

Free Cash Flow and Takeover Threats: An Experimental Study

Ryan Oprea*

A classic theory of corporate governance holds that when cash flow is high and investment opportunities scarce, takeover threats reduce managerial self-dealing and encourage dividend payment to owners. I conduct laboratory experiments studying the effect of cash flow on self-dealing and the effect of takeover threats on both agency problems and the optimality of management of cash flows. I find that higher cash flow firms suffer more severe agency problems. Moreover I find that takeover threats reduce these problems in high cash flow firms but not low cash firms. Finally, I find evidence that takeover threats cause managers in low cash flow firms to make myopic withdrawals to signal generosity.

JEL Classification: C9, D82, G33, G34, L20

1. Introduction

This paper reports an experiment examining the effects of takeover threats and cash flow on managerial decision making. The laboratory environment is motivated by Michael Jensen's (1986) free cash flow theory of takeovers, which holds that firms that generate cash flow with no high-return projects to spend it on will suffer from agency problems. Rather than disgorge cash to investors, managers with high cash inflows will spend the money on zero return vanity projects, empire building, frivolous spending, or even outright self-payment—behavior I will collectively refer to as self-dealing. These agency problems, Jensen argues, are reduced when institutional factors in capital markets allow investors to force reorganization by selling their interests in the firm. As Jensen (1986) and Scharfstein (1988) have noted, because these takeovers are frequently motivated by a desire to overthrow management, the very threat of takeover can motivate managers to keep investors happy by paying out free cash as dividends, instead of engaging in self-dealing. In this sense takeover threats are potentially good for investors.

Other authors, such as Stein (1988), have emphasized takeover threats' potential to cause myopia in management. When returns are uncertain, managers may be motivated to make decisions that please investors in the short run, ignoring long-run returns in the process. Managers may convince investors to reject takeover bids in the short run by focusing on generating short-run returns even if at the expense of long-term returns. In other words, takeover threats might make managers myopic, which may ultimately be bad for investors.

* University of California, 1156 High Street, Santa Cruz, CA 95064, USA; E-mail roprea@ucsc.edu.

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Our experiment was designed to study these two potential effects of takeover threats. The experimental design models the firm as a stochastically evolving flow of cash, owned by a representative investor and governed by a manager. In each period the manager chooses how much of the firm's cash to leave in the firm, how much to pay out to the investor in dividends, and how much to deal to herself. The firm is at its efficient scale, lacking growth prospects but still generating cash flow. The lack of growth prospects means that neither manager nor investor can influence cash flow. The existence of cash flow gives managers scope for dividend payouts and room for self-dealing. In the design, if the firm's cash flow ever drops below zero, the firm is automatically liquidated by creditors, the manager is deposed, and the investor loses remaining interest (i.e., the experiment ends). One of the treatment variables varied in this study is whether the firm faces a takeover threat. In No Takeover treatments, the investor has no effect on the payouts of the manager and is therefore completely dependent on the manager's goodwill for earnings. In Takeover treatments, the investor can choose at any point to sell the firm to the experimenter at a fixed price, thereby deposing of the manager and ending the experiment. The second treatment variable is cash flow. In High Cash experiments, the average amount of cash generated by the firm is higher than in Low Cash experiments.

This model of the firm closely mirrors the one described in free cash flow theory. The firm generates positive cash flow, but there are no productive uses for it within the firm. Without viable investment projects, this positive cash flow can either be spent to benefit the manager (for instance, on unprofitable empire building, vanity projects, or even outright theft), or it can be paid out as dividends. This tradeoff between two uses of free cash creates a conflict of interest between manager and investor and a potential for agency problems.

The typical concern (associated, for example, with Stein 1988) regarding takeover-inspired myopia is that takeover threats might cause managers to make inefficient project choices. Managers may choose to invest in short-run, quick return, or low-risk projects instead of long-term growth projects to return dividends to managers and stave off corporate raiders. It is difficult to study this sort of myopia in the type of environment described by free cash flow theory because in such environments, and so in the experimental design, the firm has no growth projects available. However, a different opportunity for myopia presents itself in the design. In addition to having direct value to investors and managers, cash insures the firm against runs of bad luck in earnings that can lead to liquidation. Optimality requires managers to make no cash withdrawals until cash exceeds a critical safe barrier level. This robs the manager of an opportunity to signal willingness to return funds early in the life of the firm. Under an optimal withdraw policy, investors must bear substantial risk with little assurance that their managers are willing to make cooperative distributions of cash. To assuage this risk and deter investors from accepting takeover bids, managers may have incentives to make withdrawals below the optimal barrier to signal that they are of a cooperative type. There is therefore some behavioral scope for myopic distribution policies as a consequence of the takeover threat.

The evidence broadly supports the relevant conjectures made by free cash flow theory. Free cash significantly worsens managerial misbehavior. Moreover, takeover threats are effective at reducing these agency problems but only in high cash flow firms. Finally takeover threats inspire myopic withdrawals, although only in low cash flow firms. As I argue below, this is consistent with the sort of myopic generosity signaling described above.

Early observations on the governance value of the takeover threat were provided by Manne (1965); although, the pioneering formal work on the mechanics of how takeovers can force managerial payout of dividends was conducted by Grossman and Hart (1980). The

theoretical work that most directly addresses the use of takeover threats in solving agency problems between managers and stockholders is Scharfstein (1988). A useful survey on the agency problems that exist between sources of finance and management is provided by Shleifer and Vishney (1997). There is also a small experimental literature on takeovers. Kale and Noe (1997) report an experiment in which a number of investors, each holding a single share of a company, must simultaneously decide whether to accept an exogenous takeover bid that will be accepted only if a threshold number of subjects choose to accept the bid. The conclusions of Cadsby and Maynes (1998) are similar to those of Kale and Noe (1997) except that investors have multiple shares and the bid requires only that a threshold number of shares (rather than a threshold number of players) be sold. Gillette and Noe (2006) study the effects of resolicitation options on free riding in takeover bids. Hamaguchi et al. (2003) also study the free rider problems that plague takeover attempts, formally studying popular models of the problem. The types of free rider problems explored in these papers are abstracted from in the design reported here. Croson et al. (2006) study bargaining over synergies from takeovers and mergers in an environment quite different from the one studied here.

