Payout Policy, Financial Flexibility, and Agency Costs of Free Cash Flow*

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Abstract

This paper builds on the agency costs of free cash to explain how firms determine their payout policies. Payout methods considered are dividends and open-market stock repurchase programs. Dividends eliminate the agency costs of free cash by reducing cash under management (insiders) discretion, but could result in underinvestment if the paid out cash is needed later for operations. Stock repurchase programs avoid the underinvestment problem by giving insiders the option to cancel the payout. They are also an incentive to pay out cash because they provide trading gains to better informed insiders through the firm's informed trade. Because their execution is optional, however, repurchase programs cannot always prevent the waste of free cash. Payout policy is thus determined as a trade-off between eliminating agency problems with dividends and preserving financial flexibility with open-market programs.

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1 Introduction

A firm's optimal payout policy depends on its life cycle stage. In the case of a new firm, shareholders invest hoping for the best return on their investment. As long as money is needed for the firm's growth, they would optimally want it to stay in the firm. Insiders (managers) invest the cash on behalf of the shareholders, and, as long as expected return on investment is high, their interests are aligned with the interests of the shareholders. This is both because insiders get compensated by the shareholders for the growth and because insiders are often shareholders themselves. Sooner or later, as the firm matures, return on initial investment and on cash generated and reinvested declines significantly. In this case, the shareholders' interest is that the firm will pay out free cash, cash that can no longer support growth. The shareholders can then invest these funds in new ventures that may offer more favorable returns.

When firm growth slows, however, insiders' interests are no longer aligned with the interests of the general shareholders. Return on investment may be dropping, but the value of insider perks associated with the investment is not. (For example, the manager's benefit from hiring new employees is high whether or not an increase in the workforce is needed to support growth.) Namely, shareholders face an agency problem. In addition they face an information problem: insiders are the first to learn that firm growth has slowed. Only later do general shareholders get this information.

To deal with these agency and information problems, the shareholders have several alternatives. One is to do nothing – let insiders do as they please. Another is to force payout of the cash according to a predetermined program. The first alternative accepts the agency problem. The second reduces it, but creates a problem that is potentially more severe. This is because adhering to a predetermined program to force cash payout could severely hurt return by constraining investment. That is, if cash is paid out too early, when it is still needed to support growth, there can be severe damage to the firm and hence to shareholder value (e.g., what if hiring of new employees is forbidden when it is still needed to support growth?) There is one more thing shareholders can do. Rather than force a cash payout, shareholders can look for mechanisms that will give insiders incentives to pay cash out once it is no longer needed for operations. While incentives are costly too, they may cost less than the agency costs of free cash and the costs of shaving investment.

The purpose of this paper is to explain payout policy as a trade-off between preventing the waste of free cash and preserving financial flexibility. That is, forcing cash out of the firm can result in underinvestment, while not forcing cash out can result in overinvestment. The shareholders' problem is thus how to get insiders (managers) to return cash to investors without hurting investment, when only the insiders get to see whether this cash is free or not.

Many firms do not pay out cash. Shareholders in this case accept the agency problem, but make it less likely that investment will be shaved. These are usually growth firms for which financial flexibility is crucial and agency costs of free cash are low. Dividends, we suggest, is the alternative of a predetermined payout program. Dividends become a commitment once declared by the board. They also informally commit the firm for future dividends. An open-market stock repurchase program, we suggest, is the (costly) payout-incentivizing mechanism. Specifically, because an open-market program does not commit the firm to repurchase any shares, it leaves the management (insiders) the option not to pay out the cash when the cash is needed for operations. On the other hand, it can incentivize payout when cash is not needed for operations by providing these better informed insiders with gains through the firm's informed repurchase trade that may outweigh their benefit from wasting free cash. The general shareholders lose from the insiders' informed trade, but at the same time they benefit from preserving the firm's financial flexibility and alleviating the problem of wasting free cash.

We develop a model of payout policy to support these arguments. In a two-period setup, the model considers a financially constrained firm that faces uncertainty about its investment needs. The firm is owned by general shareholders (outsiders) and is run on their behalf by agents (insiders). These agents are shareholders too, but they also gain private benefits from the waste of free cash. The outside shareholders dictate the firm's payout policy (e.g. through its board, shareholder meetings, and relationship investing) and choose among a dividend, a repurchase program, and no payout in order to maximize their wealth. A dividend forces cash out of the firm immediately and thereby prevents the waste of free cash, but may result in shaving of investment in the case where investment opportunity turns out to be large. A repurchase program announcement delegates the decision whether or not to pay out cash to the insiders. Given a repurchase program announcement, if the firm does not realize free cash the insiders will not execute the program as this will constrain investment and will reduce the value of their shares. If the firm does realize free cash, the insiders may waste the cash if the stock is overvalued but will execute the repurchase if the stock is undervalued. Thus, while their informed trades on the firm's behalf benefit the insiders at the expense of the (uninformed) outside shareholders, the outside shareholders also benefit from preventing a waste of cash. The payout policy set by outside shareholders is determined as an optimization (minimization) of investment shaving, trading losses to the insiders, and free cash waste.

Our model's main empirical prediction is that mature firms have high payouts and tend to disburse cash using dividends rather than repurchases. Growth firms are less likely to pay out cash but if they do, they use repurchases rather than dividends. For mature firms the expected benefits of preventing the waste of free cash are higher than the costs of investment shavings; for growth firms, the situation is reversed. This prediction is broadly consistent with the empirical evidence.

The model also generates several other new testable predictions. It predicts that risky firms, (firms with high variability of return on investment) are more likely to repurchase than pay dividends, while the opposite would be true for safe firms. This is because the incentive to repurchase is provided through gains from adverse selection for which uncertainty (risk) about future returns is necessary. No such variability is needed for dividend payouts. Another prediction is that firms that are likely to realize large amounts of free cash will tend to pay out cash using dividends more than with repurchases. This is because the more available free cash, the higher the loss when it is wasted. Dividends do a better job than repurchases in disbursing free cash so they would be the preferred payout method when the waste of free cash problem is likely to be severe. The model also offers new predictions about the way insider ownership and the quality of governance will affect payout policy. Higher insider ownership will make repurchases more likely than dividends because it increases the insiders' share in waste prevention gains while their benefits from the waste of cash do not depend on their ownership. Similarly, better governance also makes repurchases more likely than dividends because better governance is associated with lower benefits to insiders from waste and hence gives greater incentive to repurchase. While we are unaware of any systematic empirical inquiry into these predictions, they are generally consistent with the empirical evidence.

The model reveals two important properties of open-market programs that dividends do not share and that might explain the growing role of these programs as a payout tool.[1] First, the model demonstrates the flexibility in open-market programs; i.e., there is an option not to repurchase, should the availability of free cash change.[2] Dividends lack this property, as once declared they commit firms to future dividends (the stock market penalizes firms for dividend reductions). Modern corporations face an increasing need for agility that dividends lack and open-market programs provide. Second, the model suggests that open-market programs stimulate the payout of free cash by providing gains to insiders through the firm's informed trade. Given the increasing cash holdings of corporations and the declining propensity of firms to pay dividends, open-market programs may have evolved as a mechanism that motivates payout where dividends have failed.[3] Indeed, firms often respond to shareholder activists demand

[1] On the growth in repurchase programs, see, for example, Grullon and Michaely (2002), Julio and Ikenberry (2004), and Boudoukh et al. (2007).

[2] Supporting evidence on the flexibility of open-market programs is provided in Jagannathan et al. (2000), Guay and Harford (2000), and Brav et al. (2005). On investment sensitivity to financing constraints, see, for example, Fazzari et al. (1988).

[3] Cash holdings for S&P 500 firms were twice as high in 2005 as they were in 1999. See (*Business Week* July 18, 2005, "Too much cash, too little innovation.") On the importance of optimizing the firm's cash holdings see, for example, Opler et al. (1999), Almeida et al. (2004), and Harford et al. (2006). On the propensity of firms

for dividends with a willingness to initiate share repurchase programs (e.g. Kirk Kerkorian with Chrysler and Carl Ichan with Time Warner). When Microsoft finally started to pay out cash, excluding a one-time special dividend, the payout was designed to be executed primarily through a four-year open-market repurchase program rather than through dividends. Other maturing tech giants seem to follow this pattern.

The model also highlights two limitations of repurchase programs. First, repurchases provide only a partial solution to the waste of free cash problem. This is because they result in (informed) strategic repurchasing, and hence cannot completely prevent the waste of free cash. This limitation is consistent with the empirical evidence that actual repurchase rates are low.[4] Second, for repurchases to work as a payout mechanism, they cannot be interpreted in the market as bad news. If they were, we show that they would result in market selloffs. For repurchases not to be bad news, there cannot be too much uncertainty in investment prospects, or repurchases would signal poor investment prospects (even under strategic repurchasing), rendering repurchases as bad news.

Most of the theoretical literature on payout policy focuses on the importance of taxes and on signaling motivation. The tax-based literature suggests that payout policy matters because payouts trigger a tax liability. Dividends are tax-disadvantageous compared to repurchases (e.g., Black (1976)). As tax rates on dividends and repurchases have been reduced and eventually equalized (in 2003), the relative importance of other motivations has increased (see, however, Green and Hollifield (2003)). The signaling literature suggests that good firms initiate and increase dividends or stock buybacks in order to distinguish themselves from bad firms (e.g., John and Williams (1985) and Ofer and Thakor (1987)). The signaling story seems to be more applicable for self-tender offer repurchases than for open-market repurchase programs that generate significantly lower announcement returns.[5]

Very little theoretical research builds on the agency costs of free cash to explain a general payout policy. Most closely related to this paper are Chowdhry and Nanda (1994) and Lucas and McDonald (1998). These papers build on asymmetric taxation of dividends and repurchases and

to pay less dividends, see Fama and French (2001), DeAngelo et al. (2000, 2004), Skinner (2008), and von Eije and Magginson (2007).

