$r = 0.2533$
Strategic buyer	
Cash-flow	$y_{2H} = 50$
	$y_{3H} = 35$
	$y_{2L} = 30$
	$y_{3L} = 20$
Principal of debt	$F_{SB} = 50$

Table 1: The table shows the parameters used in the numerical analysis base case. The parameters imply that the net present value of project N and that of project V as stand-alone projects are equal. The strategic buyer has risk-free debt as a stand-alone firm, and if the target is acquired its debt becomes risk free thus inducing a debt overhang friction.

is in financial distress and its debt is risky.

The third set of parameters concerns the investment opportunities. With $p = 0.5$ the volatile project as a stand-alone project has a present value equal to

$$p(q_H v_H + (1 - q_H)v_L) + (1 - p)(q_L v_H + (1 - q_L)v_L) = 94, \tag{12}$$

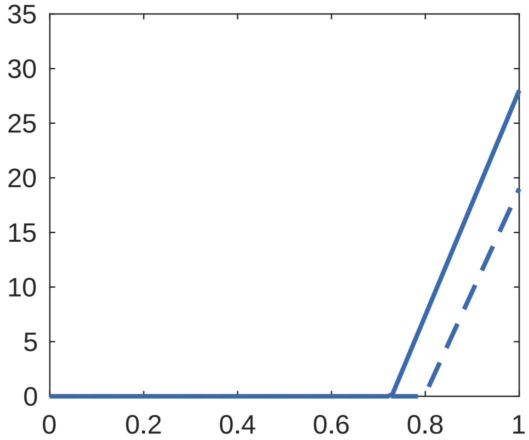
and thus the net present value is $94 - 75 = 19$. This corresponds to a return of $19/75 - 1 = 25.33\%$. We calibrate the no-risk project to have the same return; i.e. $r = 25.33\%$. This implies that as stand-alone projects, project N is strictly preferred to project V for $p < \frac{1}{2}$. However, even if $p = 0$, the net present value of project V is $10 > 0$ and as such profitable per se.

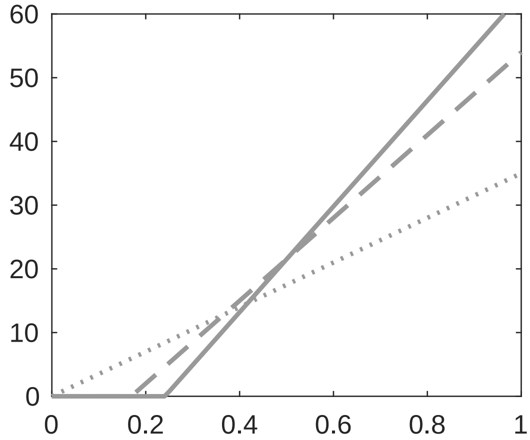
The last set of parameters concerns the strategic buyer. Cash flows are lower in the low state, but they are just sufficient to cover the existing debt thus complying with Assumption 3.

3.1 Target and strategic buyer

The target firm as a stand-alone firm is limited in getting funds for the growth option due to its existing debt. Figure 2(a) shows the effect of the high-state probability, p. The solid curve depicts the target's value, if an investment in the volatile project, V, is considered. The dashed curve is for the case of the no-risk project, N. If no investment is made, then the target's value to its equity holders is zero, because the cash flow from existing assets will at most cover the debt liability. When the high-state probability increases sufficiently, it becomes optimal to invest. This occurs when the value becomes larger than zero. We observe that the target can obtain external funding for $p = 0.73$, if it invests in the volatile project. If the no-risk project is considered, the high-state probability must be at least ($p = 0.80$). Hence, the target can only survive as a stand-alone firm if the high-state probability is very high, and in that case, it will invest in the volatile project instead of the no-risk project. Thus, the target's debt severely limits continuation and effectively crowds out the no-risk project.

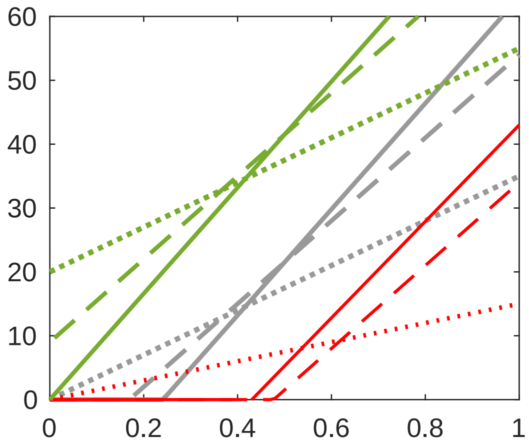
We consider the strategic buyer in a similar vein in Figure 2(b). The dotted curve shows the value of the strategic buyer as a stand-alone firm. In our base case parameterization, the debt in the strategic buyer's firm is risk free as the low-state cash flows are just enough to cover the debt obligation, cf. Assumption 3. Thus, as the high-state probability increases, so does the value of the strategic buyer. When the strategic buyer analyzes an acquisition of the target, it has to take the target's debt into account. The dashed curve depicts the strategic buyer's value if it acquires the target and invests in the no-risk project. For $p < 0.37$, the value is negative and hence an acquisition is not attractive. That

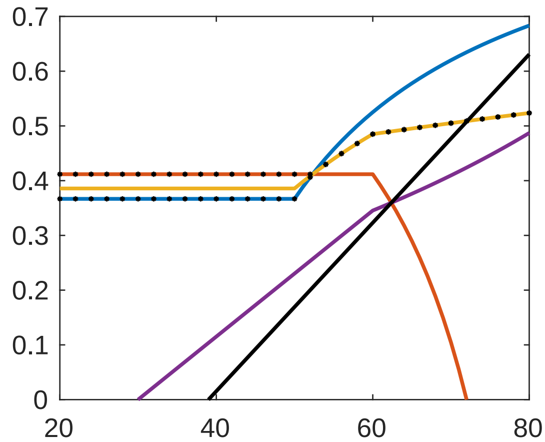




(a) Target's value as a stand-alone firm. Project V (solid). Project N (dashed).

(b) Strategic buyer's value as a stand-alone firm (dotted) or including an acquisition of the target with an investment in project V (solid) or project N (dashed).





