A THEORY OF TAKEOVERS AND DISINVESTMENT

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5 June 2004

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We present a real-options model of takeovers and disinvestment in declining industries. As product demand declines, a first-best abandonment level is reached, where overall value is maximized by shutting down the firm and releasing its capital to investors. Absent takeovers, managers of unlevered firms always abandon the firm's business too late. We model the managers' payout policy absent takeovers and consider the effects of leverage on managers' shut-down decisions. We analyze the effects of takeovers of unleveraged or under-leveraged firms. Takeovers by raiders enforce first-best abandonment. Hostile takeovers by other firms occur either at the first-best abandonment point or too *early*. We also consider management buyouts and mergers of equals and show that in both cases closure happens inefficiently *late*.

JEL Nos.: G34, C72, G13.

Keywords: disinvestment, takeover, real option, managerial incentives, payout, debt

*We thank seminar participants at the Universities of Cyprus, Lancaster and Wisconsin-Madison for comments and suggestions. Correspondence can be addressed to Bart Lambrecht (b.lambrecht@lancaster.ac.uk) or to Stewart Myers (scmyers@mit.edu).

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Abstract

We present a real-options model of takeovers and disinvestment in declining industries. As product demand declines, a first-best abandonment level is reached, where overall value is maximized by shutting down the firm and releasing its capital to investors. Absent takeovers, managers of unlevered firms always abandon the firm's business too late. We model the managers' payout policy absent takeovers and consider the effects of leverage on managers' shut-down decisions. We analyze the effects of takeovers of unleveraged or under-leveraged firms. Takeovers by raiders enforce first-best abandonment. Hostile takeovers by other firms occur either at the first-best abandonment point or too *early*. We also consider management buyouts and mergers of equals and show that in both cases closure happens inefficiently *late*.

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1 Introduction

There is no single hypothesis which is both plausible and general and which shows promise of explaining the current merger movement. If so, it is correct to say that there is nothing known about mergers; there are no useful generalizations. (Segall (1968))

The literature on mergers and acquisitions has grown by orders of magnitude since Joel Segall wrote in 1968. Most of this research is empirical, testing hypotheses derived from qualitative economic reasoning. The hypotheses relate to possible motives for mergers and acquisitions, their impacts on stock-market values, and the effects of financial-market conditions and legal constraints. But the hypotheses are multiplying, not consolidating. One can pick and choose from the hypotheses to explain almost every merger or acquisition. We do have useful empirical generalizations, but no theory of the sort that Segall was seeking.

Mergers and acquisitions seem to fall into at least two broad categories. The first type exploits synergies and growth opportunities. The second type seeks greater efficiency through layoffs, consolidation and disinvestment. This paper presents a formal theory of the second type. The theory is a continuous-time, real-options model, in which the managers of the firm can abandon its business if product demand falls to a sufficiently low level. The managers may abandon voluntarily, or be forced to do so by a takeover. (We will use "takeover" to refer to all types of mergers and acquisitions.) We analyze the managers' behavior absent any takeover threats, then consider what happens if a "raider" or another company can bid to take over the firm.

Few takeovers are undertaken solely to force disinvestment. Opportunities for disinvestment and synergy and growth may coexist in the same deal. Takeovers undertaken primarily for disinvestment are common, however. When U.S. defense budgets fell after the end of the Cold War, a round of consolidating takeovers followed. The takeovers in the oil industry in the early 1980s, including Boone Pickens's raids on Cities Service and Phillips Petroleum (Ruback (1982, 1983)) also were classic examples. So were the "diet deals" of the LBO boom of the late 1980s. The banking industry is another good example. The U.S. was "over-banked" in the 1970s, partly as a result of restrictive state banking regulations. As regulation eased, a wave of takeovers started. "Super-regionals" have grown by taking over dozens of relatively small local and regional banks, in each case shedding employees and consolidating operations.

Disinvestment is also used as a defense against takeovers. The UK bank NatWest tried this tactic (unsuccessfully) in response to a hostile takeover bid from the Bank of Scotland:[1]

NatWest has announced a further 1,650 job cuts as it launches details of its vigorous defence against the hostile £21bn ($35bn) Bank of Scotland takeover bid. The job losses are on top of the already announced programme to cut 10,000 retail banking jobs by 2001. ... Greenwich NatWest, Ulster Bank, Gartmore and NatWest Equity Partners are to be sold, with surplus capital returned to shareholders. ... NatWest poured scorn on Bank of Scotland's claims regarding cost savings and merger benefits, saying the Edinburgh firm was "attempting to hijack cost savings that belong to NatWest shareholders" and claiming unrealistic merger benefits. (BBC, October 27, 1999)

Why are takeovers necessary to shrink declining industries? The easy answers, such as "Managers don't want to lose their jobs," are not satisfactory. A CEO with stock options might end up richer by closing redundant plants and boosting the firm's stock price than by keeping the plants open. A CEO who ended up out of work as a result of a successful shutdown ought to be in demand to run other declining companies.

Of course there are reasons why incumbent managers may not want to disinvest. Their human capital may be specialized to the firm or they may be extracting more rents as incumbents than they could get by starting fresh in another firm. If these reasons apply, we are led to further questions. Can the threat of a takeover overcome the managers' reluctance to shrink their firm? Does the holdup problem described by Grossman and Hart (1980) prevent efficient takeovers? If another firm leads a successful takeover, why do the new managers act to shrink the firm? Are their incentives any different than the old managers'? Does it make a difference whether the takeover is launched by another company or by a raider with purely financial motives? We consider these and several related questions in this

[1] The Royal Bank of Scotland (RBS) ended up winning the battle for NatWest. RBS has continued to pursue "diet deals," including $10.5 billion acquisition of Charter One Financial in May 2004.

paper.

This paper is not just about takeovers, however. In order to analyze takeovers, we first had to analyze managers' payout and closure decisions and the possible disciplinary role of debt. Our results about payout and debt policy are interesting in their own right. We preview these and other results now.

1.1 Preview of the model and main results

We assume that inside managers maximize the present value of the cash flows they can extract from the firm. The managers are constrained by a requirement to pay out cash to outside investors, however. The payout has to be sufficient to prevent investors from exercising their property rights and taking control of the firm. In good times (high demand), taking control means that managers are booted out, but the firm continues as a going concern. In bad times, takeover means liquidation.

The first-best abandonment point is the level of demand where shut-down and redeployment of capital maximizes total firm value, i.e., the sum of the present values of the managers' and investors' claims on the firm. We show that managers always wait too long, as product demand declines, before abandoning. The managers have no property rights to the released capital, and do not consider its full opportunity cost. But if demand keeps falling, the managers are eventually forced to pay from their own pockets in order to keep investors at bay. Sooner or later they give up and abandon voluntarily.

The managers' payout and abandonment policies are dynamically optimal (for them). In good times, payout varies with operating cash flow. As demand falls, a switching point is reached, where payout falls to a fixed, minimum amount. That amount may be positive, zero or negative. A negative payout, when it occurs, amounts to raising money by equity issues: investors are willing to inject additional equity to keep the firm going. If equity issues are ruled out, however, managers' capture of cash flows is reduced. The managers abandon earlier, which improves efficiency.

We consider how financial leverage, and the resulting obligation to pay out cash for debt service, changes the managers' behavior. If negative payouts (equity issues) are allowed, leverage is irrelevant. If equity issues are *not* allowed in bad times, and payouts to equity investors are constrained at zero, debt financing accelerates abandonment and improves efficiency. There is an optimal debt level, which assures efficient abandonment. The optimal level is linked to the liquidation value of the firm's assets, not to its operating cash flow or market value.

Our predictions about debt and payout policy are, as far as we know, new theoretical results. These results can be viewed as formal expressions of the Jensen (1986) free cash flow theory, which says that managers prefer to capture or invest cash flow rather than paying it out. The theory goes on to suggest that high levels of debt (as in LBOs) help solve the free cash flow problem by forcing payout of cash. But the usual expressions of the free-cash-flow theory are incomplete. There has to be some restriction on managers' capture or investment of cash flow – otherwise the firm could not raise outside financing in the first place. Our model analyzes this restriction explicitly in a dynamic setting. Also, debt cannot force payout of cash if debt service can be recouped by equity issues. We show how restrictions on equity issues constrain managers and determine the optimal level of debt.

If the firm carries sufficient debt, takeovers have no role to play. Therefore we consider takeovers of unlevered or underlevered firms. The takeovers may be launched by:

1. **Raiders**, that is, financial investors who can take over the firm but cannot manage it effectively. Raiders take over the firm at exactly the right level of product demand and shut the firm down immediately. Thus raiders implement the first-best outcome, where abandonment maximizes the overall value of the firm, not its value to the managers or investors separately.

2. **Hostile takeover by another firm**. The other firm acts just as a raider would, unless it is forced to act to preempt a competing bid. Preemption means that the takeover occurs too early, i.e., at too high a demand level. Preemptive takeovers run the risk that the bidding firm will not follow through and shut down the target. (After the bidding firm takes over, it also acquires the incentives of the target management.) The right amount of debt can force

the bidding firm's management to follow through and disinvest. Equity-financed preemptive takeovers will not occur unless there is some credible, alternative bonding mechanism.

3. **Management buyouts** (MBOs). Allowing managers to buy out their own firm prompts them to disinvest at higher levels of demand, but disinvestment still happens inefficiently late, because managers lose the ability to capture cash flow when they take over and shut down. MBOs can occur only if takeovers by raiders or other firms are ruled out.

4. **Mergers of equals**. In some cases a firm that could make a hostile takeover will be better off forcing the target to accept a "merger of equals," in which the merger terms are negotiated by the two firms' managers. A merger of equals reduces the power of the target shareholders to extract value from the bidder. Since a merger of equals does not inherently change the managers' incentives, disinvestment remains inefficiently late. A raider could always contest such a merger and win, however.

At the end of the paper we comment briefly on takeovers for growth or synergy. These takeovers are more likely to be effected as mergers of equals, because both firms' managements can share the merger's value added without paying a premium to the shareholders of a target firm.

1.2 Literature review

This paper continues a line of research using real-options models to analyze the financing and investment decisions of firms rather than the valuation of individual investment projects. Several papers, including Mello and Parsons (1992), Leland (1994, 1998) and Parrino and Weisbach (1999) quantify the possible impacts of taxes and stockholder-bondholder conflicts on investment decisions and value-maximizing debt ratios. Anderson and Sundaresan (1996) and Mella-Barral and Perraudin (1997) consider the role of strategic debt service on firm's closure decisions and the agency costs of debt. Lambrecht (2001) examines the effect of product market competition and debt financing on firm closure in a duopoly.

Our paper focuses on agency problems between managers and dispersed outside investors.

We follow Myers (2000) by assuming that managers maximize the present value of their stake in the firm, subject to constraints imposed by the investors. Papers by Stulz (1990), Zwiebel (1996) and Morellec (2004) tackle much the same problem, but with interesting differences. They assume that the manager derives private benefits from retaining control and investing in new projects. The resulting incentive to over-invest creates agency costs from free cash flow. Debt service reduces free cash flow and constrains over-investment. But there are no private benefits in our setup, and we do not assume that managers always want to expand or maintain investment. Also, our model does not rely on the threat of bankruptcy to constrain management, unlike Zwiebel (1996), for example.

Formal models of takeover incentives and decisions are scarce. Lambrecht (2004) presents a real-options model of mergers motivated by economies of scale and provides a rationale for the pro-cyclicality of merger waves. There are no managerial agency costs in his model. Furthermore, he focuses on takeovers that happen in rising product markets, while this paper considers takeovers in declining markets.

Jovanovic and Rousseau (2001, 2002) model merger waves that are based on technological change and changes in Tobin's Q. Mergers amount to the purchase of used capital. Merger waves occur when there is reallocation across sectors, with high-Q firms buying low-Q firms. We do not propose to explain merger waves, which typically occur in buoyant stock markets, but the release of capital in declining industries. Gorton, Kahl, and Rosen (2000) argue that mergers can be used as a defensive mechanism by managers who do not wish to be taken over. In their model technological and regulatory change that makes acquisitions profitable in some future states of the world can induce a preemptive wave of unprofitable, defensive acquisitions. Preemptive mergers can occur in our theory, but they are offensive and profitable.

A few recent papers model takeover activity as a result of stock market valuations. Shleifer and Vishny (2001) assume that the stock market may misvalue potential acquirers, potential targets and their combinations. Managers of the firms understand stock market inefficiencies, and take advantage of them, in part through merger decisions. The takeover surplus and merger waves are driven by the relative valuations of the merging firms. Rhodes-

Kropf and Viswanathan (2003) show that potential market value deviations from fundamental values can rationally lead to a correlation between stock merger activity and market valuation. Morellec and Zhdanov (2003) consider the role of multiple bidders and imperfect information on takeover activity. In contrast to these papers, we assume efficient markets and full information throughout.