[4]In the US, Stephens and Weisbach (1998) and Jagannathan et al. (2000) document that average actual repurchase rates are between 70% and 80%. Chan et al. (2006) report similar results. Actual repurchase rates are even lower outside the US. Ikenberry et al. (2000) find the rate to be only 28% in Canada. Rau and Vermaelen (2002) find 37% in the UK, and Ginglinger and Hamon (2003) find only 10% in France.

[5]The average announcement return on self tender offers is about 15% compared to only about 2% for repurchase programs. See, for example, Comment and Jarrell (1991). Furthermore, while tender offers can be withdrawn, most of them are executed. The announcement of an open-market repurchase program, however, does not constitute a commitment to repurchase, which is needed for signaling results. See, however, Oded (2005), Massa et al. (2007), and Peyer and Vermaelen (2008).

focus on signaling results. Once announced, the repurchases in these models are not optional and thus apply to tender offers more than to open-market programs.[6]

Allen et al. (2000) consider both agency costs of free cash and signaling motivations for disbursing cash through dividends but do not consider repurchases. Free cash flow based models are more common in capital structure theory. Jensen (1986) suggests that debt could solve the problem by removing the free cash. Zwibel (1996), Fluck (1999), and Myers (2000) suggest that threat of a takeover is enough to discipline managers to disburse free cash. The agency costs of free cash flow theory has been criticized (e.g., Myers (2003, page 243)) for taking as a given that insiders will spend free cash without explaining why they would do so. Our model contributes to the theoretical literature on payout policy in modeling the agency problem at a primitive level; that is, we explicitly model the insiders' benefits from waste. We suggest that insiders may pay out cash voluntarily if they have incentives in the form of gains from the firm's informed repurchase trade. At the same time, we elaborate on the agency problem in suggesting that the general shareholders trade off the waste prevention benefits from forcing cash out (by demanding dividends) against investment distortion. Differently put, at the heart of payout policy may be the question of how to get free cash out of the firm under asymmetric information without reducing financial flexibility.

Miller and Rock (1985) use the distortion of investment caused by payout as a basis for a dividend signaling model. Grullon et al.'s (2002) maturity theory suggests that, as firms mature, both risks and investment needs will decline so that firms will have more cash and will start paying dividends. Eastbrook (1984) suggests that dividends force managers to raise capital in order to avoid the distortion of investment and that the increased monitoring of the managers associated with the issuance reduces agency problems. Stulz (1990) considers both the overinvestment and underinvestment problems to explain debt policy. In his model, payment to debt is the predetermined payout mechanism that solves the overinvestment problem at the cost of exacerbating the underinvestment problem. The role of dividends in our model is similar to the role of debt in Stulz's model.

In the conclusion of their recent survey of payout policy, Allen and Michaely (2003, page 420) suggest that "we still do not have a firm understanding of what determines the choice [between repurchases and dividends]... and how payout as a whole interacts with capital structure decisions." When combined with Stulz (1990), our model may provide an explanation. Namely, there is a pecking order: mature low-growth firms pay out free cash through debt (interest), moderate-growth firms pay out free cash through dividends, and high-growth firms

[6]This is because tender offers are performed publicly and relatively immediately (within one month). We do not consider tender offers in this paper. Of all stock repurchases, more than 90% are performed through open-market programs (see, for example, Grullon and Ikenberry (2000) and Banyi et al. (2005)).

pay out cash through repurchases, and the actual mix depends on the firm's need for financial flexibility and on the severity of agency costs of free cash. The rest of this paper is organized as follows. Section 2 develops a model of payout policy. Section 3 discusses implications of our results. Section 4 compares these predictions to the empirical evidence. Section 5 concludes.

2 A model of payout policy

We consider an all-equity financed and financially constrained firm. There are three dates indexed by $t = 1, 2, 3$. All agents are risk neutral, the interest rate is zero, and there are no taxes or transaction costs. At $t = 0$ the firm has an endowment I and an investment opportunity (project). The size of the investment opportunity and the return on investment are uncertain at $t = 0$. At $t = 1$, the size of the investment opportunity is realized to be either $I - C$ (small) or I (big) with equal probability, where $0 < C < I$. The portion of the endowment that is not needed for the investment then becomes "free cash." Thus, the level of free cash is realized to be either C or 0, depending on whether the investment opportunity is realized to be small or big. The expected return on investment is also realized at this point to be either α_1 (low) or α_2 (high) with equal probability where we assume $1 < \alpha_1 < \alpha_2$ and hence $\bar{\alpha} \equiv (\alpha_1 + \alpha_2)/2 > 1$. We identify four possible states at $t = 1$: $\{SL, BL, SH, BH\}$ where S and B indicate small vs. big investment, and L and H indicate low vs. high return on investment. At $t = 2$, funds that were invested at $t = 1$ generate return according to the state realized at $t = 1$.

There are N shares outstanding at $t = 0$. A fraction β of the shares is held by insiders, where $0 < \beta < 0.5$, and the rest is held by outside shareholders. The outside shareholders are thus the majority and can dictate the (payout) policies of the firm, and insiders run the firm on behalf of all the shareholders. Each investor group acts to maximize its own wealth. Information is symmetric at $t = 0$, but at $t = 1$ the realizations of the size of the investment opportunity (I or $I - C$) and the expected return on investment (α_1 or α_2) are observable by the insiders only. At $t = 2$ all information is public, the firm is dismantled, and shareholders are paid in proportion to their ownership.

Agency Problem - Any funds not invested in the project at $t = 1$ (i.e., all free cash) are completely wasted by the insiders between $t = 1$ and $t = 2$, unless these funds are paid out immediately at $t = 1$. The insiders realize private benefits of γ on every dollar they waste, where $0 < \gamma < 1$. The waste of free cash is thus costly to all shareholders, but benefits accrue only to insiders.[7]

[7]Essentially, we assume here that insiders cannot prevent the waste of the free cash under their control, even if it is in their interest as a group to do so. This could be because of a coordination problem, where each insider

Given that free cash is either paid out or wasted, there are four equally likely states for the terminal value of the firm $\{\alpha_1(I - C),\ \alpha_1 I, \alpha_2(I - C),\ \alpha_2 I\}$ corresponding to the states $\{SL, BL, SH, BH\}$. This is the case whether or not the cash is paid out. The expected terminal firm value is

$$\frac{1}{4}(\alpha_1 + \alpha_2)(I - C) + \frac{1}{4}(\alpha_1 + \alpha_2) I = \frac{1}{2}\bar{\alpha}(2I - C).$$

Payout Policy - At $t = 0$ the outside shareholders can 1) demand a dividend; 2) approve (announce) an open-market stock repurchase program (henceforth "open-market program" or "repurchase program" or "repurchase"); or 3) do nothing. A dividend forces cash out immediately at $t = 0$. An open-market program announcement authorizes but does not commit the insiders to buy back shares at $t = 1$. Execution of the program takes place at mangers' discretion, and information as to whether the firm repurchased or not becomes public only at $t = 2$.[8] Without loss of generality, we assume that outside shareholders will "do nothing" whenever indifferent. Without loss of generality, we also assume that if the outsiders announce a repurchase program, managers (insiders) will repurchase rather than waste the free cash whenever they are indifferent.

At $t = 1$ a subset of the *outside* shareholders face liquidity constraints and must sell a portion Q of their shares, where $Q < (1 - \beta)N$. Insiders, cannot trade *their own* shares in the market at $t = 1$, however.[9] There is a market for the stock in which the market maker sets the price p before investors place their quantity bids (anticipating the possibility of informed trade from the firm side) to earn zero expected profit.[10]

has an incentive to deviate from the insider social optimum. Sooner or later, one insider will find a way to waste the free cash and privately enjoy the benefit. (In this case γ should be thought of as *expected* private benefits from waste.)

[8] In the US corporate boards announce dividends and authorize repurchase programs. In most other countries these practices must be approved either by the board or by the shareholders. In our model the outside shareholders are essentially the board. In the US there is no reporting requirement on actual repurchases other than in the financial statements. The regulation of actual repurchases in other countries is more restrictive.

[9] In the US, SEC Rule 10b-5 requires insiders—including the firm and its officers—to refrain from trading in the firm's shares while in possession of "material" non-public information regarding their value.

The restriction on liquidity trade $Q < (1 - \beta)N$ is made without loss of generality, and limits the discussion to the feasible range of the results. While we allow outsiders to trade more than Q shares, as will be shown, trading only the liquidity needs Q is supported by the equilibrium.

[10] Prices are thus independent of the actual order flow as in Glosten and Milgrom (1985), Rock (1986), and Noe (2002). We focus on $t = 1$ because this is when the repurchase takes place, but it could be assumed that the market opens also at $t = 0$ and $t = 2$.

At the cost of significantly complicating the analysis, it is possible to have a two-sided market where liquidity buyers and sellers place ask and bid quantities, and the market maker posts ask and bid prices. Informed trade in this case is possible only in the ask market. The qualitative results and their implications for payout policy under such an alternative market mechanism are the same.

We normalize the values of free cash C and investment size I to be values per share using lower case letters c and i, respectively. We will also generally omit the time index for $t = 1$, as most of the action happens on this date. Figure 1 describes the time line.