(c) Strategic buyer's value for various debt levels: $F_{SB} = 30$ (green), $F_{SB} = 50$ (gray), $F_{SB} = 70$ (red).

(d) Thresholds for pairwise comparison of the strategic buyer's strategies: stand-alone vs. project N (blue), stand-alone vs. project V (yellow), and project N vs. project V (red). Purple (black) marks when investing in project V (N) becomes profitable per se. Dots indicate the optimal strategy.

Figure 2: Target and strategic buyer. Panels (a)-(c) illustrate the value of the target and the strategic buyer, respectively, for various levels of the high-state probability. Panel (d) illustrates the strategic buyer's optimal decision for various debt levels and high-state probabilities.

is, the target's debt implies a debt overhang friction for the strategic buyer. A takeover becomes more attractive as the high-state probability increases. However, the strategic buyer must also consider the alternative to invest in the volatile project. Since project V yields a lower net present value for a low p, the debt overhang problem is now worse. Only if $p > 0.42$ is it valuable for the strategic buyer to consider an acquisition and invest in project V, if project N is neglected. Project V becomes profitable compared to project N when $p > 0.5$, which is also the cut-off point in p at which the net present value of project V is higher than that of project N.

The debt overhang friction comes into play through two channels. One channel is the target's debt. The other channel is the strategic buyer's debt. We consider the implications of the latter in Figure 2(c). The gray curves resemble those in Figure 2(b). The green curves correspond to a decrease in the strategic buyer's debt. Decreasing the strategic buyer's debt by 20; i.e., $F_{SB} = 30$, we see that the strategic buyer's value increases. Since debt remains risk free, a decrease of the target's debt implies a parallel upward shift in the curves. Thus, the debt overhang friction is exactly as in the base case. However, if we increase the strategic buyer's debt over the base case level then debt becomes risky. The red curves correspond to the case in which we increase the debt with 20; i.e., $F_{SB} = 70$. Looking at the dotted curve, we see that the value of the strategic buyer as a stand-alone firm now depends differently on the high-state probability—it is no longer a parallel shift. The value is positive for $p > 0$, however it increases much less than in the base case indicating that the strategic buyer is now subject to risky debt per se. This implies in itself a debt overhang friction when the strategic buyer considers an acquisition of the target. If an acquisition is followed by an investment in the no-risk project, then the high-state probability must be at least $p > 0.62$ before it is profitable. If the strategic buyer instead considers investing in project V, then $p > 0.54$ is needed for it to be profitable.

Since an acquisition is not relevant for $p < 0.5$, a profitable acquisition implies investing in project V. Therefore, the total debt overhang friction is 0.54 rather than 0.62 when the strategic buyer has risky debt.

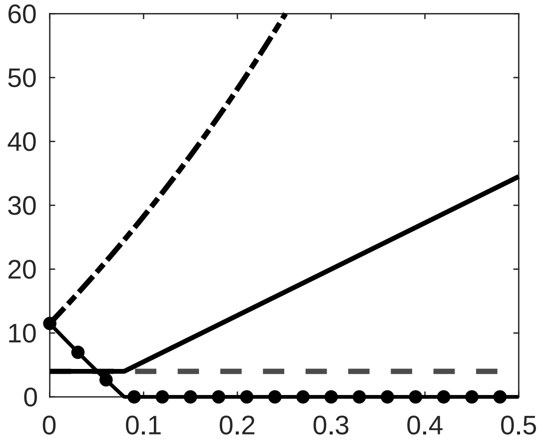
We elaborate on the effect of the strategic buyer's debt in Figure 2(d). As the strategic buyer's debt increases, the blue curve plots the level of the high-state probability at which the strategic buyer is indifferent between being a stand-alone firm or acquiring the target and investing in the no-risk project. As long as the strategic buyer's debt is risk free, this level of p remains constant. When the debt turns risky ($F_{SB} > 50$), it becomes less attractive to be combined with a firm that has existing debt. Therefore, a higher probability of high cash flows is needed for an acquisition to be attractive. The yellow curve makes a similar analysis assuming project V is undertaken. As discussed in the base case, this requires a higher p, and this restriction remains as long as the strategic buyer's debt is risk free. For risky debt, a higher level of p is required. However, the value of project V increases with a higher high-state probability, and the increase in the p-threshold is therefore more moderate compared to an investment in project N. The p-level at which investing in project V has the same value as investing in project N is depicted with the red curve. As before, the threshold stays constant for low-medium range debt levels. For higher debt levels, project N suffers from its payoff being independent of the high-state probability, and hence, it becomes unattractive relative to project V for a higher p. Hence, the p-level determining the threshold between project V and project N decreases when the strategic buyer's debt is high.

Figure 2(d) also reveals the optimal strategy from the strategic buyer's point of view. In the region below the blue curve, it is better to be a stand-alone firm instead of making a takeover and investing in project N. In the region below the yellow curve, it is better to be a stand-alone firm instead of making a takeover and investing in project V. In the region below the red curve, it is better to make a takeover and invest in project N instead of project V. Thus, for $F_{SB} \leq 60.00$, it is best to be a stand-alone firm below the blue curve, acquire and invest in project N between the blue and the red curve, and acquire and invest in project V above the red curve. For $F_{SB} > 60.00$, it is best to be a stand-alone firm for p below the yellow curve, whereas it is best to acquire the target and invest in project V above the yellow curve. Finally, we also consider when a takeover and investment is profitable at all. That is, we consider what happens if the strategic buyer cannot continue as a stand-alone firm. In this manner we address the debt overhang friction stemming from the target's debt similarly to our discussion regarding Figure 2(b). However, we now combine it with the debt overhang effect of the strategic buyer's debt. The purple curve depicts the p at which investing in the risky project becomes profitable per se. The black curve depicts the p at which investing in the no-risk project becomes profitable per se. When the strategic buyer's debt is below 30, the debt overhang friction due to the target's debt is so small that a takeover can occur for any p. Increasing the strategic buyer's debt makes it more challenging to invest in the risky project, because funding the investment now requires some positive probability that the high state occurs. Therefore, the debt overhang friction is larger for project V than for project N (the purple curve is above the black curve). When the amount of debt is substantial, $F_{SB} > 65$, project V benefits enough from a high p so that the friction is smallest for project V.