The empirical implications of our model are mostly in line with accepted evidence. See Andrade, Mitchell, and Stafford (2001) for a recent review. For example, target shareholders gain in takeovers. The gain to shareholders on the other side of the transaction is relatively small. However, the combined increase in the two firms' market values (or the combined gain to a raider and target) does *not* measure the economic value added by the takeover, because the gain to the target shareholders includes their capture of the value of the target managers' future cash flows. The target managers' stake in the firm is extinguished by takeover and shutdown. Our model also predicts that the gain to both the target and acquiring shareholders is zero in the case of friendly mergers. This is consistent with empirical studies, which typically find insignificant (or small) returns from friendly mergers.

We also predict that unlevered or underlevered firms in declining industries are more likely targets for hostile takeover attempts. We explain why an increase in financial leverage (a leveraged restructuring of the target, for example) can be an effective defense. We also note that debt financing can pre-commit management to follow through with the restructuring of the target after the takeover.

The remainder of this paper splits naturally into two main parts. In Section 2, we set out a formal description of the problem that takeovers can potentially solve. We model managers' payout policies and abandonment decisions when takeovers are excluded. We consider the effects of financial leverage, which depend on whether equity issues are allowed in times of declining demand. Section 3 shows how abandonment decisions change when takeovers are allowed. We consider takeovers by raiders, hostile takeovers by other firms, MBOs and mergers of equals, and we note some empirical and policy implications of our takeover results. Section 4 concludes.

2 Disinvestment policy absent takeovers

Consider a firm that generates a total operating profit of $K\,x_t \;-\; f$ per period, where f is the fixed cost of operating the firm. K denotes the amount of capital in place and x_t is a geometric Brownian motion representing exogenous demand shocks:

$$dx_t \;=\; \mu x_t dt \,+\, \sigma x_t dB_t, \tag{1}$$

where μ is a drift term, assumed negative in our numerical examples, and σ measures the volatility of demand. As demand (x_t) falls, the firm will at some point close down. We assume that closure is irreversible and that it releases the stock of capital K. For now we assume that the firm is all-equity financed. All capital is returned to shareholders upon closure.

2.1 First best disinvestment policy

We assume that investors are risk neutral (or that all expected payoffs are certainty equivalents). For a risk-neutral investor to hold the firm's assets the return from dividends plus expected capital gains must equal the risk-free rate of return r. Thus the first-best firm value V_t^o satisfies the following equilibrium condition:

$$rV_t^o \;=\; Kx_t \,-\, f \,+\, \frac{d}{d\Delta}\mathrm{E_t}\left[V^o{}_{t+\Delta}\right]\Big|_{\Delta=0} \tag{2}$$

Applying Ito's lemma inside the expectation operator gives the following differential equation:

$$\frac{1}{2}\sigma^2 x^2 \frac{\partial^2 V^o(x)}{\partial x^2} \,+\, \mu x \frac{\partial V^o(x)}{\partial x} \,+\, Kx \,-\, f \;=\; rV^o(x) \tag{3}$$

We solve this differential equation subject to the no-bubble condition (for $x \rightarrow +\infty$) and the boundary conditions at the closure point $\underline{x}^o$. The first-best closure policy, the corresponding firm value and payout policy are as follows:[2]

[2] The proof is standard and can be found, for example, in Mella-Barral and Perraudin (1997) and Lambrecht (2001).

Proposition 1 *First-best firm value is:*

$$
\begin{aligned}
V^o(x) &= \frac{Kx}{r-\mu} - \frac{f}{r} + \left[K + \frac{f}{r} - \frac{K\underline{x}^o}{r-\mu}\right]\left(\frac{x}{\underline{x}^o}\right)^{\lambda} && \text{for } x > \underline{x}^o \\
&= K && \text{for } x \leq \underline{x}^o
\end{aligned}
\tag{4}
$$

The first-best closure rule is:

$$
\underline{x}^o = \frac{-\lambda\left(K + \frac{f}{r}\right)(r-\mu)}{(1-\lambda)K} \tag{5}
$$

where λ is the negative root of the characteristic equation $\frac{1}{2}\sigma^2 p(p-1)+\mu p = r$. The first-best closure rule implies that $V^o(x) \geq K$ for all $x \geq \underline{x}^o$. The dividend payout flow until closure is $Kx - f$.

This expression for firm value has a simple economic interpretation: it is the present value of operating the firm forever plus the value of the option to shut down the firm. The discount factor $\left(\frac{x}{\underline{x}^o}\right)^{\lambda}$ can be interpreted as the probability of the firm closing down in future given the current demand level x. Note that the optimal closure point, $\underline{x}^o$, increases with fixed costs, f, but decreases for higher values of the drift, μ, and volatility, σ, of demand.

2.2 Disinvestment by management

Now we consider the closure policy adopted by managers. The present values of managers' and equity investors' claims are $E(x)$ and $R(x)$, respectively. With no debt, the claims must add up to total firm value, so $V(x) = E(x) + R(x)$. Inside managers maximize $R(x)$, not $V(x)$, subject to constraints imposed by outside investors. We assume that the outside investors can take collective action against the managers, exercising their property rights to the firm's assets, and either managing the firm privately or closing it down and releasing the stock of capital K. If they manage the firm, they will implement the first-best disinvestment policy and generate the first-best firm value $V^o(x)$. Collective action is costly, however. Outside investors realize only the fraction α $(0 \leq \alpha < 1)$ of firm value or the stock of capital. In other words, outside equity holders receive $\alpha \max[V^o(x), K]$ if they act collectively and take control of the firm.

The following assumptions summarize our framework.

Assumption 1 *Outside equity holders have put an amount of capital K at the disposal of the managers of a public corporation. The investors' property rights to the capital are protected. Managers can capture operating cash flows, but not the stock of capital.*

The managers' ability to use and manage this capital can be terminated in two ways:

a) the managers close the firm voluntarily, returning all its capital to its owners.

b) the outside investors take collective action, force out the management and either close the firm or manage it privately. Collective action leads to a net payoff of $\alpha \max[V^o, K]$ for the investors. The managers get nothing.[3]

Assumption 2 *Promises made by the management to pay out extra cash or to return the stock of capital in the future are not binding and can therefore not be used to obtain concessions from investors.*

Assumption 3 *Managers act as a coalition, maximizing R(x), the present value of the future cash flows (managerial rents) that they can extract from the firm. Both managers and investors are risk-neutral and agree on the value of the firm's future cash flows, regardless of how these cash flows are split between managers and investors.*

These assumptions follow Myers (2000). Managers can capture operating cash flow,[4] but investors can enforce their property rights to the capital stock if they are willing to undertake collective action. The threat of collective action constrains the managers, but the cost of

[3]"Get nothing" does not mean that the managers are penniless. They would still be paid their opportunity wage. We interpret $R(x)$ as the present value of managerial rents above the compensation that managers could earn outside the firm.

[4]It is not necessary to assume that investors' property rights to operating cash flow are completely null. The only essential point is that investors' ability to secure cash flows is weaker, or more costly to enforce, than their ability to secure capital assets.

collective action creates the space for their capture of cash flows. The size of the space is determined by $1 - \alpha$.[5]

As in Myers (2000), payout policy has to be credible and cannot be sustained by promises. For example, a payout policy that eliminates cash payouts when managers promise to "make it up later" is not credible. This paper extends Myers (2000) in two important respects, however. First, we allow outside investors to take over the firm and manage it as a going concern if the firm is more valuable alive than dead. Thus their net payoff is $\alpha \max[V^o, K]$, not just αK as in Myers's paper. Second, we zero in on the case where the firm should shut down because of declining demand. These two extensions change the managers' equilibrium payout policy and make the debt financing relevant. The extensions also allow us to model the effects of takeovers in declining industries.

We now derive total firm value, $V(x)$, outside equity value $E(x)$ and the managers' value $R(x)$. The total firm value, $V(x)$ is similar to the first-best firm value $V^o(x)$ since both are claims on the firm's total cashflow. However, the managers' closure point $\underline{x}$ will not coincide with the first-best closure policy $\underline{x}^o$. The functional form for $V(x; \underline{x})$ is therefore the same as for $V^o(x; \underline{x}^o)$, but the closure threshold takes on a different value.

When the firm is doing well and x exceeds the first-best closure threshold, $\underline{x}^o$, managers have to ensure that the equity value equals at least $\alpha V^o(x)$, where $V^o(x)$ is the first-best value. Prior to closure $V^o(x)$ satisfies the differential equation (3). We show below that by paying a dividend flow $\alpha\,(Kx - f)$ to investors when $x \geq \underline{x}^o$ management satisfies the constraint $E(x) = \alpha V^o(x)$ for all $x \geq \underline{x}^o$, provided that sufficient fixed dividend is paid when $x \leq \underline{x}^o$. In good times the dividend flow equals a fraction α of the firm's profits, and also the outside equity value equals a fraction α of the first-best firm value.

When the firm is doing badly and demand drops below $\underline{x}^o$ (when the firm should have

[5] Wrapping up all the costs of corporate governance in one parameter α is a drastic, but very useful simplification. But 1 - α does not have to be taken literally as only measuring the cost of collective action. Jensen and Meckling (1976) could interpret α as the result of outside investors' optimal outlays on monitoring and control. If monitoring and control face decreasing returns, then investors allow managers to capture some cash flows. The space $1 - \alpha$ could also represent extra bargaining power created for managers by entrenching investments. See Shleifer and Vishny (1989).

been closed) management operates under the constraint $E(x) \geq \alpha \max[V^o(x)\,,\,K] = \alpha K$. The total profits generated are given by $(Kx - f)$ and some amount of this will be paid out as a dividend. If the equity value had to be at least αK for *all* values of x, then the dividend flow would simply be given by $r\alpha K$ at all times. This is the payout policy obtained in Myers (2000) (see also proposition 3 where we consider the constraint $E(x) \geq \alpha K$). However, outsiders' upside potential when demand exceeds $\underline{x}^o$ adds extra value, which allows managers to get away with paying a dividend *less* than $r\alpha K$ when times are bad. Let the payout policy be denoted by $\eta Kx + \phi\alpha rK$, where η and ϕ remain to be determined. We denote the managerial closure threshold by $\underline{x}$. $E(x)$ satisfies the following equilibrium relationship:

$$rE_t \;=\; \eta\, K\, x \,+\, \phi\, r\, \alpha\, K \;+\; \frac{d}{d\Delta}\mathrm{E_t}\left[E_{t+\Delta}\right]\Big|_{\Delta=0} \tag{6}$$

that is, for a risk-neutral investor to hold the firm's outside equity the dividend plus the expected capital gains must equal the risk-free rate of return. Applying Ito's lemma inside the expectation operator ($\mathrm{E_t}$) gives a second-order differential equation with the general solution:

$$E(x) \;=\; \frac{\eta\, K\, x}{r-\mu} \,+\, \phi\alpha K \;+\; A_e\, x^{\lambda} \;+\; B_e\, x^{\beta} \tag{7}$$

where λ and β are the negative and positive roots to the quadratic equation $\frac{1}{2}\sigma^2 p(p-1) + \mu p = r$, and where the unknowns A_e, B_e, $\underline{x}$, η and ϕ are determined by the following boundary conditions. First, property rights protect the investors' claim on the stock of capital. Consequently, when management closes the firm at some threshold, $\underline{x}$, the equity value has to equal the stock of capital i.e. $E(\underline{x}) = K$. This implies that at closure and in the run-down to closure the outside equity value exceeds αK, the payoff from collective action. We will cover this point in more detail later.

Second, in order to rule out arbitrage opportunities the equity value must be continuous and differentiable at the dividend switch $\underline{x}^o$, so $E(\underline{x}^o) = \alpha V^o(\underline{x}^o)$ and $E'(\underline{x}^o) = \alpha V^{o\prime}(\underline{x}^o)$.[6]

[6] Since the Brownian motion can diffuse freely across the dividend switch, $\underline{x}^o$, the functions $E(x)$ and $R(x)$ cannot change abruptly across this point. Dixit (1993) shows that at reversible switching points the functions must be continuous and differentiable. Continuity is ensured by a value-matching condition. Differentiability is achieved by the smooth-pasting condition. We show in the appendix that $\underline{x}^o$ is the management's optimal dividend switch level.

Third, since the management optimally chooses the closure threshold, $\underline{x}$, it satisfies the following smooth-pasting condition: $R'(\underline{x}) \;=\; V'(\underline{x}) \,-\, E'(\underline{x}) \;=\; 0$.