Further elaboration on the parameters γ and β is warranted. We interpret the parameter γ, capturing insiders' benefits from waste, as a quality-of-governance parameter. That is, insiders always find a way to waste free cash. When governance is poor, insiders are able to spend directly on things they benefit from the most (perks); when governance is good, this is not an option. In the latter case, insiders are able to waste free cash only on things that look like they are good for the firm (i.e., "empire building"), and they receive fewer private benefits. Better governance and monitoring are thus associated with lower γ; they make it harder for insiders to choose wasting activities yielding considerable private benefits. For example, γ is relatively low if the insiders use excess cash to hire redundant employees and invest in redundant (bad) projects. It is higher if they can spend excess cash on art collection or vacation trips. It is relatively easy to present empire building activities as necessary expenses but much harder to do so with perks. Waste activities with high γ are less relevant to the enhancement of firm value, and hence we argue that better governance is associated with lower γ.[11]

Unlike the parameter γ, which directly affects only the insiders, the parameter β pertains to the zero-sum game between insiders and outsiders. The naive interpretation of the quantity β is insider ownership, but in practice β can be higher than the ownership if, for example, insiders have stock options or compensation contracts that are pegged to the growth of the firm. Such transfers to insiders would of course come at the expense of outside shareholders, as return on investment, α, is assumed to be exogenous (insiders always exert maximum effort). We bound β away from zero, because insiders likely always get a share of the pie, and away from 0.5, because we want to assume outsiders can establish policy (through the board, or shareholder meetings, or relationship investing).[12]

Definition 1 *Equilibrium is a set consisting of 1) payout policy set by the outside shareholders that specifies one of the following: a dividend, an open-market program announcement, or no*

[11] On the general association between the quality of governance and waste, see, for example, Shleifer and Vishny (1997). The waste of free cash need not be the result of insiders actively wasting the cash, but can rather be the result of passive management because of the availability of free cash, as in the "quiet life" models (e.g., Bertrand and Mullainathan (2003)).

[12] The assumption that insider ownership is low is consistent with the empirical evidence. In a sample of large US firms, Ofek and Yermack (2000) find that 90% of the CEOs own less than 5% of the shares. Similary, Jensen (2000) reports that insider ownership in the US is only 1-5%. In practice, insiders are often in control even without majority ownership. We, however, want to consider payout policy as a governance mechanism and hence focus on a principal-agent framework (outside shareholders are the principal and the insider shareholders are the agent). In Section 4 we briefly consider the implications when insiders are in control.

payout; 2) a price p set by the market maker, given the payout policy; and 3) a repurchase strategy set by the insiders if the payout policy is an open-market program, given p, such that the market maker makes zero expected profit and each shareholder group (insider and outsider) maximizes its wealth, given the information it has.

The analysis to follow will show that if the policy set by the outside shareholders is no payout, the firm has very good financial flexibility, but all free cash is wasted. With a dividend payout, all cash taken out is saved (not wasted). In this case there may be a shaving of investment, if investment opportunity is later realized to be high. An open-market program allows the insiders to cancel the payout (refrain from buying shares at $t = 1$) if it turns out that the firm does not have free cash, so that financial flexibility is retained. Insiders may choose to waste free cash when they do not have enough incentive to repurchase. They may also repurchase strategically, because they are privately informed about the firm's prospects at $t = 1$. This strategic trading (repurchasing) results in wealth transfers to the insiders at the expense of uninformed (outside) shareholders. Despite these negative wealth transfers, an open-market program will often dominate the other policies because it avoids investment shaving and partially prevents free cash waste.

The investigation is performed in stages. First, we analyze the effect of disbursing a dividend, assuming it is the only available payout method. Then, we analyze the effect of a repurchase program, assuming it is the only available payout method. Finally, we combine the two results to characterize the payout policy, i.e., to suggest how outside shareholders will choose among a dividend, an open-market repurchase program, and no payout.

2.1 Dividend

At $t = 0$ the outside shareholders can force payment of a dividend D, where $0 \leq D \leq I$. Suppose that the dividend is the only available payout method. In this case, if the investment opportunity is later realized to be small (i.e. $I - C$), then with $D \leq C$ cash would be saved and investment would not be constrained. However, if instead the investment opportunity is realized to be big (i.e. I), the firm cannot fully take advantage of the opportunity and has to shave investment. The firm value depending on D is thus

$$\bar{\alpha}\left[(I - D) - \frac{(C - D)^{+}}{2}\right] + D \tag{1}$$

where $x^{+} \equiv \max\{x, 0\}$.

Proposition 1 *Given that the only available method to distribute free cash is a dividend, the* *expected firm value (including the dividend) is maximized by choosing* $D = C$ *if* $\bar{\alpha} < 2$ *and* $D = 0$ *otherwise.*

Proofs of all lemmas and propositions appear in Appendix A. Proposition 1 suggests that if the firm can only choose between a dividend and no payout at all, it will prefer a dividend when $\bar{\alpha} < 2$ and prefer no payout otherwise. Intuitively, there is some level of expected return on investment below which the benefit from waste prevention through payment of a dividend is higher than the cost incurred from shaving investment, and above which the situation is reversed.

2.1.1 Dividend wealth effects and optimal dividend

When dividend disbursement is the only available payout method, maximizing the value for outside shareholders is equivalent to maximizing the expected firm value (including the dividend). This is because dividends paid are pro-rata, so the level of insider ownership β is irrelevant. Thus, given the result in Proposition 1, outside shareholders will demand a dividend of C if $\bar{\alpha} < 2$ and will not demand a dividend payment otherwise. Indeed, if $D = C$, outside shareholder wealth is

$$(1-\beta)\left(\bar{\alpha}\left(I-C\right)+C\right) = (1-\beta)\left(\bar{\alpha}I + C - \bar{\alpha}C\right).$$

If $D = 0$, outside shareholder wealth is

$$(1-\beta)\left(\bar{\alpha}I - \bar{\alpha}\frac{C}{2}\right).$$

The difference in outside shareholder wealth between a dividend of C and no dividend is

$$(1-\beta)\left(C - \bar{\alpha}\frac{C}{2}\right). \tag{2}$$

The decision by outside shareholders to pay a dividend depends on whether or not $\bar{\alpha} < 2$. Namely, when a dividend is the only available payout method, if $\bar{\alpha} < 2$, outside shareholders will choose $D = C$. Otherwise, they will choose no dividend.

2.2 Repurchase

At $t = 0$ the outside shareholders could choose to announce an open-market repurchase program. A repurchase program announcement publicly authorizes the firm (insiders) to repurchase shares up to a dollar value of C, but does not commit the firm to repurchase. Because a repurchase is executed through the financial markets, existence of an equilibrium with a repurchase announcement depends on the post-announcement response in the financial markets of: 1) the market maker, 2) the general shareholders (the outsiders), and 3) the firm (the insiders). In this subsection we will consider the conditions under which such an equilibrium can hold. We will abstract from dividends and assume that the only way to pay out free cash is a repurchase program. Under this assumption we characterize the existence of an equilibrium with a repurchase program and the way the outside shareholders will choose between a repurchase program announcement and no payout. Then, in Subsection 2.3, we will characterize the choice among all possible payout policies (repurchase, dividend, and no payout).

Suppose first that the firm does not announce a repurchase at $t = 0$ and hence never repurchases at $t = 1$. In this case, free cash is always wasted. Denote the price that the market maker sets in this case as p_{NA} (where subscript NA indicates no repurchase announcement). Given the four states possible at $t = 1$, the market maker condition (zero profit) is

$$(p_{NA} - \alpha_1(i - c))Q + (p_{NA} - \alpha_1 i)Q + (p_{NA} - \alpha_2(i - c))Q + (p_{NA} - \alpha_2 i)Q = 0. \qquad (3)$$

Upon rearrangement we can write

$$p_{NA} = E[p_{2NA}] = \frac{1}{4}(\alpha_1 + \alpha_2)(2i - c) = \frac{\bar{\alpha}}{2}(2i - c) \qquad (4)$$

where p_{2NA} is the expected $t = 2$ price without a repurchase announcement.

Next, suppose that at $t = 0$ the outsider shareholders authorize a repurchase program. In the states $\{BL,\ BH\}$ all cash is tied to the investment opportunity, and hence the firm can execute the repurchase only in the states $\{SL,\ SH\}$.[13] By assumption, the market maker sets a price that gives him zero expected profit. Given a repurchase strategy set by the firm (repurchase in either states SL, SH or in both states), the market maker will adjust the price p he sets at $t = 1$ relative to p_{NA} to account for two effects.

The first effect is the per-share value enhancement from the firm's trade. That is, whenever the firm repurchases, cash that would otherwise be wasted is used to repurchase shares outstanding and hence the same terminal firm value is divided by a smaller number of shares. This effect enhances the expected terminal share value $E[p_2]$ and hence also acts to increase the

[13]It is immediate to show that outside shareholders will not authorize a program larger than C (because $\bar{\alpha} > 1$). Our results will show that whenever a repurchase can distribute the cash it is optimal to announce the whole amount C. We also assume away the situation in which insiders will repurchase when they do not have free cash (i.e., in the states $\{\alpha_1 I,\ \alpha_2 I\}$). Presumably when the level of free cash is realized, cash that is not free is already tied to the investment.

price p that the market maker is willing to buy shares for at $t = 1$ over the no-announcement price p_{NA}.

The second effect is the expected wealth transfers associated with the firm's repurchase trade. Specifically, given the price p set by the market maker at $t = 1$, and the state-dependant value realized, the firm will have either trading gains or losses from the repurchase trade. Given the firm's repurchase strategy, the market maker faces adverse selection: He buys Q shares when the firm does not repurchase, but only $Q - \frac{C}{p}$ when the firm does repurchase. Because the market maker sets p to have zero expected profit, trading gains to the firm from the repurchase act to reduce the price p and result in wealth transfers to the firm from the selling (outside) shareholders; trading losses to the firm from the repurchase act to increase the price p and result in wealth transfers from the firm to the selling shareholders.

Suppose the informed insiders strategy is to repurchase whenever free cash is available, i.e., in both states $\{SL, SH\}$. In this case, the firm repurchases shares whenever the investment prospects are bad (free cash is available), and hence subsidizes market maker losses when he loses but does not participate in the gains when he wins. This is because the market maker buys Q shares when investment prospects are relatively good but only $Q - \frac{C}{p}$ shares when investment prospects are relatively bad. As a result, the market maker increases the price p he is willing to pay for the shares he buys. This also reduces the expected terminal share price $E[p_2]$ because the firm is able to buy fewer shares with the available free cash. As a result $p > E[p_2]$, in which case all (uninformed) shareholders would want to sell and hence equilibrium cannot hold.[14] The following lemma formally establishes this result.

Lemma 1 *In any equilibrium in which a repurchase program is announced:*
(i) the following condition must hold

$$p \leq E[p_2], \tag{5}$$

and (ii) the firm repurchases only in the state $\{SH\}$.