In section 2, the first part presents the basic model of the firm used in this experiment, and the next part describes the treatments and parameters used. The next two parts of this section describe optimal withdraw behavior and a testable hypothesis regarding myopic withdraws in the experiment, respectively. The last two parts of this section describe the main experimental questions and the experimental procedures. Section 3 reports the results of the experiment, and the paper concludes in section 4.

2. Experimental Design

Model of the Firm

Consider a firm consisting of one manager paired with one investor. The main attribute of the firm in period t is its free cash, c_t , which evolves over time according to three factors:

1. An independently and identically distributed shock $\varepsilon \sim N(\mu, \sigma_2)$ is added to the firm's free cash every period.
2. In each period, the manager chooses a non-negative amount w_t to withdraw from the firm's free cash. I will call this the manager's *withdraw policy*.
3. In each period, the manager chooses how to distribute the withdraw between herself and the investor. In particular, the manager chooses a fraction s_t of the withdraw to pay out to herself and a fraction d_t to pay out to the investor, where $d_t + s_t = 1$. I will call s_t the manager's *self-dealing policy* and d_t the manager's *dividend policy*.

Thus the firm's free cash in period t is

$$c_t = c_{t-1} - w_{t-1} + \varepsilon_t. \quad (1)$$

The manager has two sources of income. She is paid a wage, e , for each period the firm is in business, and she is paid her self-dealing withdraws. The manager's cumulative earnings in period t is therefore

Table 1. Parameters by Treatment

Parameter	No Takeover, Low Cash	No Takeover, High Cash	Takeover, Low Cash	Takeover, High Cash
c_0 (initial cash)	10	10	10	10
μ (shock mean)	1	6	1	6
σ (shock variance)	3	3	3	3
e (manager wage)	1	1	1	1
δ (end probability)	0.03	0.03	0.03	0.03
m (takeover bid)	N/A	N/A	100	100
Observations	29 pairs	26 pairs	30 pairs	27 pairs

$$\pi_t^M = \pi_{t-1}^M + s_t + e. \quad (2)$$

The investor is paid only what the manager pays to him in dividends. He has no direct influence over the distribution of the firm's cash and is, in this basic setup, completely at the mercy of the manager. His payoff in period t is

$$\pi_t^I = \pi_{t-1}^I + d_t. \quad (3)$$

The experiment ends if one of two events occur. First, the firm is liquidated if its cash flow ever drops below zero, and the experiment ends. I will call risk associated with liquidation *liquidation risk*. Second, to induce discount rate time preferences, the firm may end with probability δ at the end of each period. I will call the risk associated with the random ending the *random ending risk*. If the firm ends in period T for either reason, the earnings to manager and investor are π_T^M and π_T^I , respectively.

A final aspect of the environment is that there is an asymmetry of information between the manager and the investor. During the experiment the investor knows the distributional properties of the evolution of free cash but can see only the dividends he is paid each period and the amount of cash left in the firm. The investor does not know how much cash the manager is actually taking for herself.

The simple firm modeled by the design is intended to fit the basic description of a firm ripe for takeover offered by free cash flow theory. Because the random process governing the firm's cash flow does not change over time, the firm is at its efficient scale and has no useful projects to invest cash in. At its efficient scale, the firm generates positive cash flows that can either be disgorged to investors or used to benefit the manager. Finally, the manager can take self-benefiting hidden action, which generates a conflict of interest with the investor.

Parameters and Treatments

Parameters used in this experiment are given in Table 1.

This design varies two treatment variables: Takeover versus No Takeover and High Cash versus Low Cash. In No Takeover sessions, subjects participate in the experiment as just described. In Takeover sessions, investors have the additional option, at any point during the session, of ending the experiment and receiving an amount m , which is fixed across sessions and treatments, in addition to whatever earnings they have made up to that point. In essence, the

experimenter is a corporate raider offering a flat amount to take over the firm.¹ If a takeover bid is accepted in period T , the manager earns π_T^M and the investor earns $\pi_T^I + m$.

The No Takeover treatment models a firm with severe agency problems where “breakdowns of internal control processes” are predicted by free cash flow theory to inspire takeovers (Jensen 1986). This treatment gives a benchmark measure of the severity of agency problem in firms with the governance problems that might draw takeover bids in the first place. The Takeover treatment adds a single governance tool (the takeover bid), allowing examination of the effects this tool alone has on managerial behavior.

In Low Cash sessions, the mean of the shocks to cash flow each period is set at 1; while in High Cash sessions, it is set at 6. Thus, over time and on average, High Cash firms generate much higher cash flows than Low Cash firms.

Optimal Withdrawals

The investor’s earnings can be regarded as a consequence of two distinct decisions by the manager. First, the manager chooses a withdraw policy w_t , and second, she determines what fraction of the withdraw d_t to hand over as dividends. Clearly a manager’s dividend policy has a bearing on the investor’s earnings. By choosing to deal withdraws to herself, a manager directly reduces payments to the investor. However, given a choice d_t , the manager’s withdraw policy itself has a powerful effect on the investor’s earnings. Because the firm and its future earnings are liquidated if $c_t < 0$ and c_t can fall, there is an insurance value to keeping some level of cash in the firm. Withdraw policies that leave too little cash for insurance are myopic in the sense that they reduce the expected total withdraws relative to that associated with an optimal policy.

Optimal withdraw policies are well defined in continuous time versions of the environment. If cash flow evolves as an additive diffusion process (or arithmetic Brownian motion) with drift μ and volatility σ , it can be shown that the manager has a stationary optimal withdraw policy. It can be shown that the withdraw policy that maximizes discounted withdraws is a barrier policy (see Harrison 1985) with some barrier b^* :

$$d_t + s_t = \begin{cases} c_t - b^* & \text{if } c_t > b^* \\ 0 & \text{if } c_t \leq b^*. \end{cases} \quad (4)$$

That is, the strategy that maximizes future discounted withdraws has the manager withdrawing nothing whenever the firm’s cash is below some threshold b^* and withdrawing any excess cash above b^* whenever there is greater than b^* in cash in the firm.² The intuition for this result is as sketched above. Cash has a certain insurance value for the firm. Because the firm is liquidated if its cash reserves drop below zero and future withdraw options are terminated, it is prudent for the firm’s manager to maintain cash inside the firm. At some point (in fact at the barrier b^*), the marginal value of holding cash for insurance drops to zero, and all further funds should be withdrawn.