In summary, we have four equations (two value-matching and two smooth-pasting conditions) and five unknowns (A_e, B_e, $\underline{x}$, η and ϕ), leaving one degree of freedom. In particular, there exists an infinite number of pairs (η, ϕ) that satisfy the boundary conditions imposed by our model. One can show that $\frac{\partial \phi}{\partial \eta} \,<\, 0$. In other words an increase in the variable dividend component allows management to decrease the fixed dividend component. The two components are therefore substitutes. Since the dividend policy (η, ϕ) is under managerial control, management chooses among this infinite range of dividend policies the policy $(\eta^o \,, \,\phi^o)$ that maximizes the present value of the cash flows it expects to receive, subject to the payout policy being credible to outside investors. We show in the appendix that the optimal dividend policy is given by $\phi\, r\, \alpha\, K$ (i.e. $\eta^o = 0$) and hence all variation in dividends is smoothed out. Our results can be summarized in the following proposition.

Proposition 2 *Assume that outside investors face a cost of collective action but, if they absorb that cost and take control of the firm, they can run the firm efficiently or shut it down. Then the values of the firm and investors' and managers' claims are:*

$$
\begin{aligned}
V(x) &= \tfrac{Kx}{r-\mu} - \tfrac{f}{r} + \left[K + \tfrac{f}{r} - \tfrac{K\underline{x}}{r-\mu}\right]\left(\tfrac{x}{\underline{x}}\right)^{\lambda} && \text{for} \quad x > \underline{x} \\
&= K && \text{for} \quad x \leq \underline{x} \\
E(x) &= \alpha\, V^o(x) && \text{for} \quad x \geq \underline{x}^o \\
&= \phi\, \alpha\, K \,+\, A_e\, x^{\lambda} \,+\, B_e\, x^{\beta} && \text{for} \quad \underline{x} \leq x \leq \underline{x}^o \\
&= K && \text{for} \quad x \leq \underline{x} \\
R(x) &= V(x) \,-\, E(x)
\end{aligned}
$$

A_e and B_e are the solutions to the value-matching conditions $E(\underline{x}) \;=\; K$ and $E(\underline{x}^o) \;=\; \alpha V^o(\underline{x}^o)$, and $\underline{x}$ and ϕ are the solutions to the smooth-pasting conditions given in the appendix. The payout policy is:

$$
\begin{aligned}
Div &= \alpha\,(Kx \,-\, f) && \text{if} \quad \underline{x}^o < x \\
Div &= \phi r \alpha K && \text{if} \quad \underline{x} \leq x \leq \underline{x}^o
\end{aligned}
$$

When there are no costs of collective action ($\alpha = 1$), management closes the firm at the efficient point $\underline{x} \;=\; \underline{x}^o$. When the cost of collective action is strictly positive ($\alpha < 1$), *management closes the firm inefficiently late at $\underline{x} < \underline{x}^o$. The dividend flow $\phi r \alpha K$ (with $\phi\alpha \leq 1$) is the lowest payout that ensures that outside equity holders do not act to liquidate the firm when demand is below the first-best closure threshold $\underline{x}^o$.*

This proposition requires managers to pay out some minimum cash dividend in each period. If they do this, and investors expect the managers to follow the stated payout policy in future periods, then the investors do not intervene, and the managers' stake $R(x)$ is preserved. In equilibrium, the market value of the firm is tied solely to the current dividend and expectations of future dividends. We need not take "dividends" literally, however. A more elaborate version of our model could incorporate other channels for delivering value to investors. For example, outside investors would be content to absorb a dividend cut equal to α times the present value of a new capital investment. Also, a dollar spent to pay down (risk-free) debt is just as good as a dollar paid out as a dividend.

When times are bad, the outside equity holders' claim resembles a perpetual debt contract that pays a fixed coupon flow till default, and upon default pays out the liquidation value of the firm. The dividends are like coupon payments and the stock of capital released upon closure is like the firm's liquidation value in bankruptcy.[7] Note that by opting for a constant dividend management effectively engages in dividend smoothing and absorbs all underlying variation in earnings. Proposition 2 does not rule out negative values for the payout parameter ϕ. If it is negative, outside investors equity holders are injecting cash in the run-down to closure. That is, the firm would pay no dividends and raise cash with periodic share issues. Outside investors would be willing to buy the shares if the volatility, σ, of demand is sufficiently high and the firm's upside potential is sufficiently valuable to justify keeping the chances of recovery alive. But outside equity holders may be better off if they can refuse to inject cash. If so, the dividend parameter ϕ is constrained to $\phi \geq 0$. We

[7] The outside investors' claim specified in Proposition 2 resembles convertible debt, where the conversion option reduces the required coupon but offers upside if the firm does well. The higher the underlying uncertainty, the greater the upside value and the lower the required coupon. Here the "coupon" is the fixed dividend at low demand levels, and the upside is realized above the switch point $\underline{x}^o$, where payout is proportional to operating cash flow. More volatile demand increases upside value and reduces the payout parameter ϕ when x is below the switch point. Conversion of debt into equity is irreversible, however. In our model the switch between constant and variable dividend payments is reversible.

return to this case later.

2.3 Example

Figure 1 plots the various claim values and the payout policy for a numerical example.[8] Figure 1a plots the first-best firm value, V^o (solid line), the firm value under the managerial closure policy V (dashed line), the outside equity value E (dotted line), and the payoff to outside equity holders from taking collective action as a function of the state variable, i.e. $\alpha \max[V^o, K]$ (double-dashed line).

First-best closure is at $x = 0.0391$, which is the demand level where the first-best firm value value-matches and smooth-pastes to the value of the capital stock given by $K = 100$. The firm value is increasing in x. For high levels of the state variable, the value of the closure option goes to zero and firm value converges to $\frac{Kx}{r-\mu} - \frac{f}{r}$.

The managers' closure point is at $x = 0.0196$, which is the demand level where the managers' value $R(x)$ value-matches and smooth-pastes to the zero value line (see Figure 1b). Since management closes the firm inefficiently late, total firm value is below first-best value. Value is therefore destroyed (from a global optimizer's viewpoint) at the expense of the outside shareholders. The outside equity value is a U-shaped function of the state variable x: it equals K at $\underline{x}$ (closure), reaches a minimum of αK at the first-best closure and dividend switch point, $\underline{x}^o$, and thereafter increases and gradually converges to the asymptote $\alpha\left(\frac{Kx}{r-\mu} - \frac{f}{r}\right)$. The outside equity value increases in the run-down to closure, since the possibility of the capital stock being released in the near future is positive news for the outside shareholders. The payoff to outside shareholders from taking collective action (shown as a double-dotted line) is αK ($\alpha V^o(x)$) when the state variable is below (above) the first-best closure point.

Figure 1c illustrates the dividend flow (solid line) and the managers' cash flow (dashed

[8]The parameters used to generate the figure are: $\mu = -0.02$, $r = 0.05$, $\sigma = 0.2$, $\alpha = 0.8$, $K = 100$ and $f = 1$.

line).[9] When demand exceeds the first-best closure point, dividends are a fraction α of the firm's profits ($\alpha\,(K\,x\ -\ f)$). For levels of x below the first-best closure point, collective action would shut down the firm, with investors receiving a fixed payoff $\alpha K (= 80)$. To discourage investors from closing the firm in bad times, management must pay a constant dividend flow of $\phi r \alpha K\,(=\ 0.422 \times 0.05 \times 0.8 \times 100\ \approx\ 1.7)$ until the firm is closed at $x = 0.0196$. There is therefore a switch in dividend policy at the first-best closure point, where the dividend is cut to a fixed, but lower, level. Note finally that since the collective action constraint is binding at the first-best closure point (where the outside equity value equals $\alpha K\ =\ 80$), dividends cannot be cut further without triggering collective action.

Since equity value strictly exceeds αK in the run-down to closure, one may wonder why managers do not cut dividends entirely as closure approaches. "We won't pay dividends anymore," the managers might argue, "but we promise to return the stock of capital K soon enough to assure a present value of at least αK." This promise would satisfy investors if it were credible. But such promises are not binding, and managers could subsequently change their minds and keep postponing closure. In fact, if outside equity holders were to agree to a dividend that is lower than $\phi r \alpha K$, then managers would have an incentive to delay closure even further, making matters even worse. This would cause the equity value to drop and the constraint $E \geq \alpha \max[V^o, K]$ to be violated for some values of x. The payout policy specified in Proposition 2 therefore incorporates a payout parameter ϕ that will not trigger collective action.

Managers could also try to hold up outside investors by the following threat: "We can either voluntarily walk out or you have to force us out. If you force us out the cost of collective action will reduce your proceeds to αK. We offer to release the stock of capital voluntarily and to give you $\alpha K\ +\ \epsilon$. We keep $K\ -\ \alpha K\ -\ \epsilon$ to ourselves." Such blackmail would enable insiders to obtain up to $(1 - \alpha)K$ of the liquidation proceeds. We assume, however, that property rights protect the outsiders' ownership of the stock of capital in liquidation and that these rights cannot be infringed. Consequently, when management

[9] Note how the managers' cash flow turns negative as demand approaches the shutdown point. In this region, the managers contributing money from their own pockets keep the firm going in the hope of recovery. Such "propping" is common, though not universal, in our model. See Friedman, Johnson, and Mitton (2003).

decides to close the firm it must returns the entire stock of capital to its rightful owners.

2.4 Special Cases and Extensions

Closed form solutions for the management's closure threshold, $\underline{x}$, are in general not available. We therefore consider special cases that give more insight into the determinants and behavior of the managers' closure policy. First, it is straightforward to prove that if there are no costs of collective action (i.e. $\alpha = 1$), the firm is closed at the efficient demand level $\underline{x} = \underline{x}^o$, and the outside equity value $E(x) = V^o(x)$.

Since the closure threshold is primarily determined by the constraint $E \geq \alpha K$, we next consider the special case where outside investors cannot manage the firm and must shut it down if they take it over. In this case their net payoff is αK, not $\alpha \max[V^o, K]$. The closure threshold obtained under this scenario is an upper bound for the more general closure threshold obtained previously, and we can derive the threshold in closed form.

Proposition 3 *Managements' closure policy when outsiders must liquidate the firm if they take it over is given by the threshold:*

$$\underline{\hat{x}} = \frac{-\lambda \left[\alpha K + \frac{f}{r}\right](r - \mu)}{(1 - \lambda)K} \tag{8}$$

The corresponding values of the firm and of the investors' and managers' claims are:

$$\begin{aligned}
\hat{V}(x) &= \tfrac{Kx}{r-\mu} - \tfrac{f}{r} + \left[K + \tfrac{f}{r} - \tfrac{K\underline{\hat{x}}}{r-\mu}\right]\left(\tfrac{x}{\underline{\hat{x}}}\right)^{\lambda} && \text{for} \quad x_t > \underline{\hat{x}} \\
&= K && \text{for} \quad x_t \leq \underline{\hat{x}} \\
\hat{E}(x) &= \alpha K + [K - \alpha K]\left(\tfrac{x}{\underline{\hat{x}}}\right)^{\lambda} && \text{for} \quad x_t > \underline{\hat{x}} \\
&= K && \text{for} \quad x_t \leq \underline{\hat{x}} \\
\hat{R}(x) &= \hat{V}(x) - \hat{E}(x)
\end{aligned}$$

A cost of collective action ($\alpha < 1$) implies that the firm is closed down inefficiently late, at $\underline{\hat{x}} < \underline{x}^o$ and $\hat{V}(x) < V^o(x)$ (in particular $\hat{V}(\underline{x}^o) < V^o(\underline{x}^o) = K$). When there is no cost of collective action ($\alpha = 1$) the efficient outcome is restored, i.e. $\underline{\hat{x}} = \underline{x}^o$ and $\hat{V}(x) = V^o(x)$,

$\hat{E}(x) = K$ *and* $\hat{R}(x) = V^o(x) - K$*. The dividend flow equals* $r\alpha K$ *as long as the firm continues to operate as a going concern.*

Note that our dividend policy $r\alpha K$ is consistent with Myers (2000). The closure threshold in Proposition 3 shows why the firm is closed inefficiently late. Managers do not internalize the full opportunity cost of the capital stock. Their payouts are based on αK, not K. That is why αK appears in the numerator of the closure threshold.

The ratio $\frac{\hat{\underline{x}}}{\underline{x}^o}$ measures relative inefficiency of the closure policy, $\hat{\underline{x}}$:

$$\frac{\hat{\underline{x}}}{\underline{x}^o} = \frac{\alpha + \frac{f}{Kr}}{1 + \frac{f}{Kr}} \tag{9}$$

This ratio varies from $\frac{\frac{f}{Kr}}{1+\frac{f}{Kr}}$ to 1, with first-best at $\alpha = 1$. The managers' closure policy becomes less efficient as the ratio $\frac{f}{Kr}$ of fixed operating costs, f, to the opportunity cost of capital, Kr, declines. The cost of collective action allows managers to ignore part of the opportunity cost of the capital stock, but they are forced to absorb the firm's total operating costs f if they continue to operate the firm when $x = \underline{x}^o$.