Condition (5) is a no-free-riding of uninformed (outside) shareholders condition: Given a repurchase announcement, the expected terminal price must be higher than the price the market maker buys for at $t = 1$. Otherwise, all shareholders would want to sell their shares at $t = 1$ and the equilibrium breaks. Without a repurchase announcement, there is no repurchase trade and hence $p_{NA} = E[p_{2NA}]$. Given a repurchase announcement, both p and $E[p_2]$ are increased relative to p_{2NA} and $E[p_{2NA}]$ because of the value enhancement effect. However, the wealth

[14] In a two-sided market framework, this would mean the ask price is lower than the bid price, which is not sustainable in equilibrium.

transfer effect determines whether $p < E[p_2]$ or $p > E[p_2]$. Namely, the direction of the wealth transfer determines whether or not condition (5) holds.

If the firm executes the repurchase in both states $\{SL,\ SH\}$, condition (5) cannot hold because the repurchase is executed whenever investment opportunity is small and hence, other things equal, an actual repurchase is bad news. The firm is subsidizing (in expectation) the market maker losses so the price that gives him zero expected profit is higher than the expected terminal value, which is a violation of (5). To prevent this, there must be adverse selection in the firm's repurchase strategy; that is, the firm must engage in strategic trading (repurchasing).

The results in Lemma 1 are surprising and to our knowledge new. They suggest that for a repurchase to work as a payout mechanism, given availability of free cash, there must be adverse selection in the repurchase trade that leads to trading gains to the firm at the expense of uninformed shareholders. More importantly, these results suggest that a repurchase cannot distribute all free cash, consistent with the empirically low actual repurchase rates of repurchase programs.

Because in any equilibrium with a repurchase announcement the firm will execute the program only in the state $\{SH\}$, the market maker condition, given an equilibrium with repurchase, becomes

$$(p-\alpha_1(i-c))Q+(p-\alpha_1 i)Q+(p-\frac{\alpha_2(i-c)}{1-\frac{c}{p}})\left(Q-\frac{Nc}{p}\right)+(p-\alpha_2 i)Q=0. \tag{6}$$

This condition essentially requires that the average of the differences between the price that the market maker is willing to buy for and the terminal value of a share, weighted by the quantity bought in each state, be zero. The first term corresponds to the state $\{SL\}$ where investment opportunity is small and expected return is low, so the firm value is very low and hence insiders will not execute the repurchase despite availability of free cash. The second and fourth terms correspond, to the states $\{BL, BH\}$, respectively. In these states, investment opportunity is realized to be big, so the firm does not have free cash and hence does not repurchase.

The third term corresponds to the state $\{SH\}$ where investment opportunity is small but return on investment is high. If in this state the insiders do not repurchase there will be no repurchase in any state and therefore there is no point to announce a repurchase program. Thus, in an equilibrium with a repurchase announcement, the firm does repurchase in this state, and the number of shares repurchased in this case is $\frac{C}{p}=\frac{Nc}{p}$. At $t=2$ the proceeds from the investment are $N\alpha_2(i-c)$, and hence the terminal value per share in this state is $\frac{\alpha_2(i-c)}{1-\frac{c}{p}}$.

Lemma 2 uses the market maker condition (6) to refine the requirements for a repurchase announcement to be the equilibrium outcome.

Lemma 2 *In any equilibrium in which a repurchase program is announced:*
(i) the price p at which the market maker sells for at $t = 1$ is

$$p = \frac{p_{NA} + c\left(\frac{N}{4Q} + 1\right) + \sqrt{\left[p_{NA} + c\left(\frac{N}{4Q} + 1\right)\right]^2 - c\left[4p_{NA} + c\frac{N}{Q} + \alpha_2(i-c)\left(\frac{N}{Q} - 1\right)\right]}}{2}, \quad (7)$$

where p_{NA} is given in (4),
(ii) the condition $p < E[p_2]$ is equivalent to

$$p < \alpha_2(i - c) + c, \quad (8)$$

and (iii) condition (8) is equivalent to

$$\alpha_1 \frac{2i - c}{2i - 3c} - \frac{3c}{2i - 3c} < \alpha_2. \quad (9)$$

Part (i) of Lemma 2 is derived by solving the market maker condition (6) for the price p. Part (ii) of Lemma 2 is derived by imposing the no-free-riding restriction $p < E[p_2]$ from (5) on the market maker condition (6). Last, in Lemma 1 we established that for $p < E[p_2]$ it is necessary that the firm will repurchase only in state $\{SH\}$. However, it is possible that even if the firm repurchases only in this state the restriction $p < E[p_2]$ will not hold. Part (iii) of Lemma 2 combines the restrictions in parts (i) and (ii) on the price p to give the necessary and sufficient condition on the model parameters under which the no-free-riding restriction $p < E[p_2]$ will hold.

By observation, the condition (9) requires that either c is low (relative to i), or α_2 is significantly higher than α_1. Intuitively, the higher the c, the lower the value of the firm when investment opportunity is realized to be small, and hence, even if the firm repurchases only in the state with high return $\{SH\}$, the stock value in this state will be lower than the price p. As a result, the direction of the wealth transfer will be from the firm to the selling shareholders, and the requirement $p < E[p_2]$ will not hold. On the other hand, the wider the gap between α_1 and α_2, the more likely it is that in the state $\{SH\}$ the stock value is high compared to the price p. As a result the direction of the wealth transfer is from selling shareholders to the firm, and the requirement $p < E[p_2]$ will hold.

Let σ_α denote the standard deviation of return on investment α. Condition (9) suggests that for a repurchase equilibrium to exist, σ_α must be high enough.

Lemmas 1 and 2 give restrictions that originate in the zero-expected-profit for the market maker condition and the no-free-riding of outside shareholders condition. For a repurchase equilibrium to hold, it is also necessary that the insiders will find it optimal to repurchase in the state $\{SH\}$ and only in that state. Lemma 3 gives restrictions on p such that insiders will repurchase only in this state.

Lemma 3 *Insiders will execute the repurchase in the state $\{SH\}$, and only in that state, if*

$$\frac{\beta}{\gamma}\alpha_1(i-c)+c<p<\frac{\beta}{\gamma}\alpha_2(i-c)+c, \tag{10}$$

where p is given in (7).

Condition (10) is the insider participation condition. It indicates the conditions on the price p such that the insiders will execute the repurchase in the state $\{SH\}$ and only in that state. To earn zero expected profit, the market maker sets the price according to (7). At this price, $\frac{\beta}{\gamma}$ must be high enough that benefits from repurchase in state $\{SH\}$ will justify its execution. Namely, insider holdings β should be large enough so that insiders will have enough benefits from waste prevention through share value appreciation. On the other hand, their benefits from waste γ must be low enough, or else the insiders will prefer to waste the cash. At the same time, $\frac{\beta}{\gamma}$ cannot be too high. If it is, insiders will execute the repurchase also in state $\{SL\}$, and a repurchase equilibrium cannot hold because, as explained earlier in Lemma 1, under such a scenario the condition $p<E[p_2]$ will not hold and all shareholders would want to sell.[15]

Proposition 2 combines the restrictions in Lemmas 1, 2, and 3 – the no-free-riding condition (5), the market maker condition (6), and the insiders' participation condition (10) – to characterize when a repurchase announcement can be an equilibrium outcome.

Proposition 2 *Let $p_R(\alpha_1,\alpha_2,i,c)$ be the price calculated in (7). A repurchase announcement is an equilibrium outcome only if this price satisfies:*

$$\frac{\beta}{\gamma}\alpha_1(i-c)+c<p_R<\min(\frac{\beta}{\gamma},1)\alpha_2(i-c)+c \tag{11}$$

2.2.1 Feasibility of repurchase – numerical example

The following numerical example demonstrates the manner in which existence of a repurchase equilibrium depends on the model parameters. Assume the firm has with $N=10$ shares

[15] It is possible to express the price p in (9) using the model parameters as in (10). Yet, because the price p is independent of $\frac{\beta}{\gamma}$ this complex presentation obscures rather than clarifies the intuition.

outstanding and initial endowment $I = 10$. We set $\beta/\gamma = 0.8$. Returns on investments are $\alpha_1 = 2, \alpha_2 = 5$, and free cash in the small investment scenario is $C = 2$. Also, liquidity trade at $t = 1$ is $Q = 3$.

We thus have $i = I/N = 1$, and $c = C/N = 0.2$. Using (4), $p_{NA} = 3.2$. Upon substitution of the parameter values above into (11), the repurchase equilibrium condition becomes $1.48 < p_R < 3.4$. Using (7), $p_R = 3.159$, and hence, a repurchase equilibrium exists.

In Figures 2–4 we show how feasibility of repurchase equilibrium in this numerical example depends on parameter values. Figure 2 demonstrates how existence of a repurchase equilibrium in this example depends on the ratio between insider ownership and benefits from waste, $\frac{\beta}{\gamma}$. First we change the ratio $\frac{\beta}{\gamma}$ in the range $[0, 2.5]$, holding all other parameters fixed. In the figure, the lower horizontal line represents the price p, and the upper horizontal line represents $E[p_2]$. Both lines are horizontal because both p and $E[p_2]$ do not vary with $\frac{\beta}{\gamma}$.

Feasibility of a repurchase equilibrium requires that the no-free-riding condition $p < E[p_2]$ holds, i.e., that the line p is below the line $E[p_2]$. Under the parameter values in this example, Figure 2 shows that this condition is always met. The two diagonal lines that start at the origin represent the limits on p in the insider participation condition (10) for different values of $\frac{\beta}{\gamma}$. Specifically, the lower diagonal line represents the term $\frac{\beta}{\gamma}\alpha_1(i - c) + c$ and the upper (steeper) diagonal line represents the term $\frac{\beta}{\gamma}\alpha_2(i - c) + c$.