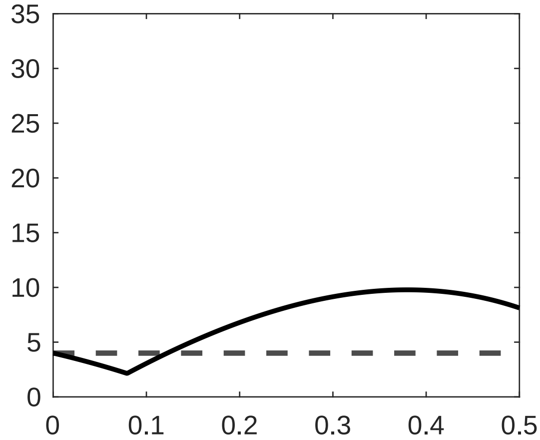
Overall, target's debt give rise to debt overhang, and so does the strategic buyer's debt if it is risky. This will play a role when we analyze whether the PE fund or the strategic buyer acquires the target.

3.2 PE fund and effort

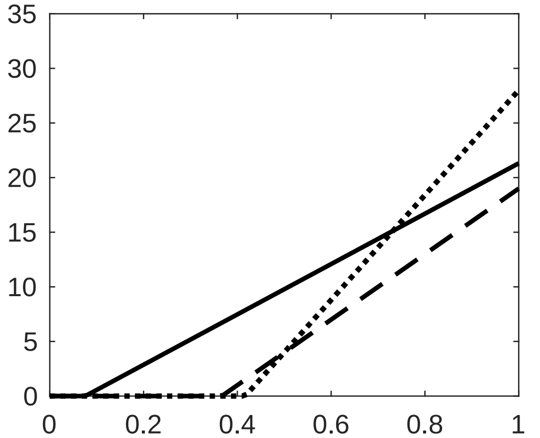
We analyze the PE fund's decisions in Figure 3. A specific characteristic of the PE fund is that it can exert effort to obtain a signal. This signal is useful for deciding the last



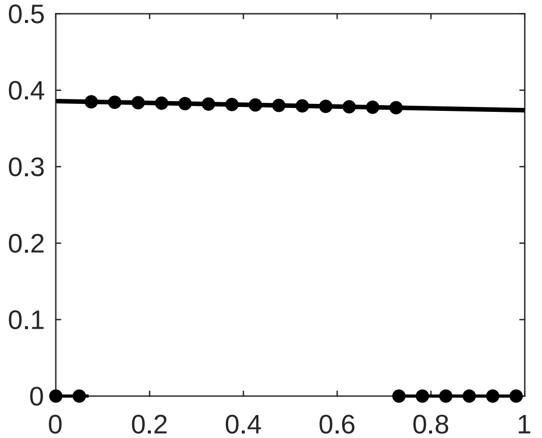
(a) Effect of effort, z: The payoff at time $t = 1$ from investing in project V with no cost of effort for $w = 0.1$ contingent on the signal s_H (dotted-dashed) and s_L (solid dotted). Investing in project N yields the dashed line. The solid curve depicts the value at $t = 0$ for project V with no cost of effort.



(b) Effect of effort, z: The fund's net value from investing in project V when providing effort (solid curve) and from investing in project N (dashed line).



(c) Effect of high-state probability, p: PE fund's payoff at time $t = 0$ when acquiring the target and investing in project V with effort (solid), no effort (dotted), or project N (dashed).



(d) Effect of effort, z: The lines mark the p-threshold at which project V without effort equals with effort (blue), with effort equals project N (red), and with effort equals no acquisition (yellow).

Figure 3: The PE fund's payoff, effort choice, value, and investment strategies.

stage investment, I_1, at time $t = 1$. Figure 3(a) shows the (expected) net payoff from the investment depending on the signal received as the PE fund exerts more effort, z. The no-risk project does not depend on the signal because it is independent of the final state, and it is illustrated as the constant dashed line. The other curves belong to project V. The dashed-dotted curve corresponds to the value if the high signal, s_H, is observed. The solid-dotted curve corresponds to the value if the low signal, s_L, is observed. In the former case, the value increases in a convex manner. Intuitively, conditional on receiving signal s_H, more effort implies a higher posterior belief that the high state is the actual outcome. In fact, if $z = \frac{1}{2}$, then the signal is perfectly informative. In the latter case, the value decreases in effort. The low signal, s_L, can only lead to a positive value, if the posterior belief of the high state is not too low. Therefore, as effort implies that the signal is more informative, a higher effort decreases the value if the low signal is observed. Indeed, if $z > 0.07$, then the PE fund obtains no value once a low signal is observed. The solid curve depicts the expected value from undertaking the project at time $t = 0$. The kink occurs when s_L leads to a zero value. This means that after the kink, the expected value increases as the fund is better off not to proceed with the volatile project if the low signal is observed.

Exerting effort is costly and we elaborate on this in Figure 3(d). The figure shows the PE fund's value of the target assuming that project V is undertaken. The constant dashed line represents the value if it invests in project N. The solid curve shows what happens as effort is exerted. Increasing effort is costly in a convex sense, see (8). When effort is low, we know from the discussion related to Figure 3(a) that effort per se does not increase the value (the solid curve in that figure is flat). Thus, the net effect is that the PE fund's value decreases in effort. For a higher level of effort, $z > 0.07$, the negative effect from observing s_L has no further impact, and hence the positive effect from s_H comes fully into play. This implies that the PE fund's value is increasing in effort. However, as effort becomes marginally more costly, the cost of exerting effort can be so high that it dominates the gain of a higher precision in the signal. An implication of this is that the PE fund's value becomes decreasing in effort. Consequently, the optimal choice of effort is where the latter effect becomes dominating; i.e., where the curve has a maximum ($z = 0.39$).