Thus far we have assumed that disinvestment is an all or nothing decision in which the whole firm is closed down. In Lambrecht and Myers (2004) we show that our results generalize to the case of gradual contraction. We consider two-stage disinvestment: as the market declines the firm first shrinks, and it is closed only if subsequently the market falls further. The results of this two-stage disinvestment model are entirely consistent with the results of the one-stage disinvestment model. Management shrinks and closes the firm inefficiently late, and the efficient outcome is restored when there is no cost of collective action. The model generalizes to the case where disinvestment happens in N stages.

2.5 Restrictions on Equity Issues

Now we return to the case where outside shareholders refuse to inject cash in the run-up to closure. Suppose that the dividend parameter, ϕ, obtained by solving the conditions set out in Proposition 2 is negative ($\phi < 0$). Constraining $\phi = 0$ means that in the run-down to closure outsiders receive zero dividends and cannot be forced to buy additional shares. This raises the outside equity value in states of low demand. As a result, equity value must exceed αK at the level $\underline{x}^o$. Thus managers can eliminate dividends at a demand level $\tilde{x}$ that is higher than the first-best level $\underline{x}^o$. This gives a new dividend switching threshold. Below $\tilde{x}$ no dividends are paid. Above $\tilde{x}$ payout is proportional to operating cash flow, that is, $\alpha\,(K\,x \;-\; f)$.

Proposition 4 *When in the run-down to closure there is scope for negative payouts ($\phi < 0$) but outsiders can refuse to contribute additional cash to the firm, managers cut cash payout to zero (i.e., $\phi = 0$) at all demand levels below $\tilde{x}$ ($> \underline{x}^o$). The values of managers' and investors' claims are:*

$$
\begin{aligned}
V(x) &= \tfrac{Kx}{r-\mu} - \tfrac{f}{r} + \left[K + \tfrac{f}{r} - \tfrac{K\underline{x}}{r-\mu}\right]\left(\tfrac{x}{\underline{x}}\right)^{\lambda} && \text{for } \; x > \underline{x} \\
&= K && \text{for } \; x \leq \underline{x} \\
E(x) &= \alpha\, V^o(x) && \text{for } \; x_t \geq \tilde{x} \\
&= A_e\, x^{\lambda} + B_e\, x^{\beta} && \text{for } \; \underline{x} \leq x_t \leq \tilde{x} \\
&= K && \text{for } \; x \leq \underline{x} \\
R(x) &= V(x) - E(x)
\end{aligned}
$$

A_e and B_e are the solutions to the value-matching conditions, and the optimal closure point ($\underline{x}$) and dividend switch ($\tilde{x}$) are determined by the smooth-pasting conditions given in the appendix. The dividend switch threshold $\tilde{x}$ exceeds the first-best closure threshold $\underline{x}^o$. Below the dividend switch threshold no dividends are paid. Above the threshold a variable dividend flow $\alpha(Kx \;-\; f)$ is paid.

Figure 2 illustrates Proposition 4.[10] Figure 2a shows that constraining $\phi = 0$ raises management's closure point from 0.0053 to 0.0061. This raises both the total firm value and the outside equity value. The value increases can be traced to the payout policies plotted

[10] The parameters used to generate Figure 2 are the same as for Figure 1, except that $\alpha = 0.2$ instead of $\alpha = 0.8$. The cost of collective action needs to be high to obtain $\phi < 0$ in an all-equity firm. Thus we set α equal to a low value in this example.

in Figure 2c. When ϕ is *not* constrained, managers pay a negative "dividend" of about -0.2 (solid line). The outside equity value (light dashed line in Figure 2a) reaches a minimum of $\alpha K = 20$ at $\underline{x}^o = 0.039$, indicating that at demand levels below $\underline{x}^o$ investors prefer to inject capital, instead of taking collective action, since there is still a chance that the firm will recover and pay higher dividends in future.

The dotted line in Figure 2c shows the dividend policy when $\phi = 0$ and equity issues are not allowed. In this case management pays zero dividends in bad times. This causes the cash flows to managers (double-dashed line) to be negative around $x = 0.01$; they would still be positive at that demand level if equity issues were allowed. Managers are forced to inject cash or "sweat equity," so they close the firm at a higher demand level.

Figure 2b plots the managers' value when equity issues are allowed (solid line) and not allowed (dashed line). Note that in good times the managers' value is higher when equity issues are not allowed. The managers' "sacrifices" in bad times raise the equity value for all levels of the state variable x, which allows managers to cut dividends at an earlier point if demand declines. Figure 2c shows that management cuts dividends at $x = 0.061$ in the constrained case, versus the unconstrained dividend switch point at $x = 0.039$.

2.6 Debt financing

Now we briefly analyze how debt financing influences firm value and the managers' actions. In the interest of space we do not go into details. A complete analysis of debt policy is beyond the scope of this paper and is developed in Lambrecht and Myers (2004).

We assume that equity issues are restricted.[11] In that case managers may not be able to pass on all debt service to investors when times are bad. Managers' cash flows after

[11] Lambrecht and Myers (2004) show that debt is irrelevant if equity issues are allowed. The reason is that insiders simply pass on the burden of debt to outside investors: when the firm is operating, dividends are reduced by the debt interest rD, and at closure the outsiders' recovery of capital is reduced by the amount of debt D. Debt does not affect managers' cash flows or closure policy.

dividends and interest repayments are now given by:

$$
\begin{array}{rlr}
 & (Kx - f) - \max[0\,,\, r\alpha\phi K - rD] - rD & \\
= & Kx - f - r\phi\alpha K & \text{if} \quad \phi > \frac{D}{\alpha K} \\
= & Kx - f - rD & \text{if} \quad \phi < \frac{D}{\alpha K}
\end{array}
$$

Note that the non-negativity constraint is binding when $r\phi\alpha K - rD < 0$, or equivalently when $\phi\alpha K < D$. It is therefore possible to find a debt level for which the non-negativity constraint is binding. Raising the debt level beyond this level forces management to close the firm earlier, because the debt service reduces managerial rents. In particular, when the non-negativity constraint is binding, the closure threshold increases monotonically with the debt level D, and there is an optimal debt level D^* that enforces closure at the first-best closure point $\underline{x}^o$. A debt level that exceeds D^* induces inefficiently early closure. Lambrecht and Myers (2004) show that the optimal debt level D^* is independent of the level of the state variable and therefore dynamically optimal. Furthermore, the optimal capital structure is linked to the liquidation value K of the firm, rather than the firm's market value as a going concern. The model therefore predicts optimal book leverage $\frac{D^*}{K}$ and not optimal market leverage.

We draw two immediate implications. First, debt can play an important role in bonding inside shareholders to a particular closure policy. We return to this point in next section where we argue that debt can commit the acquiring management to close the target firm at the value-maximizing demand level. Second, our theory says that firms with sufficiently high debt adopt an efficient closure policy. Low-debt firms are therefore more likely to be takeover targets than levered firms – there is no need for takeovers as a mechanism for enforcing efficient disinvestment if debt is set and held at the right level. That is why debt financing can serve as an effective takeover defense. Our analysis of takeovers will therefore focus on unlevered firms.

3 Disinvestment forced by takeovers

We have shown that inside managers not only extract rents from unlevered or underlevered companies, but also wait too long to close or shrink their firms when product demand declines. Now we consider whether takeovers can enforce efficient disinvestment. We assume that acquirers face no costs of collective action. We also assume that acquisition happens by surprise:

Assumption 4 *The supply of bidders is limited by entry and setup costs. Once these costs are sunk, the bidder's cost of collective action is zero ($\alpha = 1$).*

Assumption 5 *Since the supply of bidders is limited, the target and the outside investors perceive the probability of attack to be negligibly small. The target will always be acquired by surprise.*[12]

Finally we specify how the payoffs to a takeover are shared between the target shareholders, the target managers and the bidder. If the firm is shut down, the target managers get nothing, because they have no property rights to the stock of capital. The value of the target firm is split between the target shareholders and the bidder. When the target is in play, its shareholders can hold out (note the Grossman and Hart (1980) free-rider problem) and push their equity value at least to $V(x, \underline{x})$, the full firm value prior to the takeover. In addition they may acquire a fraction $(1 - \gamma)$ of the value added $(V^o(x, \underline{x}^o) - V(x, \underline{x}))$:

Assumption 6 *Target shareholders receive $V(x; \underline{x})$, the target's overall value prior to the takeover, plus a fraction $(1 - \gamma)$ of $(V^o(x, \underline{x}^o) - V(x, \underline{x}))$, the value that can be created by the takeover.*

We now consider takeovers by raiders, by other firms, management buyouts and "mergers of equals."

[12] This assumption is not strictly necessary. Suppose that managers are forewarned that a raider is lurking. The only actions that the target firm's managers could take are (1) increase debt to D* and (2) reduce capture of the firm's cash flows. We rule out (1) by focusing on unlevered or underlevered firms. Action (2) is unlikely, because managers have no incentive to reduce capture at demand levels above the point where the raider intervenes, and at that point the firm is shut down anyway. The forewarning would give the target firm time to shore up its takeover defenses, however.

3.1 Raiders

A raider is a financial investor that can take over the firm but not manage it effectively. If a raider takes over before shutdown is called for, the raider must pay for management while waiting to see whether product demand falls to the shut-down level. If demand does not fall to this level, then the raider has to take the firm public again, at a selling price reflecting the new owners' cost of collective action. Of course the raider's inability to manage the firm is no problem if the raider waits until the firm can be shut down immediately after it is taken over. We show that this is the raider's optimal strategy.

If the raider takes over and successfully implements the first-best closure policy, the payoff is $\gamma\left(V^o(x,\underline{x}^o) - V(x,\underline{x})\right)$, which is positive. This payoff is the raider's compensation for acquiring and restructuring the firm. From our previous analysis we know that the raider's payoff is zero at $x = \underline{x}$, thereafter increases with x, reaches a maximum, subsequently decreases, and gradually goes to zero as $x \to +\infty$. We can then derive an interval $[\overline{x}_r\,,\,\underline{x}_r]$ within which it is optimal for the raider to acquire the firm. We show in the appendix that upon acquisition it is optimal for the raider immediately to close down the firm (even if the raider could manage the target effectively). The optimal takeover triggers $\overline{x}_r$ and $\underline{x}_r$ (with $\overline{x}_r < \underline{x}_r$) can be found by solving the raider's optimal stopping problem in the same way as in previous section. This gives us the following proposition.

Proposition 5 *If the initial level of demand is above the first-best closure threshold $\underline{x}^o$, then the raider waits, and takes over and closes down the firm only if demand falls to the first-best closure point $\underline{x}^o$. If the raider arrives when $x < \underline{x}^o$, then the raider acquires and immediately shuts down the target as soon as demand enters the interval $[\overline{x}_r, \underline{x}^o]$.*

Proposition 5 says that in a declining market the raider acquires and restructures the firm at the efficient time. The first-best closure policy maximizes the raider's takeover surplus $\gamma\left(V^o(x;\underline{x}^o) - V(x,\underline{x})\right)$. It is not surprising that the raider closes the firm at the first-best level $\underline{x}^o$. But, why does the raider not acquire the target before $\underline{x}^o$? The intuitive explanation is that as long as the state variable exceeds the optimal closure point, it does not make any difference for the raider whether or not it has acquired the target.[13] The raider has no incentive to acquire the target early, and may indeed lose money if he or she cannot manage the target efficiently. The raider also loses if demand recovers and the firm has to be taken public again. The raider's best strategy is to take over when it is also optimal to shut down.

If the raider arrives on the scene when demand is less than $\underline{x}^o$, the first-best outcome obviously cannot be achieved, because the takeover is already overdue. If demand is in the range $\overline{x}_r \leq x \leq \underline{x}^o$, the raider will take over the firm and shut it down immediately. If demand is between $\underline{x}$ and $\overline{x}_r$, the raider will wait. The firm will either be closed down by the target's management at $\underline{x}$, or be acquired by the raider at $\overline{x}_r$, depending on which of the two thresholds is hit first.

Why does the raider, who is only interested in the financial payoff, end up maximizing the sum of the value to investors and the value to managers? The reason is that $R(x, \underline{x}^o) = 0$ at the optimal shutdown point $x = \underline{x}^o$, so $V^o = E^o$. But note that the raider does have to buy out $R(x, \underline{x})$, the value of the rents that the target management would have received absent the takeover. Unfortunately for the managers, the buyout proceeds do not go to the managers but to the target shareholders, who can hold up the bidder for at least the full value of the target firm under existing management. That is, the bidder pays $V(x, \underline{x}) = R(x, \underline{x}) + E(x, \underline{x})$ plus the fraction $1 - \gamma$ of the value added.