Feasibility of a repurchase equilibrium also requires that the insider participation condition (10) holds, i.e., that the line p will be between the diagonal lines. Figure 2 indicates that for values of $\frac{\beta}{\gamma}$ below 0.75, the line p is above the diagonal lines. Namely, the condition $p < \frac{\beta}{\gamma}\alpha_2(i - c) + c$ does not hold. In this range, there is too little incentive to repurchase because insiders' benefits from waste prevention are low relative to their gains from waste. In this range, the firm will never repurchase. For values of $\frac{\beta}{\gamma}$ in the range $[0.75, 1.8]$, the price line p is between the diagonal lines so that the firm will repurchase only in state $\{SH\}$ and a repurchase equilibrium exists. For values of $\frac{\beta}{\gamma}$ above 1.8, the price line p is below both diagonal lines. Namely, the condition $p > \frac{\beta}{\gamma}\alpha_1(i - c) + c$ does not hold. Consequently, the insiders will repurchase whenever the firm has free cash, that is, in both states $\{SL, SH\}$. This, in turn, would result in free riding (see Lemma 2), and hence in this range a repurchase equilibrium cannot hold.

In general, for values of $\frac{\beta}{\gamma}$ close to 1, the benefits from waste are of the same magnitude of the benefits from waste prevention, so the ratio $\frac{\beta}{\gamma}$ is irrelevant for existence of repurchase equilibrium. However, as this ratio deviates from 1, the incentive to repurchase becomes either too strong or too weak, and as a result, a repurchase equilibrium cannot hold.

Figure 3 demonstrates how existence of a repurchase equilibrium depends on variability in free cash c (equivalently, variability in the size of the investment opportunity). Specifically, in the numerical example, we change the parameter $c = C/N$ in the range $[0, 1]$, holding all other parameters fixed. As in Figure 2, the lower and the upper diagonal lines that meet at $c = 1$ represent the limits $\frac{\beta}{\gamma}\alpha_1(i-c)+c$ and $\frac{\beta}{\gamma}\alpha_2(i-c)+c$ in the insider participation condition (10), respectively. The concave diagonal line is $E[p_2]$, and the convex line is p.

Feasibility of a repurchase equilibrium requires that the line p be below the line $E[p_2]$ and between the lines $\frac{\beta}{\gamma}\alpha_1(i-c)+c$ and $\frac{\beta}{\gamma}\alpha_1(i-c)+c$. Figure 3 demonstrates that in the range $c < 0.38$ repurchase is feasible. Namely, the line p is between the lines $\frac{\beta}{\gamma}\alpha_1(i-c)+c$ and $\frac{\beta}{\gamma}\alpha_2(i-c)+c$, and below the line $E[p_2]$. As c increases (equivalently, as investment size in the small investment state drops), the value of the firm when investment opportunity is realized to be small declines. For $c > 0.38$, this value becomes too low compared to the price p (which averages across small and big investment states) so that the condition $p < \frac{\beta}{\gamma}\alpha_2(i-c)+c$ is violated. Namely, p becomes too high and hence the incentive to repurchase when free cash is available becomes too small even in the state with high return $\{SH\}$. As a result, the firm will never repurchase. For values $c > 0.6$, this price becomes even higher, so that the condition $p < E[p_2]$ also does not hold.[16] In general, a high value of c pushes the price p outside the range where repurchase equilibrium can hold.

Figure 4 demonstrates how existence of a repurchase equilibrium depends on variability in return on investment α. Specifically, in the numerical example, we let α_2 vary in the range $[2, 5]$, holding all other parameters fixed (and recall $\alpha_1 = 2$). The horizontal line at level 1.5 in Figure 4 represents the term $\frac{\beta}{\gamma}\alpha_1(i-c)+c$ in condition (10), and the diagonal line that meets this horizontal line at $\alpha_2 = 2$ represents the term $\frac{\beta}{\gamma}\alpha_2(i-c)+c$ in condition (10). The two upper diagonal lines are p and $E[p_2]$.

Feasibility of repurchase requires that the line p be below the line $E[p_2]$ and between the lines $\frac{\beta}{\gamma}\alpha_1(i-c)+c$ and $\frac{\beta}{\gamma}\alpha_1(i-c)+c$. When α_2 is low, a repurchase equilibrium is not feasible. Indeed the line p is above the line $E[p_2]$ and above both the lines $\frac{\beta}{\gamma}\alpha_1(i-c)+c$ and $\frac{\beta}{\gamma}\alpha_2(i-c)+c$. This happens because we have fixed $\alpha_1 = 2$, and hence for values of α_2 close to 2 there is little variability in return on investment. When variability in α is relatively low, even small deviations of $\frac{\beta}{\gamma}$ from unity push the price p outside the feasible range dictated by (10) (see Figure 2). In this numerical example $\frac{\beta}{\gamma} = 0.8 < 1$, so p is above both lines $\frac{\beta}{\gamma}\alpha_1(i-c)+c$ and $\frac{\beta}{\gamma}\alpha_2(i-c)+c$. That is, insider ownership is low compared to the benefits from waste, so there is not enough incentive for insiders to repurchase and prevent the waste of free cash. At the same time, the effect of the free cash c is relatively strong (see Figure 3) so that p is pushed

[16] That is, on this off-equilibrium path, for $c > 0.6$ even if the firm were willing to incur losses and buy, at the price that gives the market maker zero expected profit all shareholders would want to free-ride and sell.

above $E[p_2]$.[17] As α_2 is increased, the effects of both c and $\frac{\beta}{\gamma}$ are weakened. For $\alpha_2 > 2.15$, the condition $p < E[p_2]$ holds, and for $\alpha_2 > 3.8$, the condition $p < \frac{\beta}{\gamma}\alpha_2(i-c)+c$ also holds. Thus, for $\alpha_2 > 3.8$, a repurchase is feasible. Greater variability in return on investment α generally puts the price p in the range where strategic repurchasing (i.e., repurchasing only in the state $\{SH\}$) is optimal for the insiders. At the same time, with enough variability in the return on investment α, the effect of free cash c is relatively weak so that the no-free-riding condition $p < E[p_2]$ holds.

Figures 2-4 demonstrate together that the likelihood of a repurchase equilibrium to exist increases with the proximity of $\frac{\beta}{\gamma}$ to 1 and with variability in the rates of return on investment α, and decreases with the availability of free cash c (equivalently, variability in the size of the investment opportunity).

2.2.2 Repurchase wealth effects and optimal repurchase

One assumption has been that outsiders are in control and set payout policies to maximize their own wealth. Thus, for a repurchase announcement to be an equilibrium outcome, not only must the condition in Proposition 2 hold but a repurchase announcement must also dominate the policy of no payout for the outside shareholders. When considering the wealth effects of a dividend, there was no informed trade and hence we could simply identify outsiders wealth with the value of the $(1-\beta)N$ shares (including the dividend). When the payout policy is to repurchase, however, liquidity sellers are adversely affected by the firm's informed trade. Given our assumption that liquidity sellers are outside shareholders, outsiders considering whether to repurchase or not, consider the wealth of all investors except the insiders.[18]

The expected wealth of outside shareholders is the expected wealth of liquidity sellers at $t=1$ and of outside shareholders who sell their shares only at $t=2$. Thus, under a repurchase program announcement, the expected wealth of outside shareholders is given by

$$Qp + (N(1-\beta) - Q)\,E[p_2] \tag{12}$$

where p is from (7) and where

$$E[p_2] = \frac{1}{4}[\alpha_1(i-c) + \alpha_1 i + \frac{\alpha_2(i-c)}{1-\frac{c}{p}} + \alpha_2 i] = \frac{1}{4}[\alpha_1(2i-c) + \alpha_2\left(\frac{i-c}{1-\frac{c}{p}} + i\right)]. \tag{13}$$

[17] That is, on the off-equilibrium path, even if the firm were willing to repurchase, the price that gives the market maker zero expected profit would be too high and will result in free riding (market sell-offs.)

[18] Whose value the firm is maximizing is an open question in corporate finance. See, for example, Myers and Majluf (1984), and Dybvig and Zender (1991).

The wealth of outside shareholders without a repurchase program is $N(1-\beta)p_{NA}$ where p_{NA} is from (4). For a repurchase program announcement to dominate a policy of no payout, outside shareholder expected wealth with a repurchase announcement must be higher than their expected wealth without it, i.e.

$$N(1-\beta)p_{NA} < Qp + (N(1-\beta)-Q)E[p_2]$$

which upon rearrangement is

$$Q(E[p_2]-p) < N(1-\beta)(E[p_2]-p_{NA}) \tag{14}$$

Proposition 3 *If the only method available to shareholders to distribute free cash is a repurchase program, an equilibrium with repurchase, if it exists, always dominates no payout for the shareholders.*

Proposition 3 suggests that if a repurchase announcement can hold as an equilibrium outcome it is always better than a policy of no payout. Essentially the proposition states that whenever the condition in Proposition 2 holds, following a repurchase program announcement, the expected gains to outsiders from preventing the waste of free cash always outweigh their loss to insiders from adverse selection.

2.3 Payout Policy: Dividend, repurchase, or no payout

We can now combine the results from subsections 2.1 and 2.2 to characterize payout policy, or, how a firm chooses among dividend, repurchase, and no payout when all these alternative payout policies are available. The earlier analysis suggests that the wealth of outside shareholders under different payout policies is as follows:

With no payout:

$$(1-\beta)Np_{NA} = (1-\beta)N\bar{\alpha}\left(i-\frac{c}{2}\right) \tag{15}$$

With a dividend of C:

$$(1-\beta)N(\bar{\alpha}(i-c)+c) \tag{16}$$

With a repurchase program (in a repurchase equilibrium):

$$Qp + ((1-\beta)N-Q)E[p_2] = (1-\beta)NE[p_2] - Q(E[p_2]-p) \tag{17}$$

where p and $E[p_2]$ are from (7) and (13), respectively.