¹ The decision to treat m as an exogenous variable rather than a decision by an actual subject was purely a noise-reducing measure. This is a feature of the design that should be endogenized in future research.

² For a proof that the policy that maximizes discounted withdraws is a barrier policy, see theorem 3.1 in Dutta and Radner (1999).

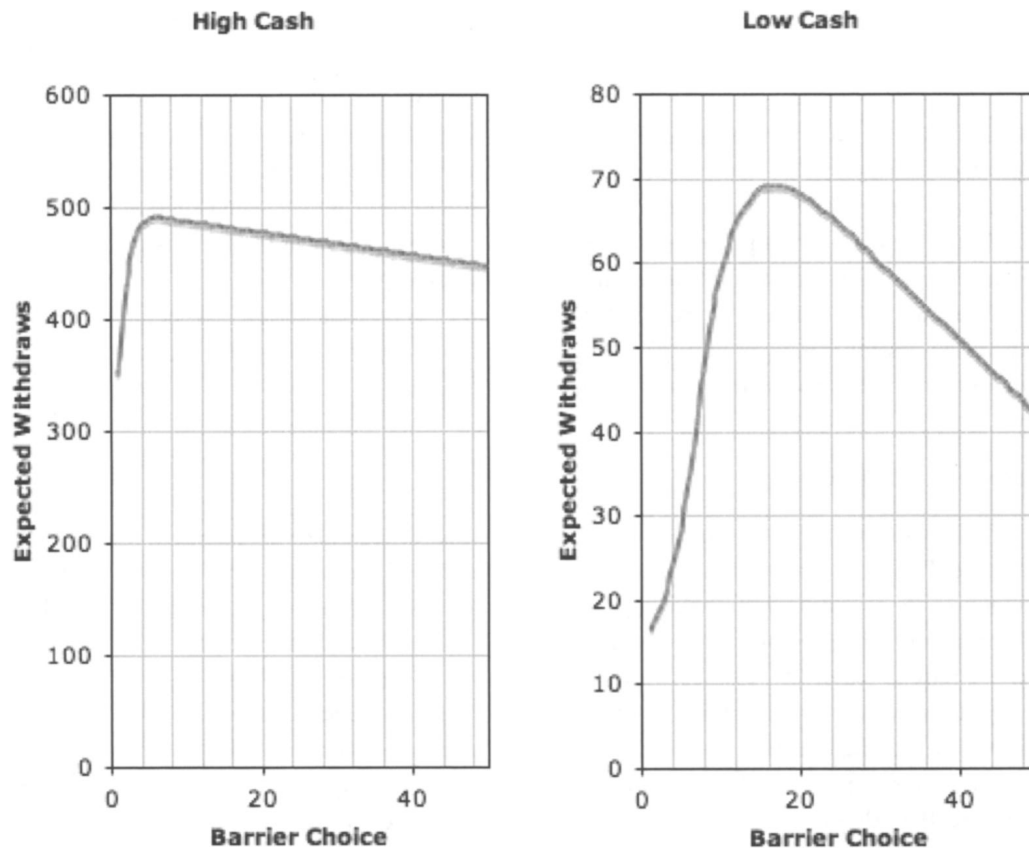


Figure 1. Mean total withdrawals at various choices of barrier cash reserves, b , in Low Cash and High Cash environments. Each data point is based on 1000 simulated experiments.

To generate predictions that are valid in the discrete environment,³ I run simulations comparing average total withdrawals under various choices of the barrier, b^* . Figure 1 presents simulation results for both the High and Low Cash flow environments. In the High Cash treatment, there is a clear optimal barrier at 5. Smaller barrier choices lead to expected withdraw loss due to added liquidation risks. Larger barrier choices are too conservative, trading withdrawals for excessive insurance. In the Low Cash treatment, the optimum is at 17. The difference in optima here is driven by differences in the likelihood of negative shocks to cash flow. Intuitively, negative runs are more likely in the Low Cash treatment leading to an increased insurance value to accumulated cash.

Why Might Takeovers Induce Myopic Withdraws?

Stein (1988) argues that, under asymmetric information, takeover bids can provide managers with incentives to make decisions that sacrifice long-term returns for short-term ones. If managers know more about the profit potentials of the firm than investors, they can signal this potential by

³ Finding b^* in a continuous time environment involves finding where the slope of the value function (the function describing expected future returns as a function of current cash) is equal to one (see Harrison 1985). Dutta and Radner (1999) show that the barrier is defined by $b^* = \ln(\lambda/\theta)^2/(\lambda + \theta)$, where θ is the positive root of $\frac{1}{2}\sigma^2x^2 + \mu x - \delta$ and λ is the absolute value of its negative root.

generating and distributing large short-term returns. This signaling can come at the expense of long-term earnings but can have the effect of deterring investors from accepting takeover bids.

Although the environment is different from the one modeled by Stein, it provides scope for a similar sort of myopic signaling. Previous experimental evidence from bargaining games indicate heterogeneity in subjects' willingness to distribute resources to counterparts. Many subjects are willing to disperse money to their subject counterparts even with little financial incentive to do so. This is particularly true in environments in which, as is true here, counterparts have been framed by the experimenter as property right holders over the pots being distributed (e.g., Hoffman et al. 1994). Other subjects act as traditional economic theory predicts, distributing little to counterparts when incentives to do so are limited.