The target managers may regard the loss of $R(x, \underline{x})$ as a breach of trust of the sort described by Shleifer and Summers (1988). The breach is efficient, however. If the breach is regarded as unfair, then the unfairness can be traced back to the difficulty of writing and enforcing the value-maximizing employment contract, which would require managers to close down at the optimal demand level $\underline{x}^o$.

Suppose that we interpret $R(x, \underline{x})$, the present value of managers rents, as the payoff to investment in firm-specific human capital. The investment is made when prospects are bright, that is, when $x > \underline{x}^o$. At that point the payoff to human capital investment is *greater* if the managers could commit to abandon at $\underline{x}^o$ rather than $\underline{x}$. That is $R(x, \underline{x}^o) > R(x, \underline{x})$ when

[13] We assume, of course, that the raider cannot be preempted by other raiders. We consider preemption shortly.

$x > \underline{x}^o$. Therefore the ex-ante incentive to invest in firm-specific human capital is *greater* if raiders can intervene ex post than if raiding is prevented by law or regulation. Raiders may disappoint managers ex post, but free entry by raiders increases ex ante value to both managers and investors. Shleifer and Summers (1988) say that a raider could take over a firm not in order to shrink its assets, but simply to capture the rents going to incumbent managers. This cannot happen in our model, because the rents are shifted to target shareholders and not captured by the raider. (The Grossman-Hart (1980) holdup problem prevents hostile takeovers motivated solely by rent-seeking.) But we agree with Shleifer and Summers that a large part of the stock-market gains to merger announcements represent transfers from other stakeholders.

Our comments about breach of trust also apply to takeovers by other firms, which we turn to now.

3.2 Hostile Takeovers

We first consider the case where firm A can acquire firm B, but not the other way around. Next, we analyze the case where A and B can acquire each other. We refer to these cases as "one-way" and "two-way" takeovers, respectively. In both cases we ignore possible synergies from combining the firms' operations, and assume that the only opportunity to add value is by forcing the target firm to shut down.

3.2.1 One-way Takeovers

Assume for now that firm A can acquire firm B, but not the other way around. The price that A must pay to B's shareholders is $V_B(x;\underline{x}) + (1-\gamma)\left(V_B{}^o(x,\underline{x}^o) - V_B(x,\underline{x})\right)$, just as in the raider case. A's managers receive the fraction γ of the value created.

If firm A acts like a raider and acquires and closes down the firm at the first-best closure point, then its shareholders are not harmed:

Proceeds to acquiring shareholders

$$
\begin{aligned}
&= \text{acquisition proceeds} - \text{payment to target shareholders} - \text{payment to acquiring management} \\
&= K - [V_B(\underline{x}^o, \underline{x}) + (1-\gamma)(V_B{}^o(\underline{x}^o, \underline{x}^o) - V_B(\underline{x}^o, \underline{x}))] - \gamma (V_B{}^o(\underline{x}^o, \underline{x}^o) - V_B(\underline{x}^o, \underline{x})) \\
&= K - V_B{}^o(\underline{x}^o, \underline{x}^o) = 0
\end{aligned} \tag{10}
$$

In other words, the takeover is zero-NPV for the acquiring shareholders, because all value created is shared between the target shareholders and the acquiring management. (Management could share its gains with its shareholders, but has no reason to do so.)

The acquirer's payoff is exactly the same as in the raider case, and we therefore obtain the same optimal acquisition threshold. However, there is a potential difference with respect to the closure policy. The raider always closes the target immediately after takeover,but the management of an acquiring company may not follow through. Once the takeover has been paid for and is a "done deal," A's managers are better off if they take the place of B's managers and continue to capture the cash flows generated by B's assets. How then can hostile takeovers lead to efficient disinvestment?

The first (partial) answer is that A's stockholders will prevent a takeover unless A's management makes a credible commitment to shut down B. Suppose that A acquires B, at a demand level $x \geq \underline{x}^o$. Investors realize that B will be shut down too late, at a demand level $\underline{x}_B < \underline{x}^o$. The payoff to the acquiring shareholders is:

$$
\begin{aligned}
&\text{Proceeds to acquiring shareholders} \\
&= \text{acquisition proceeds} - \text{payment to target shareholders} - \text{payment to acquiring management} \\
&= V_B(x, \underline{x}_B) - [V_B(x, \underline{x}) + (1-\gamma)(V_B{}^o(x, \underline{x}^o) - V_B(x, \underline{x}))] \\
&\quad - [\gamma (V_B{}^o(x, \underline{x}^o) - V_B(x, \underline{x})) + R_B(x, \underline{x}_B)] \\
&= E_B(x, \underline{x}_B) - V_B{}^o(x, \underline{x}^o) < 0
\end{aligned}
$$

In other words, the acquiring shareholders would receive the target's existing equity value, $E_B(x, \underline{x})$, but pay the first-best firm value, $V_B{}^o(x, \underline{x}^o)$. This would reduce their equity value and trigger collective action against A's managers. Therefore the takeover could not take place.

The second answer is that debt financing may provide a bonding mechanism to force shutdown. Managers could finance the takeover by the amount of debt that pre-commits them to shut down the firm immediately after the takeover. We know from previous section that such a debt level always exists, because the closure threshold is monotonically increasing in the level of debt when equity issues are restricted. This may be one explanation for leveraged buyouts, for example.

Our results can be summarized in the following proposition.

Proposition 6 *If firm A can acquire firm B, but not vice versa, then the timing of the takeover is the same as in the raider case; acquisition happens at the first-best closure point. But once the takeover has been paid for, the acquiring managers may keep the target in business instead of releasing its stock of capital to the outside investors. This problem can be eliminated by financing the takeover at the debt level that forces the target to be closed at the efficient time.*

3.2.2 Two-way Takeovers

Consider next the case where both firm A and firm B can acquire each other. We introduce the following assumption.

Assumption 7 *Managers only acquire the target if the payoff from closing down the target is positive.*

This assumption rules out preemptive takeovers that happen purely out of self-defense and for which closing the target destroys value. The assumption requires that the payoff from closure is positive (i.e. $K - V_B(x) \geq 0$) and that only takeovers that are inherently value-increasing (or value-neutral) are possible. The rationale for this assumption is developed in the appendix.

From our previous analysis we know that there exists for each firm a breakeven point, ${x_i}^*$ (i = A,B) such that $V_i({x_i}^*, \underline{x}_i) = K$ (with $\underline{x}_i < {x_i}^*$). The breakeven threshold is determined by:

$$K - V_i(x, \underline{x}_i) > 0 \text{ for all } x \in]\underline{x}_i, {x_i}^*[\ (i = A, B) \tag{11}$$

When demand falls in the interval $[\underline{x}_i, x_i^*]$, acquiring firm i and closing it down is positive-NPV. Assume, without loss of generality, that $x_B^* > x_A^*$ and that the initial level of demand exceeds x_B^*. Which firm will then be the acquirer, and at what demand level does the takeover happen? The answer to the first question is that the firm with the lowest breakeven threshold, x_i^* (in our case, firm A) will be the acquirer. As demand declines, acquiring firm B becomes a positive-NPV action for firm A at x_B^* before B can acquire A at x_A^*. The firm with the lowest breakeven threshold can therefore always preempt its opponent, if necessary.

At what level of demand will firm A acquire firm B? Ideally, A would acquire B at B's first-best disinvestment threshold, $\underline{x}_B{}^o$ (See Proposition 5 for the raider case.) However, the threat of a preemptive takeover by B could speed up a takeover by A. If A's breakeven point exceeds B's optimal disinvestment threshold ($x_A^* > \underline{x}_B{}^o$) then B has an incentive to "epsilon preempt" firm A at $\underline{x}_B{}^o + \epsilon$. This in turn would encourage A to preempt B at $\underline{x}_B{}^o + 2\epsilon$, and so on. Therefore, if $x_A^* > \underline{x}_B{}^o$, in equilibrium firm A acquires B when x equals x_A^*, which is the point where preemption by B is no longer profitable or feasible (see assumption 7). If, however, $x_A^* < x_B{}^o$, then there is no danger that B may preempt A, and A acquires B at $\underline{x}_B{}^o$. If upon acquisition the firm gets closed immediately, we have the following proposition:

Proposition 7 *If x_i^* is defined as the breakeven point at which firm i's value equals its capital stock ($V_i(x_i^*, \underline{x}_i) = K_i$, $i = A, B$), then the acquirer is the firm with the lower breakeven point, and the target is the firm with the higher breakeven point. The firm whose asset value drops first below the value of its stock of capital gets acquired by its opponent. The takeover threshold is given by:*

$$\begin{aligned} &\max[\underline{x}_B{}^o, x_A^*] \quad \text{if} \quad x_A^* \leq x_B^* \\ &\max[\underline{x}_A{}^o, x_B^*] \quad \text{if} \quad x_B^* < x_A^* \end{aligned} \tag{12}$$

Therefore corporate restructurings induced by hostile takeovers either happen at the efficient time or inefficiently early.

Note that, as in the one-way takeover, outside equityholders of the acquiring firm are faced with a holdup problem in that it is not sure whether management closes the target after the takeover. As in the one-way takeover case, debt can again act as a bonding device. Complications could, however, arise if, because of the threat of preemption, the takeover happens before the optimal closure point. If the takeover can be financed by the optimal debt level ${D_B}^*$ then this should in principle induce management to close the target at the optimal closure point ${\underline{x}_B}^o$. However, management could in the run-down to closure use the income from the more profitable firm A to soften the disciplining effect of the debt level ${D_B}^*$. This could lead to B being closed inefficiently late (see Lambrecht and Myers (2004) for more details). Outside equityholders may in that case require a higher debt level or even impose a debt level that forces management to close down the target immediately after the takeover.

Finally, it is worth pointing out that, all else equal, the firm with the highest cost of collective action (i.e., the lowest α) is the takeover target, and the firm with the lowest cost of collective action (highest α) is the acquirer. The reason is that a higher cost of collective action causes the firm to be closed inefficiently late by its managers, which decreases the firm's value $V(x, \underline{x})$ from its first-best value, $V^o(x, \underline{x})$.

3.3 Management Buyouts

Instead of collecting as many rents as possible and closing down the firm inefficiently late (at $\underline{x}$), managers could organize a management buyout (MBO). They will do so at a given demand level x if and only if the net proceeds from a buyout exceed the present value of all remaining rents to be collected:

$$\gamma \left(V^o(x; \underline{x}^o) \; - \; V(x; \underline{x})\right) \; > \; R(x; \underline{x}) \tag{13}$$

We know from the raider and takeover cases that there exists a breakeven threshold, x^*, such that $\gamma \left(V^o(x; \underline{x}^o) \; - \; V(x; \underline{x})\right) \; \geq \; 0$ for all $x \in [\underline{x}, x^*](x > x^*)$. The difference between takeover by a raider or another firm and a MBO is that the managers in a MBO forgo future rents after a buyout, while a raider or another firm has nothing to lose. It follows that managers in an MBO have an incentive to acquire the firm at a later point than a raider would. One can show that there exists a breakeven threshold x^{**} with $x^{**} < x^*$ such that:[14]

$$\gamma\left(V^o(x;\underline{x}) - V(x;\underline{x})\right) - R(x;\underline{x}) \geq 0 \quad \text{for} \quad x \in [\underline{x}, x^{**}] \tag{14}$$

Management therefore only wants to close the firm if it is sufficiently close to the shut down point $\underline{x}$. We can then prove the following proposition:

Proposition 8 *When demand is sufficiently close to the management's closure point $\underline{x}$, insiders prefer to organize a management buyout rather than to collect remaining rents before closure at $\underline{x}$. The threshold, $\underline{x}_{mb}$ at which the insiders optimally buy out the firm and close it is, however, inefficiently late as $\underline{x} \leq \underline{x}_{mb} < \underline{x}^o$. Management prefers to collect rents as long as x exceeds $\underline{x}_{mb}$ and undertakes a buyout only when x enters the interval $[\underline{x}, \underline{x}_{mb}]$.*

What is the intuition behind the result that management prefers a buyout in the run-up to closure? Consider the situation where the state variable is ϵ above the closure point. In that case the present value of the managerial rents is approximately zero, because $R(x;\underline{x})$ smooth-pastes to the zero value line at the closure point ($R'(\underline{x};\underline{x}) = 0$). But the managers' payoff from a buyout has a strictly positive slope at the closure point ($\frac{\partial\gamma(V^o(x,\underline{x}^o) - V(x,\underline{x}))}{\partial x}\Big|_{x=\underline{x}} > 0$). Consequently management will always prefer a buyout just before closure. The reason is that a buyout allows management to capture part of the value created, and hence part of the firm's stock of capital (and this for a price less than the capital's intrinsic value). Absent a buyout the stock of capital is all paid out to the outside shareholders. Management closes the firm later than a raider or another firm, because upon closure it is giving up all remaining rents. An acquirer does not sacrifice any rents.