Using the wealth without a payout term (15) as a benchmark, comparing (15) through (17) is equivalent to comparing:

$$\begin{aligned} \text{No payout} &: \quad 0, \\ \text{Dividend of } C &: \quad (1-\beta)\, Nc\left(1-\frac{\bar{\alpha}}{2}\right), \text{ and} \\ \text{Repurchase program} &: \quad N(1-\beta)\left(E[p_2]-p_{NA}\right)-Q\left(E[p_2]-p\right). \end{aligned} \tag{18}$$

Proposition 4 *For the outside shareholders, if a repurchase equilibrium exists, there exists $\bar{\alpha}_R$, in the range*

$$2-\frac{1}{2(1-\beta)}<\bar{\alpha}_R<2$$

such that for all $\bar{\alpha} < \bar{\alpha}_R$ a dividend is the dominant payout policy and for all $\bar{\alpha} > \bar{\alpha}_R$ a repurchase is the dominant payout policy.

Proposition 4 suggests that if both repurchase and dividend dominate no payout, a dividend dominates a repurchase when expected return on investment $\bar{\alpha}$ is relatively low, but a repurchase dominates a dividend when expected return on investment $\bar{\alpha}$ is relatively high.[19]

Together, Propositions 1 through 4 suggest the following:

(*i*) If expected return on funds invested is very high ($\bar{\alpha} > 2$), a dividend is never an equilibrium outcome because it is dominated by a policy of no payout (Proposition 1).

(*ii*) If $\frac{\gamma}{\beta}$ is very low or very high, a repurchase is never an equilibrium outcome because it does not dominate no payout; if $\frac{\gamma}{\beta}$ is of moderate value, a repurchase will dominate no payout unless σ_α is low or c is high (Propositions 2 and 3).

(*iii*) If both repurchase and dividend dominate no payout, i.e., if both $\bar{\alpha} < 2$ and $\frac{\gamma}{\beta}$ is of moderate value, a dividend dominates a repurchase when expected return on investment $\bar{\alpha}$ is relatively low whereas a repurchase dominates dividend when expected return on investment $\bar{\alpha}$ is relatively high (Proposition 4).

Results (*i*) – (*iii*) are summarized in Table 1.

[19] In the model, given α_1 and α_2, the wealth effects of a dividend depend only on $\bar{\alpha}$, while the wealth effects of a repurchase depend also on the specific values of α_1 and α_2. The variability of return on investment α may affect the level of $\bar{\alpha}_R$ in Proposition 4 but does not alter the qualitative result.

Table 1: Optimal payout policy as a function of: β/γ (insider benefit from waste relative to insider ownership), $\bar{\alpha} = (\alpha_1 + \alpha_2)/2$ (expected return on funds invested), σ_α (variability in return on investment), and c (variability in free cash, or equivalently, in the size of investment opportunity).

	Low $\frac{\beta}{\gamma}$	**Moderate**$\frac{\beta}{\gamma}$			**High** $\frac{\beta}{\gamma}$
		Low σ_α	**High** σ_α		
			Low c	**High** c	
Low $\bar{\alpha}$	Dividend	Dividend	Dividend/Repurchase	Dividend	Dividend
High $\bar{\alpha}$	No payout	No Payout	Repurchase	No Payout	No payout

3 Empirical predictions

What are the empirical implications of these results for payout policy? Table 1 suggest the following:

1) Higher expected return on investment (higher $\bar{\alpha}$) is associated more with repurchases than with dividends. Our interpretation of expected return is the firm's growth opportunities.

2) Higher uncertainty about return on investment (higher σ_α) is associated more with repurchase than with dividends. Out interpretation of uncertainty of return is how risky the firm is.

3) Higher uncertainty about the levels of free cash (higher c) is associated more with dividends than with repurchase. Our interpretation of c is the agency costs of free cash flow. This is because the higher the c, the more severe the loss from the waste of free cash. Firms that face high uncertainty about their investment prospects risk amassing large sums of free cash that can be subject to severe waste. Because dividends are better than repurchases in preventing the waste of free cash, these firms will tend to disburse cash using dividends rather than using repurchases.

4) The prediction about β/γ is less straightforward to interpret. Table 1 suggests that for a repurchase to be the preferred payout policy, $\frac{\beta}{\gamma}$ can be neither too low nor too high. Empirically, however, the former restriction seems to be the binding one. This is because as described in the introduction most buybacks are only partly completed and tend to be welcomed in the financial markets as good news. This suggests that, in practice, there is less of an incentive to repurchase rather than too much of one, that is, levels of $\frac{\beta}{\gamma}$ are mostly low. Indeed, although we are not aware of empirical evidence on the benefits from waste γ, in practice β is very low (1%–5%, see Footnote 13), suggesting that β is significantly lower than γ. Accordingly, our comparison with the empirical evidence will ignore the last column in Table 1 and focus on the restriction that $\frac{\beta}{\gamma}$ cannot be too low. Thus, one prediction is that high insider ownership

(high β) makes repurchases more likely than dividends. Given the assumed association of private benefits to insiders from waste γ with governance quality, another prediction is that good corporate governance also makes repurchase more likely than dividends. Like high levels of free cash c, high levels of γ are associated with agency problems.

We can summarize the empirical predictions suggested by the model as follows:

1) Growth firms have low payouts. If they do disburse cash, they tend to do so with repurchases rather than with dividends. Mature firms have high payouts. They tend to distribute free cash with dividends more than with repurchases.

2) The riskier the firm, the more likely it is to disburse free cash with repurchases than with dividends.

3) Agency problems (either through availability of free cash or though poor-quality governance) make dividends more likely than repurchases.

4) Higher insider ownership makes repurchases more likely than dividends.

4 Empirical evidence, robustness, and further research

In this section we compare the model predictions to the empirical evidence, discuss the robustness of the results, and suggest directions for further research. The model predictions are broadly consistent with the empirical evidence.

Growth – Empirically, young growth firms that naturally have high investment needs tend to have no payout. It is the larger and relatively mature firms that pay out cash (see Grullon and Michaely (2002), and Fama and French (2002)). Among the firms that do distribute cash to shareholders, growth firms that need financial flexibility prefer repurchases, while mature firms pay dividends (see Guay and Harford (2000), Jagannathan et al. (2000), Grullon and Michaely (2002), Brav et al. (2005), and DeAngelo et al. (2006)). The association of financial flexibility with repurchases is also consistent with the findings in Dittmar and Dittmar (2006) that repurchases are correlated with business cycles, because, as they argue, investment needs are correlated with business cycles.

Risk – The model's prediction about risk is also supported by the data. Indeed the empirical evidence suggests that, among firms that pay out cash, riskier firms use repurchases whereas safer firms use dividends (e.g., Jagannathan et al. (2000), Guay and Harford (2000), Grullon and Michaely (2002), and Billett and Xue (2007)). Although the model is not dynamic, this prediction is also consistent with dividend smoothing (e.g., Lintner (1956)). Specifically, if dividends are associated with stability and repurchases are associated with volatility, then dividends would be smooth while payout through repurchase would not.

Agency Problems – Agency problems in the model are generated both by high c (possible levels of free cash) and high γ (benefits to insiders from waste that we have identified with quality of governance). In the model, both will lead to a repurchase rather than a dividend. Consistent with this prediction, John and Knyazeva (2006) find that dividends are preferred over repurchases when agency problem are severe. While the literature suggests that in general agency considerations play a significant role in payout policy (e.g., Grullon and Michealy (2004, 2007)), we are not aware of any study that investigates how the choice of payout method depends on governance quality. The cross-country evidence is consistent with the prediction that repurchases would be an efficient payout tool only in the presence of good governance. Indeed, repurchases are common practice only in countries that have good corporate governance, while countries with poor corporate governance tend regulate repurchases strictly and even to ban them, suggesting that in these countries, repurchases cannot enhance the wealth of outside (uninformed) shareholders. In these poor corporate governance countries dividends are the only available payout method.[20] Overall the model suggests that better governance is associated with more payout, which is consistent with the findings in La Porta et al. (2000).

Insider Ownership – The association between insider ownership β and repurchases is consistent with findings about the correlation between stock options and repurchases documented in Weisbenner (2000), Fenn and Liang (2001), and Kahle (2002). While these authors suggest that insiders use repurchases to compensate for the dilution of earnings from stock option grants, our model implies that it is also possible that stock options motivate insiders to pay out cash through repurchases by offering them a greater share of the benefit from waste prevention.

As was briefly discussed in the introduction, the model highlights two important properties of open-market programs that dividends lack. First, unlike dividends, which become a commitment once declared and that informally commit the firm to future dividends, with an open-market program announcement the firm retains the option not to repurchase.[21] This option is valuable because it gives the firm the flexibility to distribute cash only when it realizes that the cash is indeed free. Second, the model suggests that unlike dividends, repurchases also motivate payout by providing gains to insiders through the firm's informed trade. While these gains to informed insiders are generally viewed in the literature as a negative property of open-market programs (e.g., Barclay and Smith (1988), Brennan and Thakor (1990)), we

[20] Desai et al. (2003) provide evidence that American conglomerates use dividends to avoid the agency costs of free cash in their foreign affiliations where property rights are weak. Furthermore, in countries with poor governance, ownership is concentrated (e.g., La Porta et al. (1999)), suggesting that insiders rather than outsiders are in control.

[21] The stock market penalties for dividend reductions are well documented, e.g., Aharony and Suary (1980). There are no such penalties documented for repurchases (see Stephens and Weisbach (1998)).

suggest that they might not represent a zero-sum game. That is, the repurchase trade does not merely transfer wealth from outsiders to insiders; it also enhances social wealth. Together these properties suggest that when shareholders do not want to impose a dividend that could cause managers to shave investment, or cannot impose dividend payment on managers in order to avoid agency problems associated with the waste of free cash, an open-market program may be the second-best choice. If so, then an open-market program can complement dividends and help increase total free cash payout. We know there is a general decline in the propensity of firms to pay dividends over the last two decades (Fama and French (2001), DeAngelo et al. (2000, 2004)). This documented decline started before the documented increase in repurchase activity, suggesting that repurchases have evolved as a mechanism to encourage payouts when dividends cannot do the job.