Such heterogeneity in generosity implies *ex ante* asymmetric information between the investor and manager over the manager's generosity and therefore, the manager's willingness to make dividend distributions once they begin making withdrawals. This asymmetric information is damaging to investors because, in the Low Cash treatment, cash flows begin well below the barrier level. As a result, an investor must wait until cash has evolved to the barrier level before discovering how generous her manager's dividend policy will be and therefore, learning the relative value of the takeover bid. This waiting has a real cost to the investor because he undertakes random ending risk while waiting for the barrier level of cash to accumulate. Depending on his prior beliefs about the distribution of generosity in the manager population, the investor may be tempted to accept the takeover bid instead of incurring these waiting costs.

Alternatively, an investor may turn away takeover bids if he receives dividends early in the experiment as a signal of generosity. Such early withdrawals would be myopic because they occur at cash reserves below the barrier level and therefore serve to lower expected total withdrawals. Early dividends are a pure cost to a selfish manager in that they lower the manager's expected total withdrawals. Early dividends are a pure cost to a selfish manager in that they lower the manager's expected total withdrawals and therefore her total payments to self. Generous managers, however, may receive some nonpecuniary benefits from early dividends, making the provision of the signal less costly than it is to more selfish types. It is therefore possible that myopic withdrawals might have a signaling function in the environment analogous to the one described in Stein (1988). Rather than making myopic decisions to signal the profitability of a firm as in Stein (1988), managers might make myopic decisions to signal their private motivation to return dividends in later periods.

Myopic signaling policies of this sort generate clear testable predictions. In the High Cash treatment, the optimal barrier of 5 is lower than the initial level of cash. Thus firms have an opportunity to signal their generosity from the beginning of the experiment without departing from the optimal policy. Generosity signaling, therefore, should not induce myopic withdrawals in the High Cash treatment. In the Low Cash treatment, however, the barrier of 17 is greater than the initial level of cash, meaning signaling generosity early in the experiment requires the firm to use myopic policies. Thus under the myopic signaling hypotheses, we should see increased myopic withdrawals at cash levels below 17 in the Low Cash, Takeover treatment (relative to Low Cash, No Takeover) but should see no change in withdraw patterns due to the Takeover variable in High Cash treatments.

Experimental Questions

The core of free cash flow theory is the claim that conflicts of interest between managers and investors are created by substantial levels of free cash flow. This does not necessarily mean

that investors earn less on investments in higher cash flow firms. Rather, it means that in such firms managerial self-dealing increases relative to alternative uses of funds. Thus free cash flow theory suggests a first question.

QUESTION 1. Does higher cash flow cause managers to deal a greater proportion of withdraws to themselves?

It is often argued that takeovers correct for these conflicts of interest between managers and shareholders. In this design, we are interested not in the efficiencies generated in the wake of a takeover (something not modeled here) but in the effect of the threat on managers. The threat of reorganization (which in this experiment leads inevitably to turnover in management) gives managers an incentive to make investors happy with dividend payouts. Takeover threats provide both an opportunity cost to the investor's maintaining interest in the company and a mechanism for punishing managerial misbehavior. The disciplinary effect of takeover threats is especially emphasized in Scharfstein (1988). This is a second empirical question.

QUESTION 2. Does the threat of takeover reduce the proportion of withdraws, s , that managers deal to themselves? Is this effect stronger under High Cash than Low Cash?

Takeover threats may also give managers incentives to form suboptimal withdraw policies. Optimal withdraw policies leave managers with little scope to reassure investors of their dividend plans. This is because cash reserves begin well below the point at which optimal managers begin withdrawing from their cash reserves and make their first dividend payments. Investors face random ending risk if they wait for cash to accumulate and, if they are sufficiently pessimistic about the generosity of managers, may choose to avoid this risk by accepting the takeover bid before the optimal manager is able to distribute dividends. Making early, myopic withdraws provides the manager with an opportunity to signal her generosity to investors and forestall acceptance of takeover bids. Under such a signaling outcome, we would expect to see takeover inducing myopia in Low Cash firms but not in High Cash firms.

QUESTION 3. Does the threat of takeover cause Low Cash firms to institute myopic withdraw policies?

Procedures

A total of 226 George Mason University undergraduates were recruited for participation in this experiment in September 2004. Experiments were computerized, anonymous, and lasted no more than one hour. Subjects sat at visually isolated terminals where they received self-paced computerized instructions. After an initial set of instructions, subjects participated in five isolated practice experiments in which they were managers. This gave subjects experience with the interface but, more importantly, ample experience with the random process governing the evolution of their cash flow. Upon completing practice experiments, subjects were given a second, shorter set of instructions,⁴ randomly assigned a role (manager or investor), and randomly and anonymously matched with another subject for the actual experiment.

⁴ In the practice experiments, because subjects were acting in isolation, they were not given the opportunity to make dividend withdraws. The second set of instructions explained the portion of the interface with which subjects made dividend withdraws, the difference between managers and investors, and, in Takeover experiments, how takeovers worked.