We explore how the trade-offs just described change with the high-state probability in Figure 3(c). The dashed curve assumes the PE fund invests in the no-risk project. The dotted curve corresponds to the case in which the PE fund invests in project V without exerting effort, whereas the solid curve assumes effort is exerted. When p is very low, $p < 0.08$, it is not optimal for the PE fund to acquire the target at all. Thus, the target's debt implies a debt overhang friction. For a higher p, it is valuable to acquire the target, exert effort and invest in project V. Increasing p further until $p = 0.37$, then it becomes valuable to acquire the target and invest in project N. For $p > 0.42$, it is also valuable to acquire and invest in project V, however without exerting effort. Interestingly, the latter strategy becomes optimal when $p > 0.73$. The intuition for this is that for very high probabilities of a high state, the importance of the signal becomes too small. Referring to Figure 3(b), this implies that the maximum of the solid curve is below the dashed line. Thus, the change in the beliefs from the prior to the posterior becomes too small. Finally, we also observe that the PE fund never finds it optimal to invest in the no-risk project. This fits with the intuition that PE funds acquire targets to make more substantial changes.

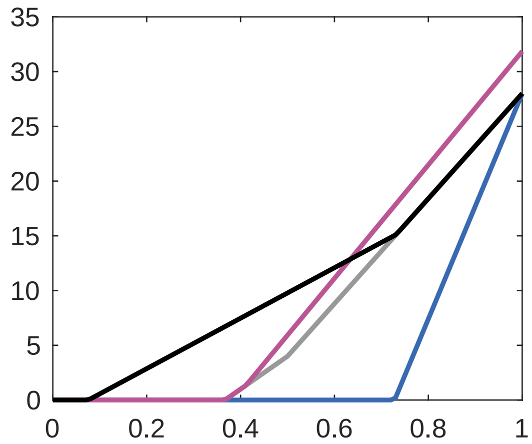
The optimal strategy depends on the combination of effort, z, and the high-state probability, p. Figure 3(d) depicts with the solid curve the optimal choice of effort for a given high-state probability, assuming the PE fund invests in project V and provides effort. Effort has a slightly decreasing relation with the high-state probability. The reason that effort is not more sensitive in p is due to the fact that the cost of effort does not depend on

p and the benefit only slightly comes into play in our binomial payoff structure. However, as previously discussed, it is not always optimal to exert effort. When p is low, it is better to invest in project N. When p is high, the benefit of effort through its impact on the posterior belief is small. In both of these cases, the PE fund is better off not exerting effort. The optimal strategy is depicted with the bullet-curve.

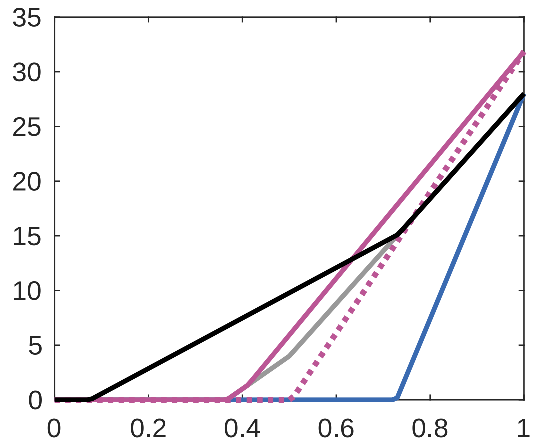
3.3 Acquisition – PE fund or strategic buyer

We turn to the acquisition strategies when both the PE fund and the strategic buyer may acquire the target. Figure 4(a) shows the value of the various possible strategies as the probability of the high state increases. The target as a stand-alone firm is represented by the blue line. This resembles the outcome in Figure 2(a). The gray curve illustrates the strategic buyer's excess value of an acquisition. That is, we know from Figure 2(b) that the strategic buyer's value of acquiring the target and investing using the possible strategies is the maximum of the solid curve and the dashed curve. The value of the strategic buyer as a stand-alone firm is the dotted line. Thus, we find the strategic buyer's valuation of the target by taking the distance between the maximum of the dashed and solid curves and the dotted line. From our earlier discussion, we established that the strategic buyer will not acquire the target as long as $p < 0.37$. This implies the acquisition value is zero in that region. For higher probabilities, the strategic buyer acquires the target and invests in the no-risk project. When $p > 0.5$, the volatile project dominates which in the figure shows up as a kink on the gray curve. For $p = 1$, the high state will prevail with certainty, and thus the value of the target and the strategic buyer's valuation coincide in our base case.

The PE fund's valuation of the target follows from Figure 3(c). The outcome is depicted as the black curve in Figure 4(a). An acquisition is not profitable for $p < 0.08$. For a higher p, the PE fund finds it attractive to acquire the target and invest in the volatile



(a) Effect of high-state probability, p: Value of PE fund (black), strategic buyer (gray), and target (blue). The pink curve shows the effect of introducing a synergy effect, $g = 5\%$, for the strategic buyer.



(b) Effect of high-state probability, p: In addition to panel (a), the pink dotted curve shows the effect of introducing risky debt, $F_{SB} = 70$, for a similar synergy gain, $g = 5\%$.

Figure 4: Value of players using their optimal strategy. Panel (a) elaborates on the base case and extends the model with synergy gains to the strategic buyer. Panel (b) introduces risky debt for the strategic buyer in addition to synergy gains.

project. It will do so and provide effort as long as $p < 0.73$. The kink on the curve thus corresponds to the level of p at which the PE fund is better off investing in the volatile project without providing effort. For high p levels, the PE fund and the strategic buyer evaluates the target firm equally.

Our base case shows a number of key effects. However, we have so far not allowed the strategic buyer to have any benefits compared to the PE fund. The only benefit from the strategic buyer's point of view regarding an acquisition of the target is that it may be better able to fund the growth option due to its existing assets in place. We now change this assumption and allow the strategic buyer to obtain synergy gains when combining the target firm's assets with its own assets. To focus the analysis, we assume synergies only occur if the volatile project is undertaken and its payoff and cash flows from existing assets are in the high state. In this case, the outcome of project V increases with the net gain rate g. In our analysis, we assume a 5% gain. This impacts the strategic buyer's valuation positively. The outcome of this is depicted as the pink curve in Figure 4(a). We also consider an increase in the strategic buyer's debt to $F_{SB} = 70$, implying its debt is risky. This is depicted as the dotted pink curve in Figure 4(b). With a synergy gain, the optimal strategy for the strategic buyer remains the same for a high-state probability below 0.41; however for a higher level of p, the strategic prefers the volatile project over the no-risk project. Thus, this happens for a lower p compared to the case of no synergy effect. The strategic buyer's opportunity to reap synergy gains implies that it can win a takeover contest with the PE fund. This happens for high probabilities of a high state, $p > 0.63$. With risky debt and synergy gains, the strategic buyer only invests in the risky project when $p > 0.51$ and it wins a takeover for $p > 0.76$.