MBOs undertaken to shrink or shut down the firm should not occur if takeovers by raiders or another firm are allowed. The raiders or other firm would act first as demand declines. However, MBOs often involve partial buyouts, which may be more difficult to achieve through takeovers as takeovers typically require the whole firm to be bought.

[14]This result follows from the fact that $R(\underline{x};\underline{x}) = 0$, and $R'(x;\underline{x}) > 0$ for all $x > \underline{x}$.

3.4 Mergers

Suppose A and B join in a "merger of equals." We assume that the merger does not create any synergies. In a merger of equals, the target firm B is not in play, and the target shareholders do not receive a bid premium. Since R_A and R_B are already the maximum rents that insiders can extract from each firm, $R_A(x) + R_B(x)$ is the most that the managers of A and B can achieve jointly. By merging, the managers simply combine and redistribute the existing rents. Managers do not have an incentive to close down either firm, because closure would require payout of the stock of capital.

The managers of firm A will consider a merger, instead of a hostile takeover, only if the present value of the joint rents is larger than the payoff from a takeover:

$$R_A(x) + R_B(x) > R_A(x) + \gamma\,(K - V_B(x; \underline{x}_B)) \tag{15}$$

$$R_B(x) > \gamma\,(K - V_B(x; \underline{x}_B)) \tag{16}$$

In other words, the rent value $R_B(x)$, which would captured by target shareholders in a takeover, but is retained by managers in a merger, has to exceed the acquiring firm's gain in a hostile takeover.

The decision whether to merge or to acquire is similar to the management's decision whether to keep collecting rents or to buy out the firm in a MBO. It follows from the analysis of the MBO case that there exists a threshold x^{**} such that for all x below (above) x^{**} firm A prefers to acquire (merge with) firm B.

If A can undertake a hostile takeover, then firm B's rents have to be redistributed in a merger. A's managers will demand at least $\gamma\,(K - V_B(x; \underline{x}_B))$. Only the remaining value $(R_B(x) - \gamma\,(K - V_B(x; \underline{x}_B)))$ could be shared with the target management. Therefore the target management always loses out in a merger, and resists a merger as long as possible. The managers of the target firm B refuse to merge until A's threat to acquire B is credible. We know from proposition 7 that A would acquire B at $\max[\underline{x}_B{}^o, x_A{}^*]$ (prior to this point A's threat to acquire B is not credible), and only at this point will B accept the merger. Whether A prefers a merger to a takeover at this point is determined by the inequality (16).

If A decides to merge, it can make a take-it-or-leave-it offer to the management of B, in which B gets a modest golden parachute payment. (Note that A has all the bargaining power.) We summarize these results in the following proposition:

Proposition 9 *There is a breakeven demand threshold x^{**}, such that for all levels of demand below (above) x^{**} the acquiring management prefers a hostile takeover (merger), where x^{**} is the solution to the equation $R_B(x^{**}) = \gamma(K - V_B(x^{**}; \underline{x}_B))$. The takeover or merger happens at the point where A would acquire B (as given in Proposition 7). A takeover (merger) occurs if the restructuring takes place at a state variable level below (above) x^{**}. In a hostile takeover, the target is closed down immediately. In a non-synergistic merger the managers' closure policies are maintained.*

3.5 A comparison of takeover mechanisms

We are now in a position to compare takeover mechanisms and to draw implications. We start by comparing the takeover timing and closure policies across the four takeover mechanisms studied. The takeover thresholds for a raider, hostile takeover, management buyout and merger are $\underline{x}_r$, $\underline{x}_{ht}$, $\underline{x}_{mb}$ and $\underline{x}_{ht}$, respectively. (Mergers occur at the time when a hostile takeover becomes credible. Thus the threshold for a merger is $\underline{x}_{ht}$.) Recall also that the first-best and the managers' closure policies are given by the demand thresholds $\underline{x}^o$ and $\underline{x}$, respectively.

Table 1 summarizes the main results: Raiders are first-best. Hostile takeovers are second-best: closure (and takeover) happen either at the efficient time, or inefficiently early if there is an incentive to preempt. Management buyouts come third: closure happens inefficiently late, but still at a higher level of demand than the level that forces managers to shut down. Closure is least efficient in mergers, since the managers' policies remain in place, and the managers collect rents for as long as possible.[15]

[15]These results are the opposite of Lambrecht (2004) where mergers are first-best and hostile takeovers take place inefficiently late. In his model there are, however, no managerial agency costs and mergers are motivated by synergies instead. In the absence of any frictions it follows from Coase theorem that both

Table 1: Takeover and closure thresholds: a comparison across takeover mechanisms

	takeover threshold	**closure threshold**
raider	$\underline{x}_r = \underline{x}^o$	first-best (at $\underline{x}^o$)
hostile takeover	$\underline{x}^o \leq \underline{x}_{ht}$	first-best (at $\underline{x}^o$) or too early (at $\underline{x}_{ht}$)
management buyout	$\underline{x} \leq \underline{x}_{mb} < \underline{x}^o$	inefficiently late (at $\underline{x}_{mb}$)
merger	$\underline{x}^o \leq \underline{x}_{ht}$	inefficiently late (at $\underline{x}$)

Several empirical or policy implications can be drawn from our analysis.

1. Raiders and possibly also hostile takeovers improve efficiency by forcing closure of the target firm at the correct level of demand. Acquiring managers and target shareholders are the main beneficiaries. The total gains to target and acquiring shareholders overstates the value added by hostile takeovers, however, because the target shareholders gain at the target managements' expense.

2. Non-synergistic mergers are a management-friendly alternative to hostile takeovers. These mergers redistribute rents between the acquiring and the target managements, but do not lead to more efficient closure. "Friendly" mergers also have a hostile side, however, because the target management only agrees to a merger when a hostile takeover by the other firm becomes credible.

3. Hostile takeovers are more likely to occur when few managerial rents remain to be collected in the target and when the acquiring management is capable of capturing a relatively large fraction (γ) of the value created. Mergers are more likely to occur in situations where there are still significant rents to be collected and/or in situations where the acquiring firm would have to pay too high a bid premium (γ is small). We expect target firms in hostile takeovers to be closer to voluntary shutdown than target firms in mergers.

managements should be able and willing to merge at the first-best point as this optimizes the total merger surplus. In a hostile takeover, however, target shareholders can hold out and demand a bid premium. This bid premium is internalized by the acquirer as an extra cost, and causes takeovers to take place inefficiently late.

4. We expect mergers between firms that are equal or similar (particularly in terms of how efficiently they are run). Hostile takeovers are more likely to involve firms that are different. When firms are similar, say identical for argument's sake, then preemptive motives become important and can speed up the takeover. Managers will prefer merging to a hostile takeover when ample rents remain to be collected, and when demand is still relatively high.

5. MBOs should not occur in the presence of raiders, hostile takeovers or mergers, since these takeover types are triggered at higher levels of demand.

6. Firms with significant debt (and no way to cover debt service with equity issues) are less likely to be a takeover targets.

7. Hostile takeovers may be financed by debt to ensure that the acquiring management does not merely replace the target management, but closes the target after the restructuring.

8. Hostile takeovers, especially by raiders, generate significant positive returns for target shareholders. MBOs generate smaller, but positive, returns to the target shareholders. Non-synergistic mergers generate zero returns for the acquiring and target shareholders. A raider or hostile acquirer (if present) could therefore "win" in a competition with a MBO or merger.

4 Conclusions

This paper starts with the observation that disinvestment in declining industries is usually accompanied by – and apparently forced by – takeovers. We decided to explore such takeovers theoretically. To do so we made several modeling choices.

1. We assumed that the firm's managers act as a coalition in their own self interest. They maximize the present value of future managerial rents, that is, the value of their capture of the firm's future operating cash flows. Their rents are constrained by outside investors' ability to take control of the firm and its assets if the investors do not receive an adequate rate of return. We assume that their rate of return comes from payout of cash to investors. Managers close the firm when the burden of paying out cash to investors overcomes their

reluctance to leave the firm and give up the chance of future managerial rents.

2. Investors can exercise their property rights only after absorbing a cost of collective action. This cost creates a gap between the overall value of the firm and its value to investors. The gap allows the managers to capture part of the firm's operating cash flows. That capture is not necessarily inefficient, because managers may contribute human capital that is specialized to the firm. Managerial rents can provide a return on that capital. Nevertheless, the managers' reluctance to give up their rents leads them to shrink or shut down the firm too late, at a demand threshold lower than the first-best threshold. Closure at the first-best threshold maximizes the sum of the values of the managers' and investors' claims. Just maximizing shareholder value is not efficient when the firm's cash flows and value are shared between managers and investors.

3. We built a dynamic, infinite-horizon model incorporating the option to abandon the firm and release its assets to investors. The model is similar to real-options analyses of abandonment, except that the *managers* decide when to exercise. The infinite (or indefinite) horizon is necessary to support outside equity financing.[16] The demand for the firm's products is treated as a continuous stochastic state variable. The continuity of demand is important, because it allows us to distinguish several cases in a common setting. For example, we can compare managers' demand thresholds for closure to the thresholds for takeover and closure by raiders or by other firms in hostile takeovers or mergers. We can see how these thresholds depend on investors' costs of collective action, the drift and variance of demand and the fixed costs of continuing to operate the firm. We could not have done all these analyses in a matchstick model with two or three dates and two or three discrete demand levels.

Our model generates the predictions about takeovers that are summarized at the end of the last section. The model also generates new predictions about payout policy and the links between debt and disinvestment.

As far as we know, our characterization of optimal payout policy (optimal for the managers) is a new theoretical result. The firm's payout policy has two regimes. When times

[16] See Fluck (1998) and Myers (2000).

are good and demand is high, managers pay out a constant fraction of operating cash flow. The payout fraction is decreasing in the outsiders' cost of collective action. When times are bad and demand is low, dividends are cut to a constant, minimum level, which continues until the firm is either closed or recovers to the point where dividends are again linked to operating cash flow. In some cases the minimum dividend is negative, that is, managers can get away with cutting dividends to zero and also issuing shares. We constrast this case with the case where investors refuse to provide fresh equity and payout is constrained at zero.

If equity issues are allowed in bad times, the level of debt financing is irrelevant. Managers pay debt service from the cash that would otherwise be paid out to equity investors. Managers simply pass on the burden of debt to the shareholders. But if the shareholders refuse to provide new equity, and enough debt is issued, then debt service comes at the margin out of managers' pockets. The debt service reduces managerial rents in bad times and forces managers to close the firm earlier. There exists an optimal debt level D^* that maximizes overall firm value by forcing managers to implement the first-best closure policy. This debt level D^* is dynamically optimal, but independent of the level of demand. D^* is a fraction of the book (liquidation) value of the firm's assets. It is not linked to the firm's market value.

We believe that this characterization of optimal debt policy is a new theoretical result. None of the standard theories of capital structure prescribes debt linked to the liquidation value of the firm's assets rather than the market value of the going concern. Our analysis of financing will require further thought and elaboration, however. For example, it is not clear whether managers could credibly commit to (or be forced to) maintain the optimal debt level as demand falls and the threat of closure increases. The assumed prohibition on equity issues likewise deserves further attention. The prohibition is in shareholders' interest, and could be enforced by contract or by a board of directors.[17]

[17] We do not see explicit contracts restricting equity issues, but additional shares have to be "authorized" by existing stockholders before the shares are sold to investors.

5 Appendix: Proofs

Proof of proposition 2

The dividend policy for $x \geq \underline{x}^o$ (i.e. when insiders operate under the constraint $E \geq \alpha V^o$) is straightforward. $V^o(x)$ is the present value of receiving $K\,x - f$ till $\underline{x}^o$ is hit. Hence, a dividend policy that pays a fraction α of the cash-flows ensures that $E(x) = \alpha V^o(x)$ for $x \geq \underline{x}^o$.