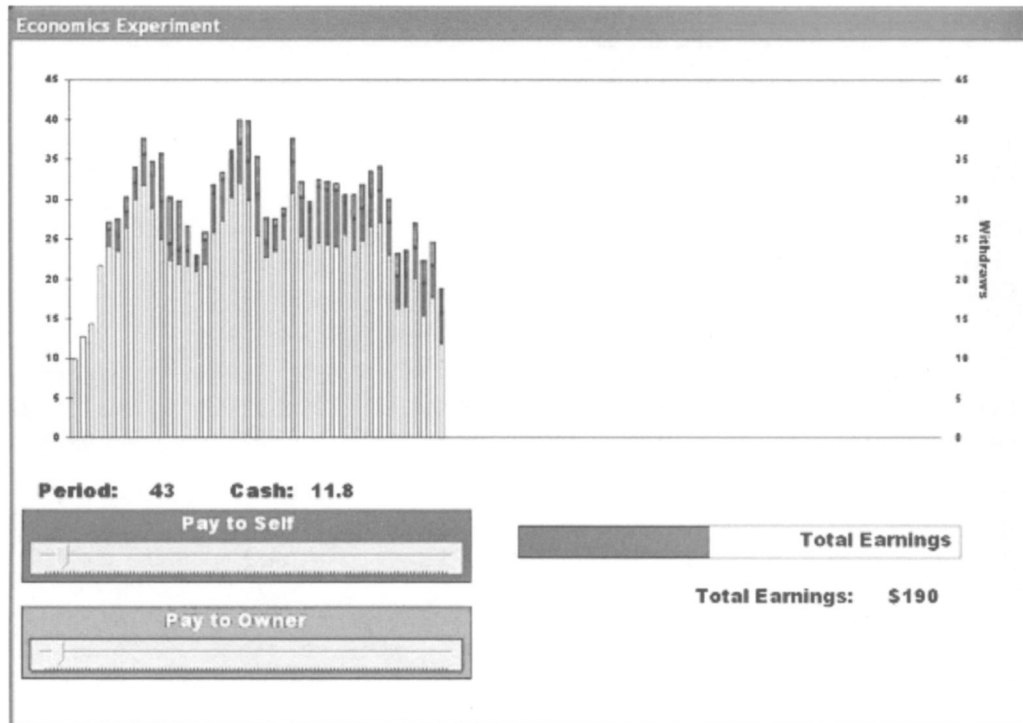


Figure 2. Experiment display. This is an example of the managers screen. The investors screen was identical except that the Pay to Self and Pay to Owner sliders were absent, and the blue bars representing the amount of self dealing were not visible. In Takeover sessions, investors also had a button that, when clicked, accepted the takeover bid.

During the actual experiment managers saw the display in Figure 2. This display represented each period as a vertical bar divided into white, red, and blue sections. The white portion represented cash left in the company, the red portion represented cash paid out as dividends, and the blue portion represented cash paid to the manager. Managers used the Pay to Self and Pay to Owner (dividends) sliders to control, in real time, how great self-payments and dividends were in the current period. Every five seconds, the current amount paid to self and paid as dividends were registered and subtracted from the company cash flow, the random shock was applied, and a new period began.

Investors viewed a similar display that differed in two respects. First, investors saw cash left in the firm (represented with white bars) and dividend payouts (red bars) but did not observe self-dealing amounts. Second, investors did not have access to sliders controlling withdrawals and distributions. In No Takeover treatments, investors simply watched the evolution of cash and dividend payments. In Takeover regimes, investors could click a button labeled “Sell the Firm” to accept the takeover bid.

During practice experiments the random ending time was randomly determined for each subject separately and in real time. For the actual experiment, the random ending was determined only once and replicated across all subjects to allow calibration of payoff rates and to maximize comparability across sessions. The ending period used in the experiment, 84, was chosen out of a set of random draws and was unusually long. This exceptional length ensured that firms could in principle last long enough to accumulate the barrier level of cash, allowing a

Table 2. Summary Data

	Low Cash		High Cash	
	No Takeover	Takeover	No Takeover	Takeover
Average Cumulative Withdraws by Use				
Dealt to self	24.10	15.67	183.96	178.63
Paid as dividends	13.59	11.87	110.15	152.74
Average Cash per Period				
Left in firm	15.95	7.12	25.32	35.96
Dealt to self	0.768	0.786	3.392	2.654
Paid as dividends	0.458	0.499	1.674	2.273
Average Proportion of Cash per Period				
Left in firm	0.863	0.839	0.723	0.785
Dealt to self	0.084	0.096	0.193	0.122
Paid as dividends	0.052	0.065	0.084	0.093
Causes of Session Ending				
Takeover	N/A	0.300	N/A	0.259
Bankruptcy	0.793	0.667	0.481	0.296
Random ending	0.207	0.033	0.481	0.444
Average Period Life Span of Firm by Causes of Ending				
Overall	40.24	23.03	55.55	63.77
Random or bankrupt	40.24	22.38	57.65	69.2
Takeovers	N/A	24.55	N/A	48.28
Observations	29	30	27	27

test for myopia. Subjects were paid five U.S. cents for every dollar of earnings made in the experiment. In addition to a \$5 fee for showing up on time, on average, managers earned U.S. \$12.10 and investors earned \$9.21. Experiments lasted, on average, 50 minutes including practice and instructions.

3. Results

Table 2 presents an overview of outcomes in the experiment under each treatment. Before posing the main questions, several regularities are worth noting. First, under High Cash the threat of takeover has little effect on average cumulative self-dealing but increases cumulative dividend payments by nearly 50%. In an average period, managers increase the amount of cash they pay out to investors while decreasing their average self-dealing. This decrease in average per-period self-dealing has little effect on cumulative levels of self-dealing largely because firms also tend to last longer under takeover threats than otherwise. Overall, then, takeover threats cause managers to distribute more free cash in dividends without reducing total self-dealing income in large part because firms are managed to live longer under takeover threats than otherwise.

The effects of takeover threats in Low Cash firms are nearly the inverse of those in High Cash firms. Cumulative self-dealing is sharply reduced under takeover threats, and dividend payments are marginally reduced as well. Firms last roughly half as long under takeover threats (even when the takeover bid is not accepted), and this seems to be due to the fact that firms end the average period leaving half as much cash in their firms. Furthermore on average, over the