Overall, our model implies that an acquisition of a firm with existing debt is less likely to occur if the probability of high cash flows is small. The target firm is interesting for a PE fund for medium ranged high-state probabilities, and the PE fund will exert costly effort to improve the value of the target's growth option. For higher high-state probabilities, the target is valuable for the PE fund, but the strategic buyer finds the target sufficiently attractive so that it outbids the PE fund. For a target with an embedded growth option we summarize the outcome of our analysis in a prediction:

Prediction 1a: If the growth option has a moderate probability of success, PE funds are active in acquisitions in which their effort (value creation plan) is expected to substantially increase value. If the growth option has a high success probability, targets are mainly acquired by strategic buyers, specifically when strategic buyers gain from synergy effects.

Our discussion of the strategic buyer's debt also has implications for acquisitions. Specifically, more debt makes a strategic buyer less likely to be a competitor relative to a PE fund when bidding for a target.

Prediction 1b: Strategic buyers with high leverage are less active in acquiring targets with growth options. The premium paid to a target in a PE fund-acquisition is lower, when strategic buyers have high leverage.

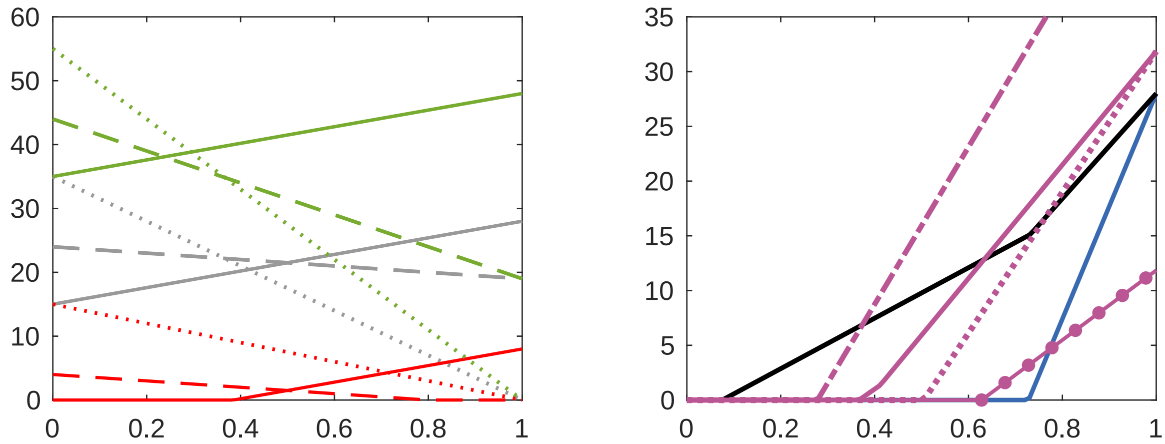
4 Cross-subsidization and the gains of effort

4.1 Cross-subsidization

Our analysis so far assumes that the target's and the strategic buyer's cash flows from assets in place are positively correlated. This clearly impacts decision when debt is risky. Therefore, we now change this so that the strategic buyer's cash flow is negatively correlated with that of the target.[1]

Figure 5(a) depicts the strategic buyer's value of the possible strategies for three levels of debt. The notation is as in Figure 2(c) with positively correlated cash flows. As before, it is optimal to be a stand-alone firm for low high-state probabilities. However, we observe that the strategic buyer's value is less volatile as p varies. This is due to the fact that subsidization from one firm's cash flow to the other firm's debt occurs. We consider the value of the three players' optimal strategy in Figure 5(b). The PE fund's value (black curve) and target's value (blue carve) are as before. The pink curves are related to the strategic buyer. As long as the strategic buyer's debt is risk free, the strategic buyer's excess value from an acquisition of the target is similar to the case when cash flows are positively correlated. This corresponds to the solid curve. The dotted curve is for risky debt and positive correlated cash flow; it is the same as in Figure 4(b). The dash-dotted curve assumes negative correlation and risk-free debt with a face value of 30. Thus, negative correlation implies an effect even with risk-free debt, because the strategic buyer now benefits from the target's high cash flows. It implies that the strategic buyer is willing

[1]Specifically, we assume that y_{2H} and x_{2L} occur at the same time.



(a) The value of a strategic buyer when cash flows are negatively correlated for various debt levels: $F_{SB} = 30$ (green), $F_{SB} = 50$ (gray), $F_{SB} = 70$ (red).

(b) Value of target, the PE fund, and the strategic buyer in the base case. The solid and dotted curves are as in Figure 4(b). With negative correlation, the dash-dotted (solid-dotted) curve corresponds to $F_{SB} = 30$ ($F_{SB} = 70$).

Figure 5: The value of a strategic buyer with negative correlated cash flows. Panel 5(a) illustrates for various levels of debt. Panel 5(b) illustrates the strategic buyer's optimal strategy with a synergy gain, $g = 5\%$, for various debt levels.

to outbid the PE fund for much lower levels of p (0.37). In contrast, a high level of debt puts the strategic buyer in a really bad position. In fact, it can imply that a strategic buyer will never bid for a target.

Our analysis yields predictions regarding whether it is a strategic buyer or a PE fund that takes over a target with embedded growth options.