The payout policy for $x \leq \underline{x}^o$ (i.e. when insiders face the constraint $E \geq \alpha K$) is similar to the one derived in Myers (2000). The payout policy can in general be written as $\eta K x + \phi r \alpha K$. It is clear that (to prevent collective action) the variable dividend component ($\eta K x$) and the fixed component ($\phi r \alpha K$) can be substituted against each other. A smaller slope implies a larger dividend cut at $\underline{x}^o$ but larger dividends in the run-down to closure, which in turn speed up closure. An increase in the closure threshold, however, raises the total firm value (since $\underline{x} < \underline{x}^o$). Since at the first-best closure threshold $\underline{x}^o$ the outside equity value is fixed at αK (i.e. $E(\underline{x}^o) = \alpha K$) it follows that at $\underline{x}^o$ any increase in firm value goes to the insiders and hence $\frac{\partial R(\underline{x}^o)}{\partial \eta} < 0$. This means that management wants the variable component to be as small (negative) as possible. However, a negatively sloped payout policy implies that management wants a low (or negative) payout for high x, with a promise to pay a higher payout in the run-down to closure. As the dividend policy gets more and more negatively sloped, this precipitates closure, bringing it forward towards the first-best closure point $\underline{x}^o$. In the limit, the dividend policy would become a vertical line at $\underline{x}^o$. It would involve a massive equity issue (negative dividend) at $\underline{x}^o$ for some amount A, immediately followed by a massive positive dividend $A - (1 - \alpha)K$, upon which the firm would be closed and the stock of capital would be returned. This payout policy is similar in spirit to inside management closing the firm at $\underline{x}^o$ in exchange for a payment equal to $(1 - \alpha)K$, which is in violation with our assumption that property rights cannot be infringed upon through blackmail. Moreover, even if outsiders were willing to accept the equity issue, they would face a holdup problem since there is no guarantee that insiders would close the firm immediately after the equity has been issued. Analogously, any other negatively sloped payout policy is not feasible as management's promise to "make up" in the run-down to closure is not credible. Consequently, zero is the lowest value for η that is acceptable to outsiders. The optimal dividend policy is therefore of the form $\phi r \alpha K$.[18]

[18] This payout policy can be compared to the one derived in Myers (2000). He finds that if collective action always involves closure then the payout policy equals $r\alpha K$.

Once management has cut dividends to $\phi r \alpha K$ at $\underline{x}^o$, it cannot reduce dividends further in the run-down to closure without triggering collective action. This ensures that the dividend policy remains dynamically optimal over time.

The solutions for $E(x)$ and $R(x)$ follow directly from solving the following value matching conditions for A_e and B_e:

$$\begin{aligned} E(\underline{x}) &= \phi \alpha K + A_e \underline{x}^{\lambda} + B_e \underline{x}^{\beta} = K \\ E(\underline{x}^o) &= \phi \alpha K + A_e \underline{x}^{o\lambda} + B_e \underline{x}^{o\beta} = \alpha V^o(\underline{x}^o) \end{aligned} \tag{17}$$

The below smooth-pasting conditions identify $\underline{x}$ and ϕ:

$$\begin{aligned} \lambda A_e(\underline{x}, \phi) \underline{x}^{\lambda-1} + \beta B_e(\underline{x}, \phi) \underline{x}^{\beta-1} &= V'(\underline{x}) \\ \lambda A_e(\underline{x}, \phi) \underline{x}^{o\lambda-1} + \beta B_e(\underline{x}, \phi) \underline{x}^{o\beta-1} &= \alpha V^{o'}(\underline{x}^o) \end{aligned} \tag{18}$$

Note that the latter conditions are optimality conditions, where $\underline{x}$ and ϕ are optimally chosen by the management. The value-matching condition guarantees that the cost of collective action constraint is binding at $\underline{x}^o$ since $E(\underline{x}^o) = \alpha V^o(\underline{x}^o) = \alpha K$, which implies that the dividend parameter ϕ cannot be lowered any further without triggering collective action. Note that the no-arbitrage constraint rules out the possibility that the outside equity value equals αK in the run-down to closure (as this would cause the outside equity value to jump from αK to K at closure).

$\underline{x}^o$ is the management's optimal dividend switch. Indeed, raising the dividend switch raises the equity value above $\alpha V^o(x)$ to the right of $\underline{x}^o$, leaving management worse off. On the other hand, lowering the dividend switch below $\underline{x}^o$ causes the constraint $E \geq \alpha \max[V^o, K] = \alpha K$ to be violated (in particular this would lead to $E(\underline{x}^o) < \alpha K$).

When $\alpha = 1$ then $\underline{x}^o = \underline{x}$. Indeed, in that case the collective action constraint becomes: $E(x) \geq \max[V^o(x), K] = V^o(x)$. Consequently, the equity value equals the first best firm value ($E(x) = V^o(x)$) and the closure policy therefore has to be first best. When, however, the cost of collective action is positive (i.e. $\alpha < 1$) then the collective action constraint relaxes, allowing the equity value to fall below the first best firm value. This enables management to delay closure beyond the first-best closure point.

Proof of proposition 3

When the collective action constraint is given by $E \geq \alpha K$ we have the continuous-time version of Myers (2000). If the dividend flow is denoted by d, then the equity value satisfies the following differential equation:

$$r\hat{E}(x) \;=\; \frac{1}{2}\sigma^2 x^2 \frac{\partial^2 \hat{E}(x)}{\partial x^2} \;+\; \mu x \frac{\partial \hat{E}(x)}{\partial x} \;+\; d \tag{19}$$

The general solution to the above differential equation is:

$$\hat{E}(x) \;=\; \frac{d}{r} \;+\; \hat{A}_e\, x^{\lambda} \;+\; \hat{B}_e\, x^{\beta} \tag{20}$$

Management pays the required dividend flow for as long as the state variable exceeds some closure threshold, $\hat{\underline{x}}$. Upon closure the stock of capital is returned in its entirety to the shareholders. Apart from the dividends and the release of capital, no other cash flows accrue to the outside equity holders. This leads to the following boundary conditions:

$$\lim_{x \to +\infty} \hat{E}(x) \;=\; \frac{d}{r} \quad \text{and} \quad \hat{E}(\hat{\underline{x}}) \;=\; K \tag{21}$$

These two boundary conditions determine the constants A and B. Solving gives:

$$\hat{E}(x) \;=\; \frac{d}{r} \;+\; \left(K \;-\; \frac{d}{r}\right)\left(\frac{x}{\hat{\underline{x}}}\right)^{\lambda} \tag{22}$$

Finally, the dividend flow, d, is determined by the condition that $\hat{E}(x) \geq \alpha K$ at all times; i.e. the dividend flow should be high enough to prevent the outside equity holders from taking collective action. It is easy to see that $\hat{E}(x)$ is decreasing in x and reaches a minimum at $x = +\infty$. Consequently,

$$\lim_{x \to +\infty} E(x) \geq \alpha K \iff \frac{d}{r} \geq \alpha K \iff d \geq r\alpha K \tag{23}$$

Hence, $r\alpha K$ is the lowest dividend flow that ensures that outsiders never take collective action. Indeed, a lower dividend level would mean that the outside equity value falls below $\alpha\, K$ for sufficiently high values of x and that outsiders would take collective action.

Proof of proposition 4

The proof is entirely analogous to the one for proposition 2 except that the boundary conditions are different. Namely, A_e and B_e are the solutions to the value-matching conditions:

$$\begin{aligned} E(\underline{x}) \;&=\; A_e \underline{x}^{\lambda} \;+\; B_e\, \underline{x}^{\beta} \;=\; K \\ E(\tilde{x}) \;&=\; A_e \tilde{x}^{\lambda} \;+\; B_e\, \tilde{x}^{\beta} \;=\; \alpha V^o(\tilde{x}) \end{aligned} \tag{24}$$

where $\underline{x}$ and $\tilde{x}$ are the solution to the smooth-pasting conditions:

$$\begin{aligned} \lambda\, A_e\, \underline{x}^{\lambda-1} \,+\, \beta\, B_e\, \underline{x}^{\beta-1} &= V'(\underline{x}) \\ \lambda\, A_e\, \tilde{x}^{\lambda-1} \,+\, \beta\, B_e\, \tilde{x}^{\beta-1} &= \alpha V^{o'}(\tilde{x}) \end{aligned} \tag{25}$$

Proof of proposition 5

The raider maximizes its payoff from restructuring the target by implementing the first-best closure policy. This payoff (denoted $S_r(x)$) is given by:

$$\begin{aligned} S_r(x) &= \gamma\,(V^o(x,\underline{x}^o) \,-\, V(x,\underline{x})) \\ &= \gamma\left(A(\underline{x}^o)x^\lambda \,-\, A(\underline{x})x^\lambda\right) && \text{for}\quad \underline{x}^o \,<\, x \\ &= \gamma\left(K \,+\, \tfrac{f}{r} \,-\, \tfrac{kx}{r-\mu} \,-\, A(\underline{x})x^\lambda\right) && \text{for}\quad \underline{x} < x \le \underline{x}^o \\ &= 0 && \text{for}\quad x \le \underline{x} \end{aligned}$$

When $x > \underline{x}^o$ then the raider's acquisition option is given by:

$$\begin{aligned} OS_r(x) &= \gamma\left(A(\underline{x}^o)\underline{x}^\lambda \,-\, A(\underline{x})\underline{x}^\lambda\right)\left(\frac{x}{\underline{x}}\right)^\lambda \\ &= \gamma\,(A(\underline{x}^o) \,-\, A(\underline{x}))\; x^\lambda \end{aligned} \tag{26}$$

It follows that for $x > \underline{x}^o$ the raider's takeover option is independent of the takeover threshold, $\underline{x}_r$, since the raider's surplus grows at the same rate as the discount rate. The raider therefore has no incentive to exercise its takeover option prior to $\underline{x}^o$.

Next, we derive the value of the takeover option when $x \le \underline{x}^o$.

A) Focussing first on the derivation of $\underline{x}_r$ (i.e. acquisition happens in a downward trend of the state variable) the raider's option to acquire has the following general solution $OS_r(x) \;=\; B\,x^\lambda$, where the constant B is determined by the following value matching condition:

$$OS_r(\underline{x}_r) \;=\; \gamma\left(\left[K \,+\, \frac{f}{r} \,-\, \frac{K\underline{x}_r}{r-\mu}\right] \,-\, A(\underline{x})\,\underline{x}_r{}^\lambda\right) \;=\; B\,\underline{x}_r{}^\lambda \qquad \text{for}\;\; \underline{x} \le \underline{x}_r \,\le\, \underline{x}^o \tag{27}$$

Solving for B gives:

$$OS_r(x) \;=\; \gamma\left[K \,+\, \frac{f}{r} \,-\, \frac{K\underline{x}_r}{r-\mu}\right]\left(\frac{x}{\underline{x}_r}\right)^\lambda - \gamma\, A(\underline{x})\, x^\lambda \tag{28}$$

Optimizing with respect to $\underline{x}_r$ we find that $\underline{x}_r = \underline{x}^o$ where $\underline{x}^o$ is the first best closure threshold as defined in proposition 1.

B) Considering next the derivation of $\overline{x}_r$ (i.e. acquisition happens in an upward trend of the state variable with $\overline{x}_r < \underline{x}^o$) the option to exercise has the following general solution $OS_r(x) = C_1 x^{\lambda} + C_2 x^{\beta}$, where the constants C_1 and C_2 are determined by the following value matching conditions:

$$\begin{aligned} OS_r(\underline{x}) &= C_1 \underline{x}^{\lambda} + C_2 \underline{x}^{\beta} = 0 \\ OS_r(\overline{x}_r) &= C_1 \overline{x}_r{}^{\lambda} + C_2 \overline{x}_r{}^{\beta} = K - V(\overline{x}_r, \underline{x}) \end{aligned} \tag{29}$$

Finally, the optimal acquisition trigger, $\overline{x}_r$ is the solution to the following smooth-pasting condition:

$$OS_r'(\overline{x}_r) = \lambda C_1 \overline{x}_r{}^{\lambda-1} + \beta C_2 \overline{x}_r{}^{\beta-1} = -V'(\overline{x}_r, \underline{x}) \tag{30}$$

In conclusion the value of the raider's takeover option is given by:

$$\begin{aligned} OS_r(x) &= \gamma \left[V^o(x, \underline{x}^o) - V(x, \underline{x})\right] && \text{for} \quad \underline{x}^o < x \\ &= \gamma \left[K - V(x, \underline{x})\right] && \text{for} \quad \overline{x}_r \leq x \leq \underline{x}^o \\ &= \gamma \left[C_1 x^{\lambda} + C_2 x^{\beta}\right] && \text{for} \quad \underline{x} \leq x < \overline{x}_r \end{aligned}$$

where $\underline{x}$ is the target management's closure threshold, and C_1 and C_2 and $\overline{x}_r$ are determined by the boundary conditions given in the proof.

Proof of proposition 7

The proof is given in the main text. It is worth, however, to point out the importance of assumption 7 for deriving the result. Suppose that management B knows that it is under threat of being acquired at time t. Then it has the choice between preemptively acquiring the opponent, A, or being acquired, the payoffs being respectively $\gamma (K - V_A(x_t))$ and $-R_B(x_t)$. Hence, if $\gamma (K - V_A(x_t)) > -R_B(x_t)$ then management B would prefer acquiring to being acquired. Since $-R_B(x_t)$ is a negative number this means that management B would be willing to undertake value reducing takeovers (i.e. $0 > \gamma (K - V_A(x_t)) > -R_B(x_t)$) provided it is able to inject the money to cover the losses. Assumption 7 rules out this possibility. This could be justified on the grounds that managers are cash constrained and not capable to finance the takeover on their own account (the reason for this is that managers cannot sell their future rents to generate cash). Therefore only takeovers that are value increasing (or value neutral) are possible. The assumption also rules out the case where firms acquire each other in good times (i.e. $x > \underline{x}^o$) using debt financing merely to eliminate the threat of being taken over in the future.