The model also highlights two limitations of repurchase programs. First, repurchases are only a partial solution to the agency costs of free cash problem. Namely, because repurchases are optional, they must provide insiders with enough incentive to forgo the private benefits from waste and execute the repurchase. This incentive comes in the form of trading gains that result from (informed) strategic repurchasing. Because strategic repurchasing is necessary, repurchases cannot completely prevent the waste of free cash. Second, for repurchases to work as a payout mechanism, they cannot be accepted in the market as bad news. Specifically, all else equal, the more the free cash the poorer the investment prospects, and hence availability of free cash is bad news. Yet, because repurchases are executed through trade in the financial markets under asymmetric information, their possible execution must not be associated (ex-ante) with poor investment prospects. If it were, we show that the announcement of a program would result in market selloffs. Thus, for actual repurchases not to be bad news, there cannot be too much variability in investment prospects, or actual repurchases would be associated with poor investment prospects (even under strategic repurchasing), making execution of a repurchase bad news. While this second limitation is an interesting theoretical result of repurchases, the empirical evidence does not seem to suggest that this limitation is binding.

Our story is consistent with Stulz (1990), who suggests that debt level is determined as a trade-off between the need for financial flexibility and the need to prevent the waste of free cash. This is because debt payments are even more predetermined than dividends. We suggest there is a pecking order in which mature low-growth firms pay out free cash through debt (interest), moderate-growth firms pay out free cash through dividends, and high-growth firms pay out cash through repurchases. The actual mix of mechanisms depends on the need for financial flexibility and on the severity of the agency costs of free cash. This is because severe agency problems imply mandatory payout, in which case debt is better than a dividend payout and a dividend is better than repurchase. The need for financial flexibility implies optional payout in which case the preference order is reversed.

The model also provides an alternative to the traditional signaling explanation for the positive announcement return of open-market programs and dividends. Both can enhance the expected wealth of original shareholders by preventing the waste of free cash.

Insiders in Control – Our analysis focuses on the case in which outsiders are in control and set the payout policy. While technically, boards of directors determine payout policies, managers often have a large influence on these decisions. In Appendix B we briefly consider the case where insiders are in control. It is shown that the qualitative results are similar to those summarized in Table 1. However, in this case, for dividends to be the dominant payout tool, the benefits from waste prevention must cover not only the losses from investment distortion but also the insiders' benefits from waste. Thus, if insiders are assumed to be in control, the prediction would be that firms are even less likely to pay out dividends. At the same time, there is higher motivation to announce a repurchase, because it is the insiders who benefit from the firm's informed trade, and they also benefit from free cash waste, when the repurchase is not executed. Thus our model predicts that other things equal, when insiders in control, there will be less dividend payouts and more repurchase payouts.

Simultaneous Use of Dividends and Repurchases – Finally, in the model, the firm can disburse cash using only one payout method, dividend or repurchase. In practice, though, most repurchasing firms are also dividend payers (see Grullon and Michaely (2002)). In a more complex version of the model, where free cash has a fixed positive component, it could be possible to show that the certain component of free cash will always be paid out as dividends, and the rest would be paid out as in our model, consistent with this evidence.[22] This is also consistent with the findings that firms tend to pay permanent components of free cash with dividends and transitory components of free cash with repurchases (see, for example, Jagannathan et al. (2000)).

5 Conclusion

This paper builds on the agency costs of free cash to explain how firms determine their payout policy. Our results suggest that dividends eliminate the agency costs of free cash by forcing cash out, but could result in underinvestment if the cash paid out is later needed for operations. Open-market programs avoid the underinvestment problem by leaving insiders the option to

[22] Intuitively, payout of certain free cash never results in shaving of investment. With an open-market program, however, insiders can either waste this certain cash or use it for repurchase, in which case they have trading gains at the expense of the outsiders.

cancel the payout. Instead, they stimulate payout by providing trading gains to these better informed insiders at the expense of the general shareholders. Because their execution is optional, open-market programs cannot always prevent the waste of free cash. Payout policy is thus determined as a trade-off between eliminating agency problems (with dividends) and preserving financial flexibility (with open-market programs).

6 Appendix A – Proofs of Lemmas and Propositions

Proof of Proposition 1: Maximizing (1) over D is equivalent to minimizing

$$(\bar{\alpha}-1)D+\bar{\alpha}\frac{(C-D)^{+}}{2}. \tag{19}$$

The function (19) is piecewise linear in D on the segments $\{(0,C),(C,I)\}$. In order to optimize the dividend level, it is thus enough to compare the value of (19) on the extreme points $D\in\{0,C,I\}$. If $D=0$, the value of (19) is

$$\bar{\alpha}\frac{C}{2}. \tag{20}$$

If $D=I$, the value of (19) is

$$(\bar{\alpha}-1)\,I. \tag{21}$$

If $D=C$ the value of (19) is

$$(\bar{\alpha}-1)C \tag{22}$$

which is always lower (better) than (21). Thus, optimization implies choosing $D=C$ or $D=0$ depending on whether or not

$$(\bar{\alpha}-1)C<\bar{\alpha}\frac{C}{2}$$

which can be rearranged to

$$\left(\frac{\bar{\alpha}}{2}-1\right)<0 \tag{23}$$

and implies choosing $D=C$ if $\bar{\alpha}<2$ and choosing $D=0$ otherwise.■

Proof of Lemma 1: For part (*i*) of the lemma, suppose $p>E[p_2]$. Expecting this, not only would liquidity traders sell their shares but also all other outside shareholders would want to sell their shares. But, if the market maker buys all shares at $t=1$ and $p>E[p_2]$, then his expected gain is negative. Therefore $p>E[p_2]$ is not a sustainable equilibrium outcome.

For part (*ii*) of the lemma, we will show that if the firm buys in both states $\{SL,SH\}$ the condition $p\leq E[p_2]$ cannot hold. Suppose that the firm repurchases in both states $\{SL,SH\}$.

Then the market maker condition is

$$(p-\frac{\alpha_1(i-c)}{1-\frac{c}{p}})\left(Q-\frac{Nc}{p}\right)+(p-\alpha_1 i)Q+(p-\frac{\alpha_2(i-c)}{1-\frac{c}{p}})\left(Q-\frac{Nc}{p}\right)+(p-\alpha_2 i)Q=0 \quad (24)$$

which can be rearranged to

$$(p-E[p_2])-\frac{Nc}{4Qp}\left((p-\frac{\alpha_1(i-c)}{1-\frac{c}{p}})+(p-\frac{\alpha_2(i-c)}{1-\frac{c}{p}})\right)=0.$$

Suppose that $p\leq E[p_2]$. Then it must be the case that

$$(p-\frac{\alpha_1(i-c)}{1-\frac{c}{p}})\frac{Nc}{p}+(p-\frac{\alpha_2(i-c)}{1-\frac{c}{p}})\frac{Nc}{p}\leq 0$$

or

$$p\leq\frac{\alpha_1+\alpha_2}{2}(i-c)+c=\bar{\alpha}(i-c)+c. \quad (25)$$

Solving the market condition (24) for the price p and substitution into (25) yields

$$p=\frac{p_{NA}+\left(\frac{N}{2Q}+1\right)c+\sqrt{\left(p_{NA}+\left(\frac{N}{2Q}+1\right)c\right)^2-c\left(2\bar{\alpha}i+(2c+2\bar{\alpha}(i-c))\frac{N}{Q}\right)}}{2}\leq\bar{\alpha}(i-c)+c$$

where p_{NA} is given in (4). Upon rearrangement

$$p_{NA}+\left(\frac{N}{2Q}+1\right)c+\sqrt{\left(p_{NA}+\left(\frac{N}{2Q}+1\right)c\right)^2-c\left(2\bar{\alpha}i+(2c+2\bar{\alpha}(i-c))\frac{N}{Q}\right)}\leq 2(\bar{\alpha}(i-c)+c)$$

which can be further rearranged (by squaring each positive side of the quadratic inequality) to

$$-c\left(2\bar{\alpha}i+(2c+2\bar{\alpha}(i-c))\frac{N}{Q}\right)\leq 4(\bar{\alpha}(i-c)+c)^2-2(2\bar{\alpha}(i-c)+2c)\left(p_{NA}+\left(\frac{N}{2Q}+1\right)c\right)$$

or

$$c(2\bar{\alpha}i-4\bar{\alpha}c+4c)\leq 4(\bar{\alpha}(i-c)+c)^2-4p_{NA}(\bar{\alpha}(i-c)+c).$$

Substituting p_{NA} using (4) and further rearranging, we can write this as

$$2c(2\bar{\alpha}i-4\bar{\alpha}c+4c)\leq(2\bar{\alpha}(i-c)+2c)\left[4(\bar{\alpha}(i-c)+c)-(4(\bar{\alpha}(i-c))+\bar{\alpha}c)\right]$$

which boils down to

$$\bar{\alpha} \leq 1$$

or

$$\alpha_1 + \alpha_2 \leq 2$$

which never holds, since by assumption $1 < \alpha_1 < \alpha_2$. Thus, our conjecture $p \leq E[p_2]$ is wrong. Hence, whenever the firm repurchases in both states $\{SL, SH\}$ the market maker condition implies that $p > E[p_2]$ which can never hold in equilibrium. Now since the stock value is higher in state $\{SH\}$ than in state $\{SL\}$, a firm that repurchases in the state $\{SL\}$ will always repurchase in the state $\{SH\}$. Thus, in any equilibrium the firm would repurchase only in the state $\{SH\}$ if at all.■

Proof of Lemma 2: Part (i) - The market maker condition (6) can be rearranged to

$$p^2 - \left(p_{NA} + c\left(\frac{N}{4Q} + 1\right)\right)p + cp_{NA} - \frac{\alpha_2(i-c)}{4}c + (c + \alpha_2(i-c))\frac{Nc}{4Q} = 0.$$

where $p_{NA} = \frac{\bar{\alpha}}{2}(2i - c)$. The solution of this quadratic equation is

$$p = \frac{p_{NA} + c\left(\frac{N}{4Q} + 1\right) \pm \sqrt{(p_{NA} + c\left(\frac{N}{4Q} + 1\right))^2 - 4c\left(p_{NA} - \frac{\alpha_2(i-c)}{4} + (c + \alpha_2\,(i-c))\,\frac{N}{4Q}\right)}}{2}.$$

which can be rearranged to

$$p = \frac{p_{NA} + c\left(\frac{N}{4Q} + 1\right) \pm \sqrt{(p_{NA} + c\left(\frac{N}{4Q} + 1\right))^2 - c\left(4p_{NA} + c\frac{N}{Q} + \alpha_2\,(i-c)\left(\frac{N}{Q} - 1\right)\right)}}{2}. \quad (26)$$

Only the positive solution in (26) is feasible, which is (7).