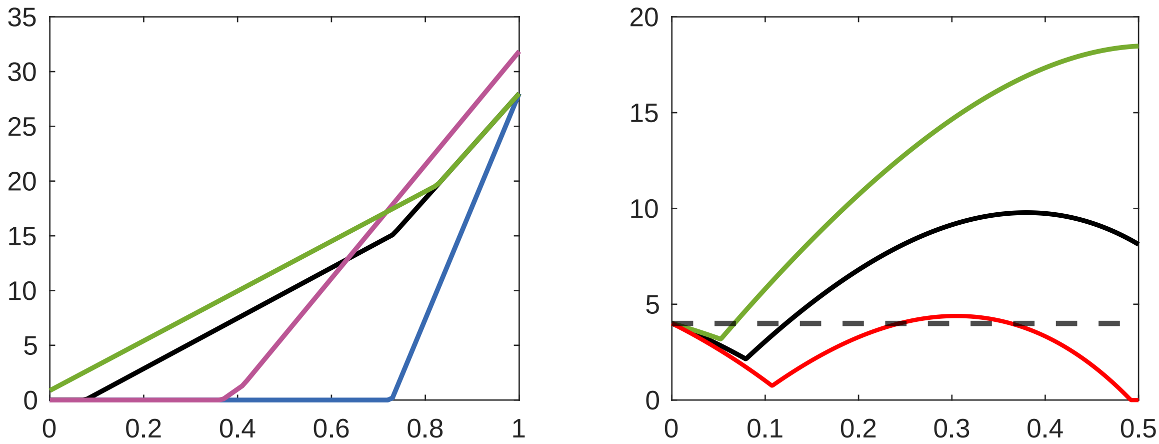
Prediction 2: A strategic buyer's acquisition activity is less sensitive in leverage when cash flows are positively correlated. A strategic buyer with more negatively correlated cash flow is less likely to acquire the target for higher leverage. The premium to the target's shareholders is more sensitive in strategic buyers' leverage with negative correlation.

4.2 Cost of effort and first-stage investment

The PE fund's opportunity to obtain an informative signal by exerting effort is beneficial because it helps the fund to make a better investment decision at time $t = 1$. Specifically, the lower the first stage investment is, the larger is the PE fund's benefit. To see the intuition for this, we note that the PE fund's competitive advantage over a strategic buyer is its possibility to exert effort and by that obtain an informational advantage. Indeed, effort helps to make a better investment decision, because the posterior belief of a wrong signal decreases. For example, the posterior belief that the second-stage investment is viable, albeit a bad signal is received, decreases in effort.[2] The changes in the posterior beliefs are independent of the distribution of the investment cost. That is, neither I_0 nor I_1 affect the direct benefits of increasing z. However, the gross value of effort depends on an additional factor. The other factor is the second-stage investment, I_1, because only this part of the investment cost is decided upon after observing the signal.

In Figure 6(a) we illustrate the effect of a lower I_0, while keeping the total investment, $I_0 + I_1$, constant. For simplicity, we introduce w as the first-stage investment cost which is a fraction of the total investment cost, $w = I_0/(I_0 + I_1)$. The green curve corresponds to the case in which the first-stage investment is $w = 5\%$ of the total investment. The case with $w = 10\%$ is depicted with the black curve (the strategic buyer's value and the target's value do not depend on w). As discussed, we clearly see that the lower first-stage investment implies that the PE fund's value increases. In unreported results, we find that the optimal effort does not vary much in w. This is intuitive as the effect in the posterior beliefs and the cost of effect are independent of the level of effort. We further note that our model yields that the PE fund is willing to acquire the target for even very low high-state probabilities. The effect can in fact be so strong that it outweighs the target's debt

[2]Increasing effort, z, from 0 to 0.2 decreases the posterior, $\Pr(v_H|s_L)$, from 0.3 to 0.16.



(a) Effect of high-state probability, p: Value of PE with initial investment $w = 10\%$. (black), strategic buyer with synergy gain, $g = 5\%$ (pink), target (blue). The green curve introduces reduced the initial investment to $w = 5\%$.

(b) Effect of effort, z: The PE fund's value net of effort cost for different levels of the first-stage investment, $w = 5\%$ (green), $w = 10\%$ (black), and $w = 15\%$ (red). In all cases the cost of effort depends on I_0, see equation (13).

Figure 6: Value from optimal strategy and first-stage investment. Panel 6(a) illustrates the value of players from the base case with a synergy gain for the strategic buyers. The green curve lowers the initial investment, $w = 5\%$. Panel 6(b) elaborates on the effect of various initial investments when the cost depends on, I_0: $w = 5\%$ (green), base case $w = 10\%$ (black), $w = 15\%$ (red).

overhang friction; that is, for w low enough, a target will always be acquired.

The above discussion analyzes how the decision to exert effort depends on the initial investment, I_0, when effort costs are independent of I_0. However, it is conceivable that the cost of effort can depend on how much of the total investment is done early. For example, it can be more difficult to obtain the same reduction in the signal's variance—i.e., the benefit through the posterior beliefs—when the initial investment is higher. We address this by endogenizing the scaling factor k in (8) as follows:

$$\kappa(z) = \hat{k}\sqrt{I_0}\left((1+z)^n - 1\right) + c, z \in [0, \tfrac{1}{2}]. \tag{13}$$

Hence, a higher initial investment cost makes effort more costly, however with a marginally decreasing effect. We think of the latter effect as being due to, for example, that learning takes place. To compare with our earlier results, we normalize $\hat{k} = 4/\sqrt{I_0^b}$ (=1.46), where I_0^b is the initial investment in our base case. Thus, when $I_0 = I_0^b$ it follows that $\hat{k}\sqrt{I_0} = 4$ which is exactly the level of k used in the base case.

Figure 6(b) depicts how the PE fund's effort and value depend on the fraction of investment paid in the first stage, w. The black curve is the base case with $w = 10\%$ analyzed previously. The green curve corresponds to the case in which the initial investment is decreased to 5%. This is similar to the case in Figure 6(a) with the extension that w directly impacts the cost of effort. The lower w implies that effort becomes less costly. As a result, the PE fund increases effort. In this case, it is beneficial for the fund to exert full effort, $z = \frac{1}{2}$, so that the signal is fully informative. This affects the fund's valuation substantially. With the fixed scaling, as in Figure 6(a), the lower initial investment increases PE fund's value 30% (from 10 to 13) when $p = 0.5$. Incorporating the scaling effect, as in Figure 6(b), the increase in the fund's value is 85% (from 10 to 18.5; in this case effort increases to its maximum, $z = 0.5$). If we instead increase the first-stage investment to 15%, the PE fund is less willing to exert effort and invest in the volatile project. This case corresponds to the red curve. While it is still optimal to exert effort, $z = 0.3184$, the fund's value decreases substantially to just above 4 which is the value the fund can obtain with project V without providing effort. In this case, the target will be acquired by the strategic buyer if there is just a small synergy gain. These observations give us:

Prediction 3a: A larger late-stage-investment fraction implies a more valuable target for a PE fund. The premium to the target's shareholders increases in the late-stage-investment fraction.