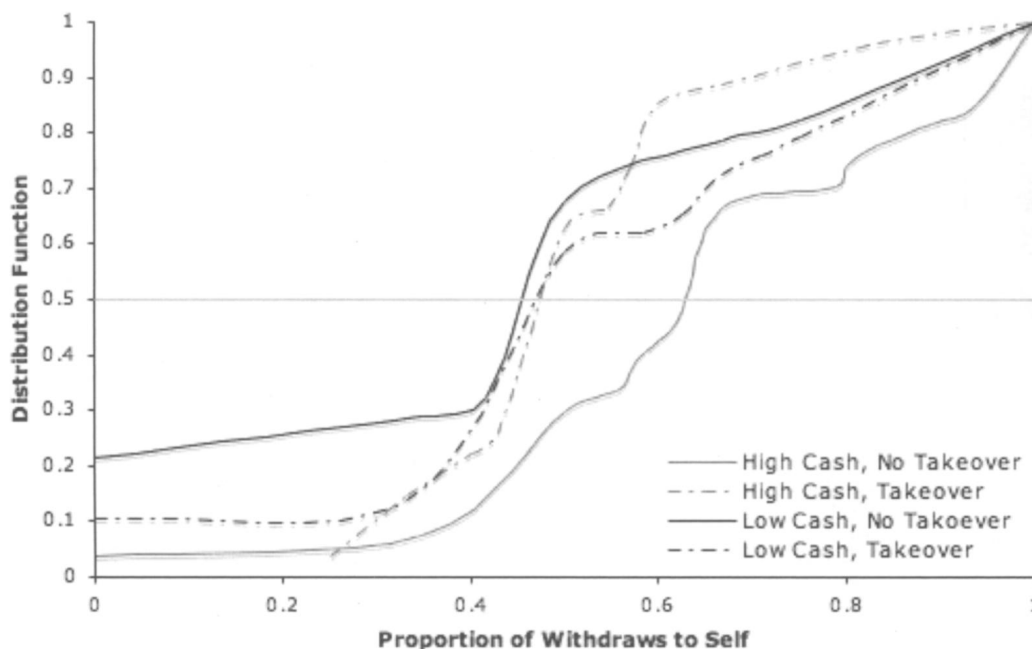


Figure 3. Distribution Functions of the Average Proportions of Withdraws Paid to Self, s_t , by Treatment

entire session, firms tend not to make different average withdraws for self-dealing or dividend payouts under takeover threats. This seems consistent with the idea that takeover threats induce firms to make myopic withdraws early in the session rather than allowing cash to accumulate. The average amount of cash left in the firm under No Takeover is much closer to the barrier level than it is under Takeover.

In the next section the experimental questions are examined more formally. In all tests described in support of the results reported below, the unit of observation is the behavior of a single firm: a single investor–manager pair. The p -values on all results reported in this section are two-tailed.

Main Results

In this section, I pose the paper's motivating questions statistically. First, are agency problems between the manager and investor more severe in higher cash flow firms as free cash flow theory suggests? A natural measure of the severity of a firm's agency problem is the average proportion of withdraws the manager deals to herself, s_t . Figure 3 shows cumulative density functions (CDFs) of the by-subject median s_t . The horizontal gray line is the median. Under the No Takeover regime, the median level of s_t is clearly higher under High Cash than Low Cash. This is statistically confirmed by a Mann-Whitney test ($p = 0.0243$). No comparable effect holds in Takeover treatments. This evidence constitutes our first finding.

RESULT 1. Absent takeover threats, managers provide themselves with a significantly larger share of withdraws, s_t , in High Cash firms than Low Cash firms. This is not true under the threat of takeover.

The second question is whether takeover threats cause managers to apportion a smaller proportion of their withdraws to themselves than they do in the absence of such threats. In

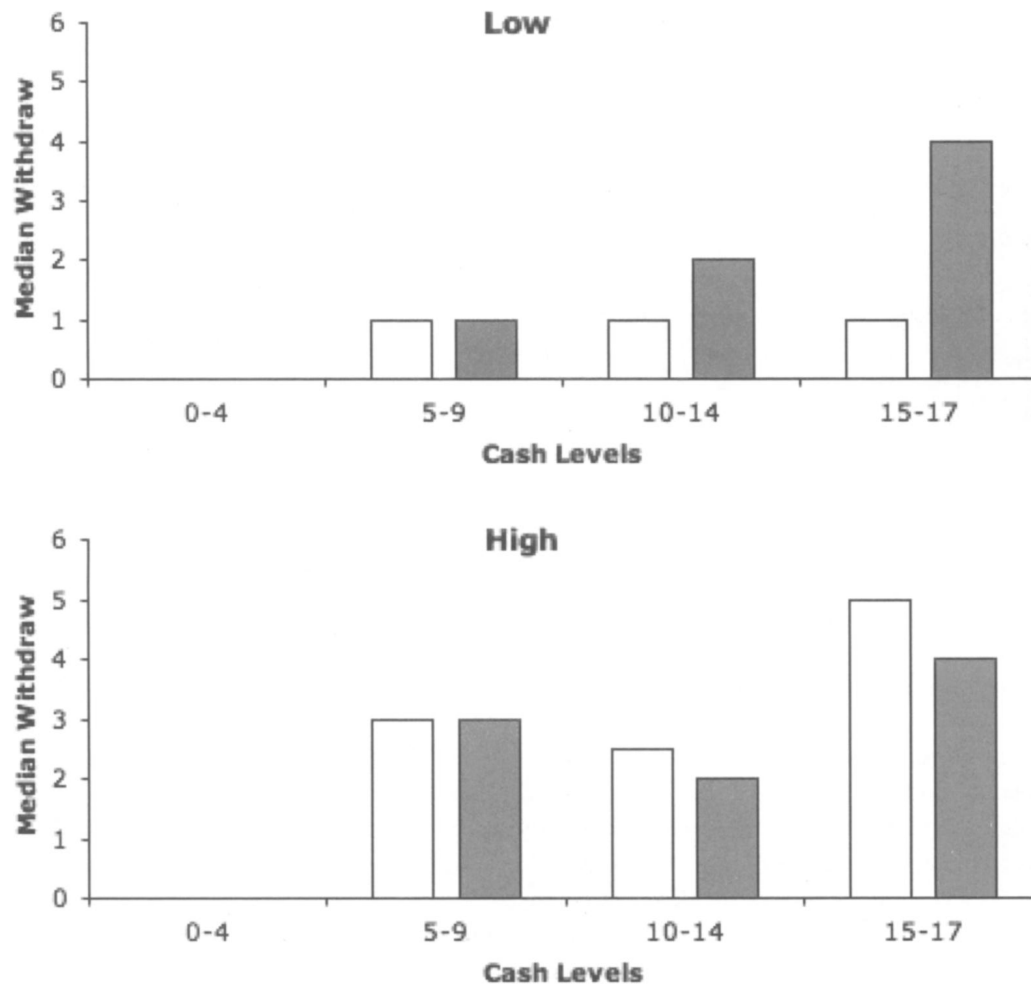


Figure 4. Median Withdraws Prior to Accumulation of the Barrier Level of Cash in Low Cash Treatments.