Proof of proposition 8

We know from proposition 7 that a raider with payoff $\gamma\,(K - V(x;\underline{x}))$ acquires and restructures the firm at the efficient point, $\underline{x}^o$. The management's option to buy out the firm at $\underline{x}_{mb}$ can be written as:

$$\begin{aligned} OMB(x;\underline{x}_{mb}) &= \left[\gamma\,(K - V(\underline{x}_{mb};\underline{x})) - R(\underline{x}_{mb};\underline{x})\right]\left(\frac{x}{\underline{x}_{mb}}\right)^{\lambda} \\ &= \left[\gamma\left(K + \frac{f}{r} - \frac{K\underline{x}_{mb}}{r-\mu}\right) - R(\underline{x}_{mb};\underline{x})\right]\left(\frac{x}{\underline{x}_{mb}}\right)^{\lambda} - \gamma A(\underline{x})x^{\lambda} \end{aligned} \tag{31}$$

Optimizing with respect to $\underline{x}_{mb}$ and evaluating the first order condition at $\underline{x}^o$ gives:

$$\left[\gamma\frac{\partial\left(K + \frac{f}{r} - \frac{K\underline{x}_{mb}}{r-\mu}\right)\left(\frac{x}{\underline{x}_{mb}}\right)^{\lambda}}{\partial\underline{x}_{mb}} - \frac{R(\underline{x}_{mb};\underline{x})}{\partial\underline{x}_{mb}}\left(\frac{x}{\underline{x}_{mb}}\right)^{\lambda} - R(\underline{x}_{mb};\underline{x})\left(\frac{-\lambda}{\underline{x}_{mb}}\right)\left(\frac{x}{\underline{x}_{mb}}\right)^{\lambda}\right]\Bigg|_{\underline{x}_{mb}=\underline{x}^o} < 0 \tag{32}$$

The inequality follows from the fact that the first term is zero and the second and third term are negative. Consequently, $\underline{x}^o$ cannot be a maximum for $\underline{x}_{mb}$, and the optimal value for $\underline{x}_{mb}$ is situated to the left of $\underline{x}^o$.

Proof of proposition 9

The proof follows directly from proposition 8 and is described in the main text preceding proposition 9.

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Figure 1a: Total firm value (V) and outside equity value (E)

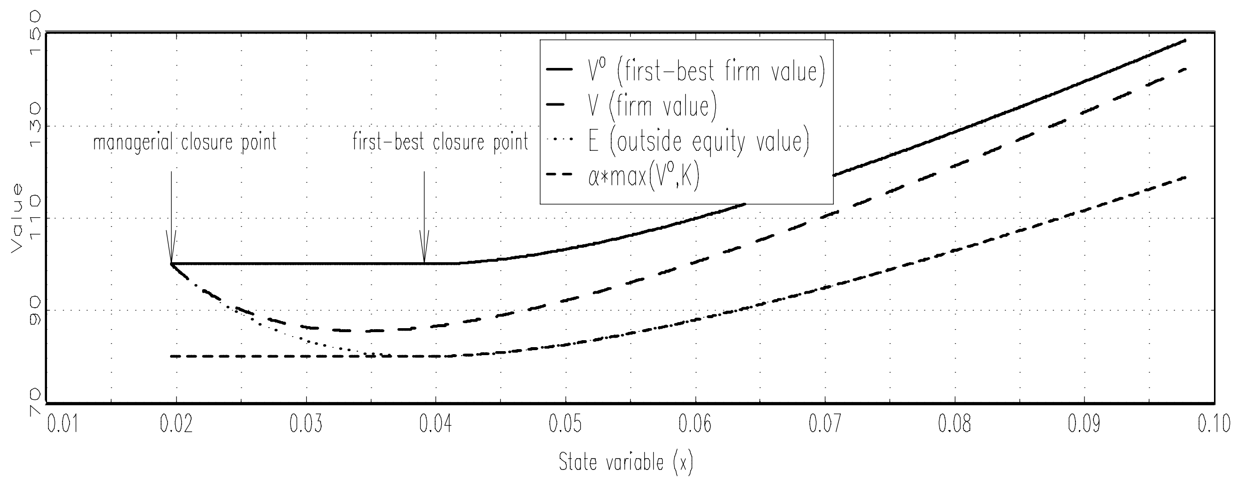

Figure 1b: Value to managers (R)

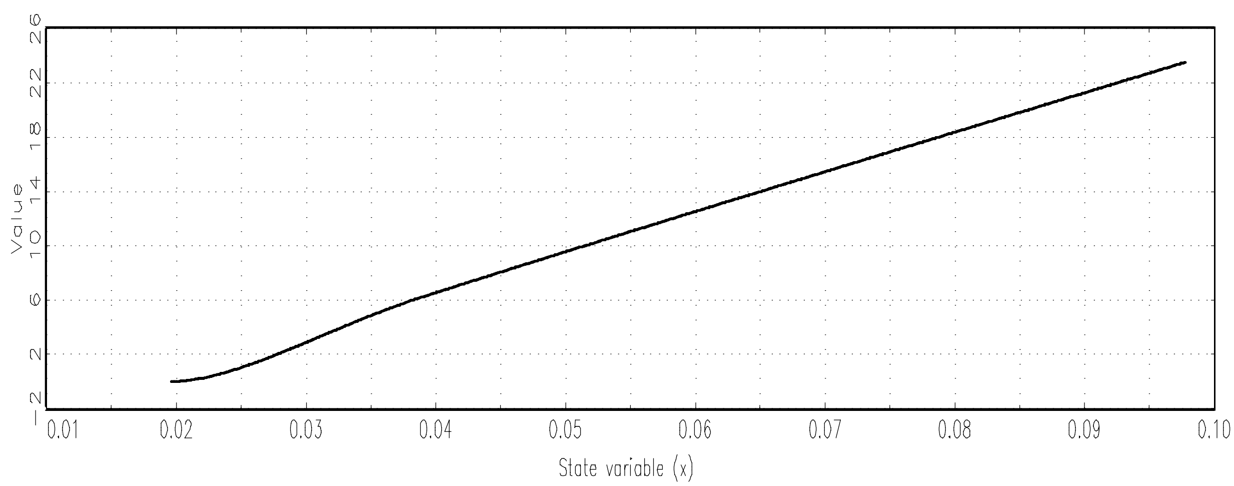

Figure 1c: Dividends and cash flow to managers

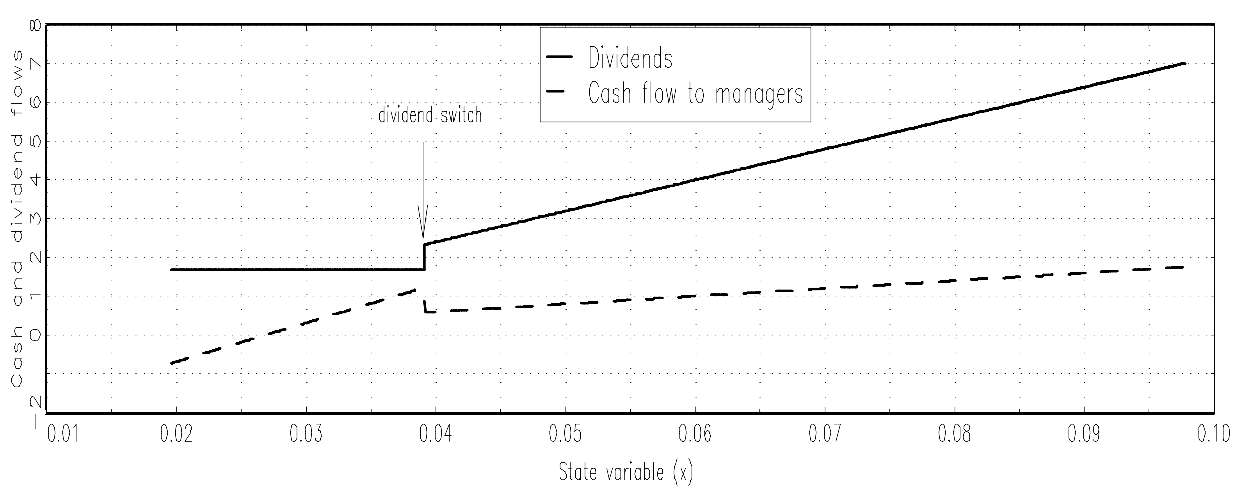

Figure 2a: Total firm value (V) and outside equity value (E)

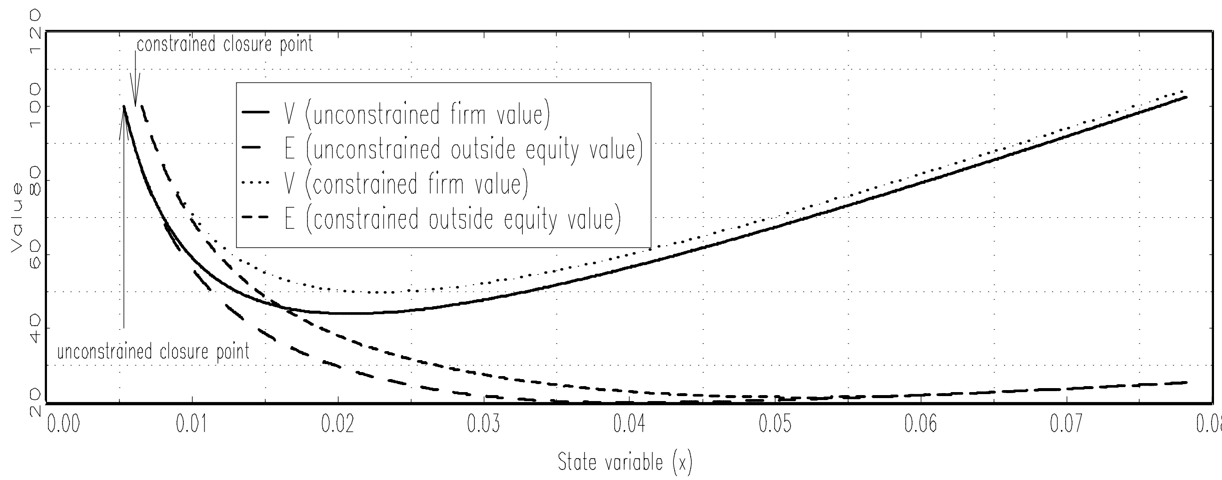

Figure 2b: Value to managers (R)

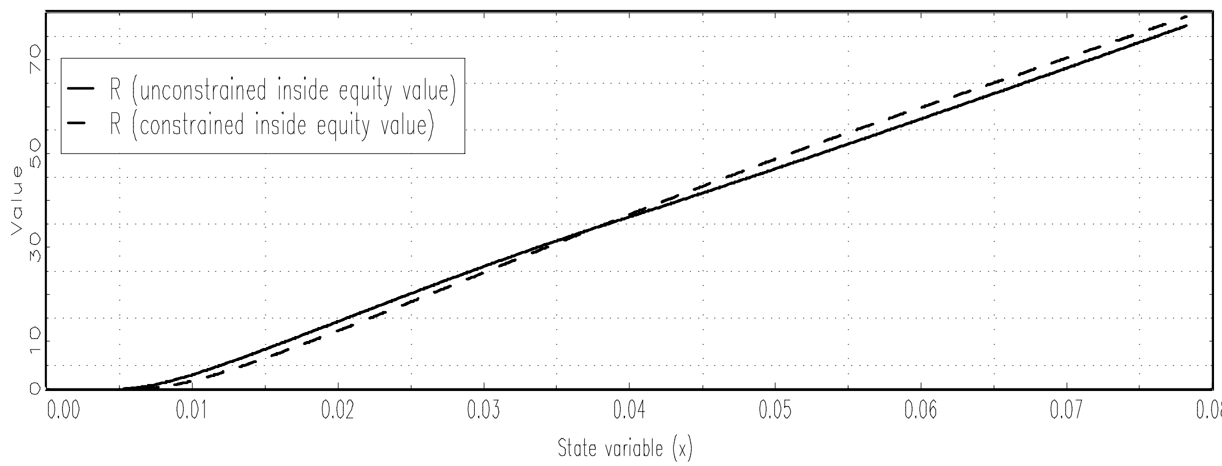

Figure 2c: Dividends and cash flows to managers