Prediction 3b: A smaller late-stage-investment fraction implies that a target is more likely to attract a strategic buyer; particularly when effort costs increase in early investments.

5 Conclusion

Private equity funds and strategic buyers scan the corporate market to find attractive target firms. Targets can be attractive when their assets embed valuable growth options; however, the target can be limited in exploiting these due to existing debt. We analyze the role of private equity funds jointly with the effect of debt overhang and the effect of cross-subsidization with a strategic buyer's existing firm. One the one hand, a private equity fund's skill to obtain better information—and by that making more efficient investment—helps the fund in acquiring a target. On the other hand, exerting effort is costly and may outweigh the benefits of effort. Overall, our model predicts that private equity funds are most active when the likelihood of a successful growth-option investment is neither high nor low. In contrast, strategic buyers are more active when a growth option is likely to be successful and when synergies by merging assets are likely.

Our framework can be extended in several dimensions. In particular, it is conceivable that introducing macroeconomic risk in our model can lead to further valuable insights. For example, since debt overhang is likely a less binding friction in a boom, we conjecture that strategic buyers' activities are more related to the business cycle than activities by private equity funds. This indicates that targets should get a higher premium in boom states. Further studies can be done to investigate this. Such studies could also elaborate on the importance of other characteristics of private equity funds; for example considering the fact that private equity funds have limited time to deliver a return.

Appendix

A Calculation of posterior beliefs

To derive the value of the PE fund, it is necessary to know the probabilities for all possible events. In particular, the posterior beliefs are useful in this calculation. Figure 7 outlines the conditional probabilities through the various stages as a help. For simplicity, we leave out the time index in the realized cash flow x. Since all players update their belief according to Bayes' rule, we are also interested in the posteriors after observing the signal at time $t = 1$ and the posteriors after observing the target's cash flow at time $t = 2$. These posteriors are outlined in Figure 8.

Below we briefly show the calculation for some of the posteriors.

For the posteriors at time $t = 2$:

$$\begin{aligned} \Pr(x_H, s_H) &= \Pr(x_H, v_H, s_H) + \Pr(x_H, v_L, s_H) \\ &= p\left(q_H + (0.5 + z) + (1 - q_H)(0.5 - z)\right), \end{aligned} \tag{14}$$

$$\begin{aligned} \Pr(x_L, s_H) &= \Pr(x_L, v_H, s_H) + \Pr(x_L, v_L, s_H) \\ &= (1 - p)\left(q_L + (0.5 + z) + (1 - q_L)(0.5 + z)\right), \end{aligned} \tag{15}$$

$$\begin{aligned} \Pr(x_H, s_L) &= \Pr(x_H, v_H, s_L) + \Pr(x_H, v_L, s_L) \\ &= p\left(q_H + (0.5 - z) + (1 - q_H)(0.5 + z)\right), \end{aligned} \tag{16}$$

$$\begin{aligned} \Pr(x_L, s_L) &= \Pr(x_L, v_H, s_L) + \Pr(x_L, v_L, s_L) \\ &= (1 - p)\left(q_L + (0.5 - z) + (1 - q_L)(0.5 + z)\right). \end{aligned} \tag{17}$$

The posteriors at time $t = 2$:

$$\begin{aligned} \Pr(v_H | x_H, s_H) &= \frac{\Pr(x_H, v_H, s_H)}{\Pr(x_H, s_H)} \\ &= \frac{p q_H (0.5 + z)}{p\left(q_H (0.5 + z) + (1 - q_H)(0.5 - z)\right)}, \end{aligned} \tag{18}$$

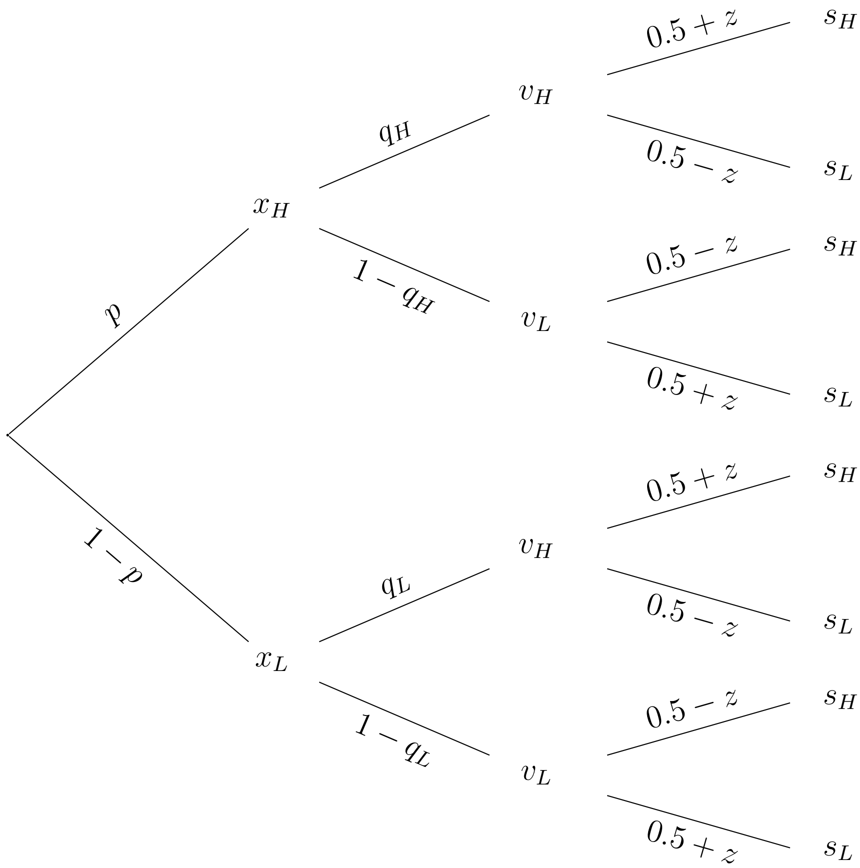


Figure 7: Probability tree. Conditional probabilities through the various stages in the model.