Figure 3, CDFs of median levels of s_t under High Cash, Takeover are to the left of those under High Cash, No Takeover, indicating a reduction in self-dealing. A Mann-Whitney test establishes that this reduction is significant ($p = 0.0174$). CDFs in Figure 3, however, indicate that median self-dealing is unaffected by the takeover threat under Low Cash. Indeed, Mann-Whitney tests comparing the median s_t s across treatments confirm that takeover threats have little impact on the degree of self-dealing ($p = 0.255$) under Low Cash.

RESULT 2. Takeover threats significantly increase the proportion of withdraws distributed to investors under High Cash but do not affect distributed levels in Low Cash.

Our third question is whether Takeover induces firms to make myopic withdraws prior to accumulating an optimal level of cash reserves. Figure 4 shows median withdraws in both Takeover and No Takeover treatments in each of four binned levels of cash reserves. The data come only from firms that have not yet accumulated 17 in cash, the barrier level for Low Cash firms. Focusing attention on behavior in Low Cash treatments, it is clear that withdraws are identical at cash levels below the initial level of 10. However, at higher cash levels, Takeover threats induce larger myopic withdraws. In both the 10–14 and 15–17 range, Mann-Whitney

tests confirm a statistically significant difference in withdraws at the 1% level.⁵ Figure 4 also provides evidence that a similar result does not obtain in High Cash treatments. Withdraws are not higher under Takeover than No Takeover in any range, and differences are insignificant.

Together these results support the idea that managers attempt to signal generosity by making myopic withdraws. Managers in Low Cash firms make only modest withdraws before achieving the optimal barrier. Takeover threats induce them to make larger myopic withdraws. Similar patterns do not surface in High Cash firms, where signaling generosity does not require firms to make myopic withdraw decisions.

RESULT 3. In Low Cash firms, takeover threats cause increased myopic withdraws. Similar effects do not appear in High Cash firms.

Withdraw Behavior

Maximizing total withdraws in this environment requires the firm to refrain from making any withdraws until a barrier level of cash has accumulated in the firm and otherwise attempting to maintain the barrier level through withdraws. Accumulating less cash than this optimum leaves the firm at risk of bankruptcy; whereas, accumulating more provides too much insurance at the expense of withdraws. Do the subjects employ barrier-like policies? Do they maintain too much or too little in cash reserves?

Each data point in Figure 5 represents a single firm. A firm's coordinates are its median cash holdings and the median squared deviation of its cash holdings from its median cash holdings. The first variable gives a measure of the firm's cash reserves that is minimally influenced by cash reserves before the accumulation of its barrier choice. The second variable measures the degree to which a firm tends to maintain a fairly constant level of cash and therefore, utilizes a barrier-like withdraw policy. Firms implementing barrier policies should have cash reserves that deviate very little from their own median cash reserves. In the Low Cash treatments, a withdraw maximizing firm will have a median level of cash around 17 and deviations close to zero. In the High Cash treatments, a withdraw-maximizing firm will have a median level of cash near 5 and again, deviations close to zero. Data points in Figure 5 are coded based on the eventual fortunes of the firm. Firms that ended in bankruptcy are signified with hollow circles, those that lasted until the random ending of the experiment are signified with crosses, and those that ended in takeover are signified with a small filled dot.

A first observation from Figure 5 is that there is heterogeneity in the character of subjects' withdraw policies. Note that a sizable proportion of subjects show very little deviation from their median cash reserves, indicating something like a barrier policy. However, in three of the treatments a sizable proportion of subjects have distinctly higher variation in their cash reserves, indicating cash accumulation over a large portion of the experiment.

Figure 5 also indicates that managers in High Cash firms tend to retain *larger* cash reserves than managers in Low Cash firms in both Takeover and No Takeover treatments, a reversal of the optimal policy. Under No Takeover, the median of median cash reserves is 14.38 under High Cash versus 10.14 in Low Cash. Under Takeover, the measure for High Cash is 21.59 versus 7.12 in Low Cash. These differences are significant at the 5% and 1% levels,

⁵ Moreover, in these bins takeover threats induce an increase in the median dividend payout but no increase in the median self-dealing amount.