$$\Pr(v_H|x_L, s_H) = \frac{(1-p)\, q_L\, (0.5+z)}{(1-p)\,(q_L + (0.5+z) + (1-q_L)\,(0.5+z))}, \tag{19}$$

$$\Pr(v_H|x_H, s_L) = \frac{p q_H\, (0.5-z)}{p\,(q_H + (0.5-z) + (1-q_H)\,(0.5+z))}, \tag{20}$$

$$\Pr(v_H|x_L, s_H) = \frac{(1-p)\, q_L\, (0.5z)}{(1-p)\,(q_L + (0.5-z) + (1-q_L)\,(0.5+z))}. \tag{21}$$

For the posteriors at time $t=1$:

$$\begin{aligned}
\Pr(s_H) &= \Pr(x_H, v_H, s_H) + \Pr(x_H, v_L, s_H) + \Pr(x_L, v_H, s_H) + \Pr(x_L, v_L, s_H) \\
&= \Pr(x_H, s_H) + \Pr(x_L, s_H) \\
&= p\,(q_H\,(0.5+z) + (1-q_H)\,(0.5-z)) \\
&\quad + (1-p)\,(q_L\,(0.5+z) + (1-q_L)\,(0.5-z))
\end{aligned} \tag{22}$$

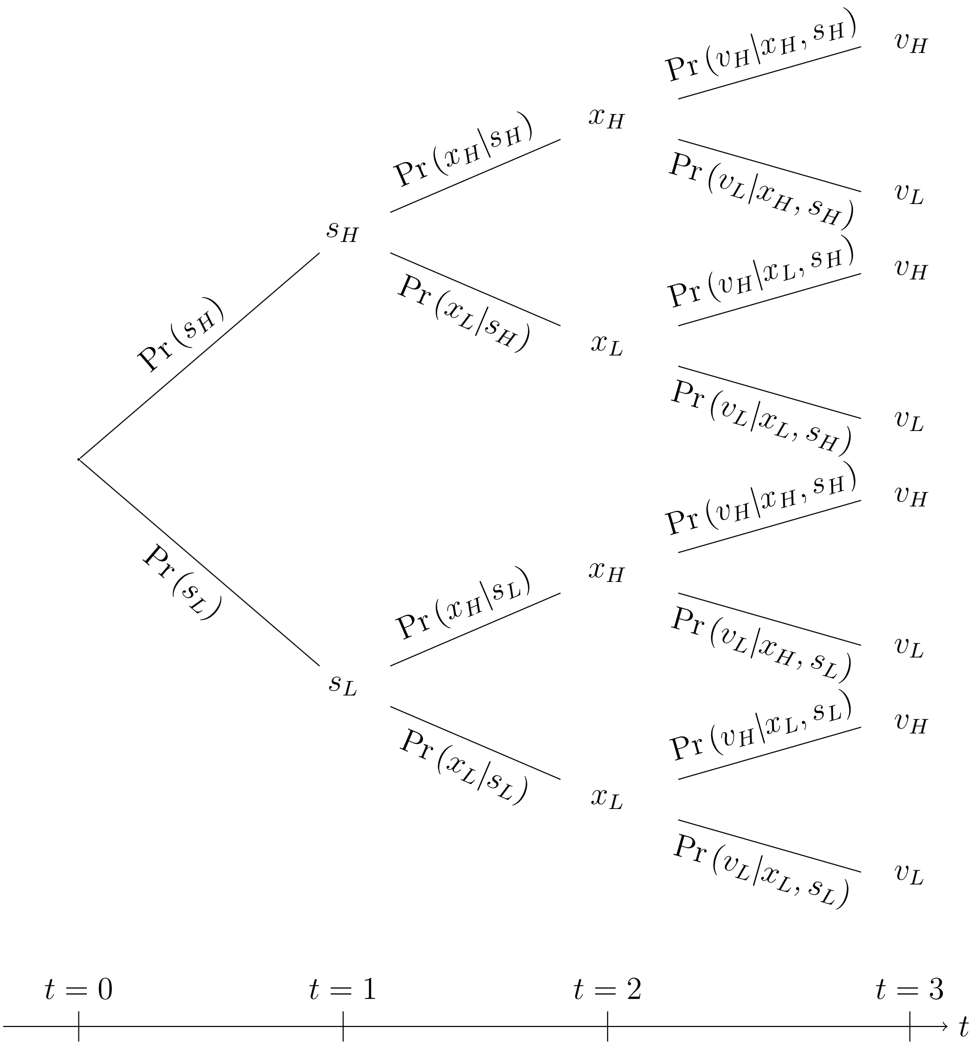


Figure 8: Probability tree. Posterior beliefs after observing the signal at time $t = 1$ and the posterior beliefs after observing the target's cash flow at time $t = 2$.

$$
\begin{aligned}
\Pr(s_L) &= \Pr(x_H, v_H, s_L) + \Pr(x_H, v_L, s_L) + \Pr(x_L, v_H, s_L) + \Pr(x_L, v_L, s_L) \\
&= \Pr(x_H, s_L) + \Pr(x_L, s_L) \\
&= p\left(q_H(0.5 - z) + (1 - q_H)(0.5 + z)\right) \\
&\quad + (1 - p)\left(q_L(0.5 - z) + (1 - q_L)(0.5 + z)\right).
\end{aligned}
\tag{23}
$$

To get the posteriors at time $t = 1$, we use the above joint and marginal probabilities:

$$\Pr(x_H|s_H) = \frac{\Pr(x_H, s_H)}{\Pr(s_H)}, \tag{24}$$

$$\Pr(x_L|s_H) = \frac{\Pr(x_L, s_H)}{\Pr(s_H)}, \tag{25}$$

$$\Pr(x_H|s_L) = \frac{\Pr(x_H, s_L)}{\Pr(s_L)}, \tag{26}$$

$$\Pr(x_L|s_L) = \frac{\Pr(x_L, s_L)}{\Pr(s_L)}. \tag{27}$$

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