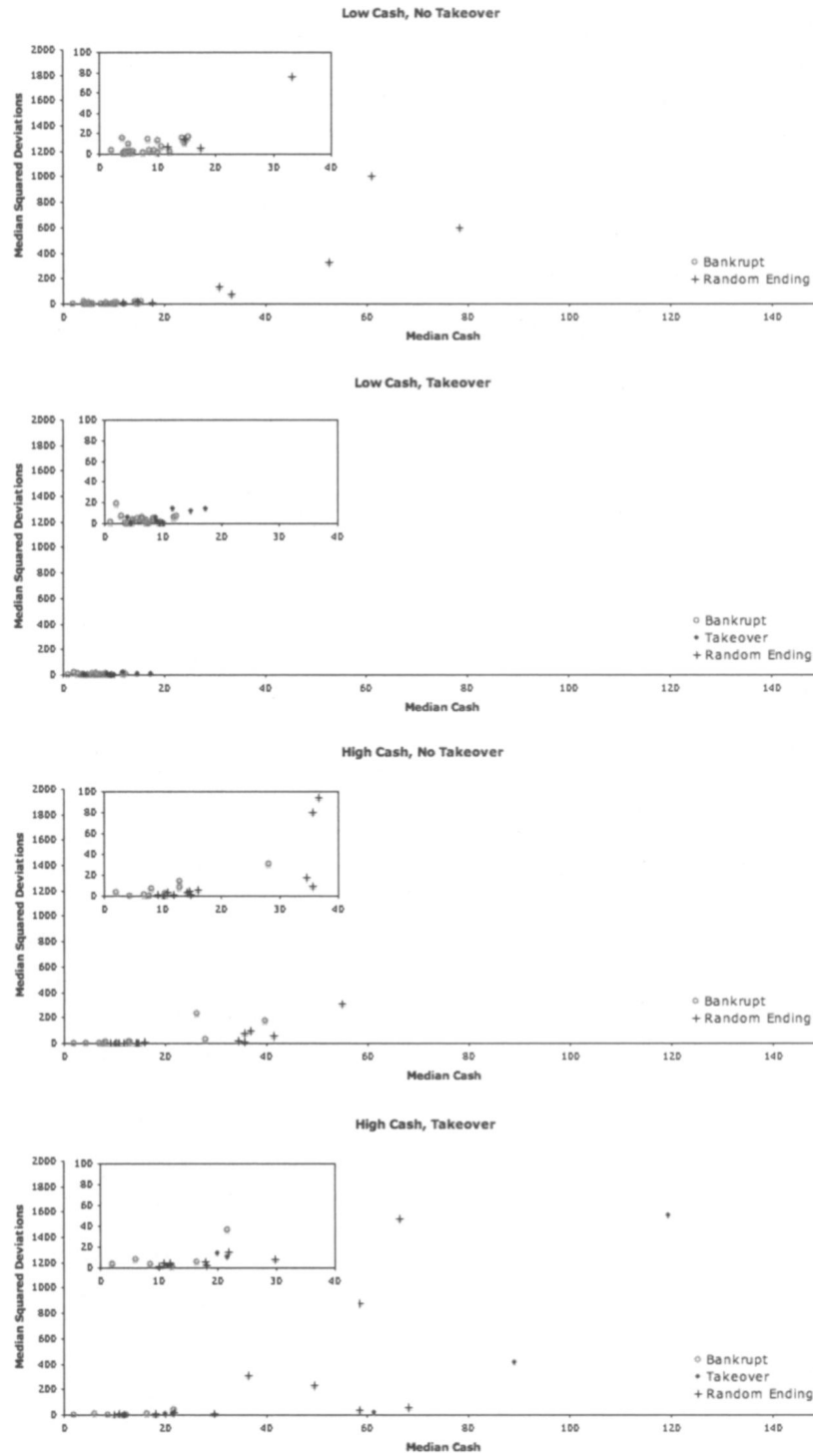


Figure 5. Median cash and median squared deviations from median cash by firm and treatment. Inset in upper left corner shows a subset of observations with relatively low cash holdings and deviations.

respectively, by Mann-Whitney tests. Moreover, Wilcoxon tests reveal (at the 1% level) that High Cash reserves are significantly greater than the optimal level of 5, and Low Cash reserves are significantly smaller than the optimum of 17. Thus, Low Cash firms overall tend to utilize myopic withdraw policies, holding inefficiently low levels of cash, and High Cash firms tend to utilize overly conservative policies, holding inefficiently large reserves of cash.

RESULT 4. Low Cash firms tend to hold smaller cash reserves than High Cash firms. Low Cash firms tend to hold too little cash; whereas, High Cash firms tend to hold too much relative to the optimum.

Finding 3 reports evidence of myopic signaling in Low Cash firms under Takeover threats. Is there any evidence of a more systematic effect of takeover threats on median cash reserves? Looking at Figure 5, it appears that cash reserves tend to be somewhat lower under Takeover in Low Cash treatments; whereas, the reverse seems to hold in High Cash treatments. The difference is not significant (using Mann-Whitney tests) in the High Cash treatment ($p = 0.128$) but is significant in the Low Cash treatment ($p = 0.048$). Figure 5 seems to indicate that the latter difference is driven largely by firms that have greatly varied cash reserves over the course of the experiment and are therefore, electing not to utilize barrier policies. Takeover threats in the Low Cash treatment seem to discipline firms to follow barrier policies. Indeed, dropping firms with median squared deviations greater than 50 leaves samples in Takeover and No Takeover that are insignificantly different from one another at either level of cash flow.

RESULT 5. Takeover threats reduce the median level of cash reserves held by Low Cash firms. Takeover threats also appear to induce firms to follow barrier policies under Low Cash. Similar effects do not obtain in High Cash firms.

4. Discussion

Observers have long noticed that takeover threats can help solve agency problems between shareholders and managers. Jensen (1986) argues that takeover threats should be particularly useful in firms with high cash flows and no internal growth prospects. In these cases, Jensen argues, the temptation to engage in self-dealing can be particularly strong, and takeover threats will be particularly salient.

This paper provides experimental evidence for both of these claims. In this experiment, subjects control withdraw and distribution policies of cash flow in a dynamic stochastic environment. Subjects in firms with relatively high cash flows tend to distribute a smaller portion of their withdraws to investors. In a second set of treatments, an exogenous takeover bid gives investors an incentive and opportunity to depose management. Such a takeover threat has no effect on dividend distributions in low cash environments but has a significant and positive effect in high cash ones.

This experiment also produces evidence that takeover threats may be particularly useful tools for disciplining high cash flow firms because they can encourage myopia in lower cash flow firms. Firms with lower cash flow in this environment must accumulate a greater cash reserve to provide optimal insurance against runs of bad luck. Doing so, however, leaves low cash flow firms with little scope for reassuring investors of their loyalty to investors' interests

when cash reserves are too low. Under the threat of takeover, such firms may be tempted to make inefficiently risky withdraws to signal loyalty and deter the acceptance of takeover bids. Indeed there is evidence of myopic signaling in the data: Takeover threats generate myopic withdraws in low cash flow firms but not in high cash flow firms.

More generally, this experiment provides evidence on withdraw policies under dynamic stochastic cash flows. A large number of subjects hold something close to barrier policies, the optimal class of withdraw policies. However, there is little evidence that these barrier-like policies involve optimal choices of cash reserves. Subjects in high cash flow environments tend to hold larger cash reserves than those in low cash flow environments; although, optimal barrier choices dictate the opposite ranking. Moreover, a share of subjects in both environments engage in policies that involve severely high and widely varying cash reserves. Although the experimental design does not afford an opportunity to investigate the causes and robustness of these deviations from optimality, the findings suggest that future experimental work on withdraw behavior in stochastic cash flow environments may be warranted.

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