Part (ii) - The market maker condition (6) can be rearranged to

$$(p - E[p_2]) - \frac{Nc}{4Qp}(p - \frac{\alpha_2\,(i-c)}{1 - \frac{c}{p}}) = 0.$$

From Lemma 1, in any equilibrium with a repurchase announcement $p < E[p_2]$, which by inspection is thus equivalent to

$$p < \frac{\alpha_2\,(i-c)}{1 - \frac{c}{p}}$$

which can be further rearranged to

$$p < \alpha_2 (i - c) + c.$$

Part (iii) - Substituting (7) into (8) yields

$$\frac{p_{NA} + c\left(\frac{N}{4Q} + 1\right) + \sqrt{(p_{NA} + c\left(\frac{N}{4Q} + 1\right))^2 - c\left(4p_{NA} + c\frac{N}{Q} + \alpha_2 (i - c)\left(\frac{N}{Q} - 1\right)\right)}}{2} < \alpha_2 (i - c) + c$$

where p_{NA} is from (4). Upon rearrangement

$$p_{NA} + c\left(\frac{N}{4Q} + 1\right) + \sqrt{(p_{NA} + c\left(\frac{N}{4Q} + 1\right))^2 - c\left(4p_{NA} + c\frac{N}{Q} + \alpha_2 (i - c)\left(\frac{N}{Q} - 1\right)\right)} < 2\left(\alpha_2 (i - c) + c\right)$$

which can be further rearranged to

$$-c\left(4p_{NA} + c\frac{N}{Q} + \alpha_2 (i - c)\left(\frac{N}{Q} - 1\right)\right) < 4\left(\alpha_2 (i - c) + c\right)^2 - \left(\alpha_2 (i - c) + c\right)\left(4p_{NA} + c\left(\frac{N}{Q} + 4\right)\right)$$

and further rearranged to

$$c\left[4\left(\alpha_2 (i - c) + c\right) - 4p_{NA} + \alpha_2 (i - c)\right] < 4\left(\alpha_2 (i - c) + c\right)^2 - \left(\alpha_2 (i - c) + c\right) 4p_{NA}$$

which is

$$4p_{NA} - 4\alpha_2 (i - c) < 3c.$$

Substituting p_{NA} using (4) this becomes

$$(3\alpha_2 - \alpha_1 - 3)\, c < 2\left(\alpha_2 - \alpha_1\right) i$$

which can be rearranged to (9).■

Proof of Lemma 3: Given that the state realized is $\{SH\}$, the insiders will execute the repurchase only if the terminal value of their shares with a repurchase is higher than the terminal value of their shares without one. That is, the firm (insider) participation condition is

$$\beta N \alpha_2 (i - c) + \gamma C \leq \beta N \frac{\alpha_2 (i - c)}{N - \frac{C}{p}}.$$

This condition can be rearranged to

$$p \leq \frac{\beta}{\gamma}\alpha_2(i-c)+c. \tag{27}$$

On the other hand, for a repurchase equilibrium to exist, Lemma 2 requires that the insiders must not repurchase in the state $\{LS\}$. That is, in any equilibrium with a repurchase announcement

$$\beta N\frac{\alpha_1(i-c)}{N-\frac{C}{p}} < \beta N\alpha_1(i-c)+\gamma C$$

After rearrangement, this condition can be written as

$$\frac{\beta}{\gamma}\alpha_1(i-c)+c < p \tag{28}$$

We can combine conditions (27) and (28) to write the restrictions on insider participation as (10).■

Proof of Proposition 2: Condition (8) is binding only if $\frac{\beta}{\gamma} < 1$. Otherwise, condition (27) is binding. Combining these conditions yields (11). ■

Proof of Proposition 3: Write the market maker condition (6) as

$$p - E[p_2] - \frac{Nc}{4Qp}(p - \frac{\alpha_2\,(i-c)}{1-\frac{c}{p}}) = 0$$

and rearrange to

$$E[p_2] - p = \frac{1}{4}\frac{Nc}{Q}\left(\frac{\alpha_2\,(i-c)}{p-c} - 1\right). \tag{29}$$

Using (4) and (13), write

$$\begin{aligned} E[p_2] - p_{NA} &= \frac{1}{4}\left(\alpha_1(2i-c)+\alpha_2\left(\frac{i-c}{1-\frac{c}{p}}+i\right)\right) - \frac{1}{4}\left(\alpha_1+\alpha_2\right)(2i-c) \\ &= \frac{1}{4}\left(\alpha_2\left(\frac{i-c}{1-\frac{c}{p}}+i\right) - \alpha_2\,(2i-c)\right) \\ &= \frac{1}{4}\alpha_2\,(i-c)\left(\frac{p}{p-c}-1\right) = \frac{1}{4}\alpha_2\,(i-c)\,\frac{c}{p-c} \end{aligned}$$

or

$$E[p_2] - p_{NA} = \frac{1}{4}\alpha_2 (i - c) \frac{c}{p - c}. \tag{30}$$

A repurchase dominates no payout if condition (14) holds. Upon substitution of $E[p_2] - p$ and $E[p_2] - p_{NA}$ from (29) and (30), respectively, condition (14) becomes

$$Q\left(\frac{1}{4}\frac{Nc}{Q}\left(\frac{\alpha_2 (i-c)}{p-c} - 1\right)\right) < N(1-\beta)\left(\frac{1}{4}\alpha_2 (i-c)\frac{c}{p-c}\right)$$

which can be rearranged to

$$\beta\alpha_2 (i - c) + c < p. \tag{31}$$

Given our assumption $\beta < 0.5$, it is enough to show that

$$\frac{\alpha_2}{2}(i - c) + c < p.$$

Upon substitution of p from (7) and rearrangement, this condition becomes

$$\alpha_2 (i - c) < c + 2(\alpha_1 + \alpha_2)\left(i - \frac{c}{2}\right)$$

which always holds.■

Proof of Proposition 4: Given that a repurchase dominates no payout and that in the range $\bar{\alpha} > 2$ no payout dominates a dividend, we only need to consider the range $\bar{\alpha} < 2$. For outside shareholders to favor repurchase over a dividend, we have from (18) that

$$(1-\beta) Nc\left(1 - \frac{\bar{\alpha}}{2}\right) < N(1-\beta)(E[p_2] - p_{NA}) - Q(E[p_2] - p)$$

or

$$Q(E[p_2] - p) < N(1-\beta)\left(E[p_2] - p_{NA} - c\left(1 - \frac{\bar{\alpha}}{2}\right)\right).$$

Using (29) and (30) from the proof of Proposition 3 to substitute for $E[p_2]-p$ and $E[p_2]-p_{NA}$, respectively, this condition can be written as

$$Q\frac{N}{Q}\frac{1}{4}c\frac{c + \alpha_2 (i-c) - p}{p-c} < N(1-\beta)\left(\frac{1}{4}\alpha_2 (i-c)\frac{c}{p-c} - c\left(1 - \frac{\bar{\alpha}}{2}\right)\right)$$

or

$$\frac{c + \alpha_2 (i-c) - p}{p-c} < (1-\beta)\left(\alpha_2\frac{i-c}{p-c} - (4 - 2\bar{\alpha})\right).$$

Upon rearrangement

$$(3 - 2\bar{\alpha} - 4\beta + 2\bar{\alpha}\beta)(p - c) + \beta(\alpha_2(i - c)) < 0$$

or

$$[(1 - \beta)(4 - 2\bar{\alpha}) - 1](p - c) + \beta(\alpha_2(i - c)) < 0. \tag{32}$$

There are two ranges to consider. If $(1 - \beta)(4 - 2\bar{\alpha}) > 1$, which is equivalent to

$$1 < \bar{\alpha} < 2 - \frac{1}{2(1 - \beta)} \tag{33}$$

then the condition (32) becomes

$$p < \frac{\beta}{1 - (1 - \beta)(4 - 2\bar{\alpha})}\alpha_2(i - c) + c$$

which never holds since the right-hand side is negative in the range (33). If, instead, $(1 - \beta)(4 - 2\bar{\alpha}) < 1$, which is equivalent to

$$2 - \frac{1}{2(1 - \beta)} < \bar{\alpha} < 2 \tag{34}$$

then the condition (32) becomes

$$\frac{\beta}{1 - (1 - \beta)(4 - 2\bar{\alpha})}\alpha_2(i - c) + c < p. \tag{35}$$

Consider the range (34), if $\bar{\alpha} = 2 - \frac{1}{2(1-\beta)}$, condition (35) becomes

$$\alpha_2(i - c) + c < p$$

which by Proposition 2 never holds. Alternatively if $\bar{\alpha} = 2$, (35) becomes

$$\beta\alpha_2(i - c) + c < p$$

which as shown in the proof of Proposition 3 always holds. Since in the range (34) both sides of (35) are increasing in $\bar{\alpha}$, there exists $\bar{\alpha}_R$ in the range (34) below which a dividend dominates a repurchase and above which a repurchase dominates a dividend.■

7 Appendix B - Insiders in control

When insiders are in control their choice of payout policy depends on their wealth under each policy rather than the wealth of the outsiders. However, given their choice of payout policy, the wealth terms of all agents (insiders, outsiders and the market maker) are unchanged, and hence, given a choice of payout policy the strategies of all agents are unchanged. Consequently, the conditions for existence of repurchase equilibrium are unchanged (Lemmas 1–3 and Proposition 2 are unchanged.) To find the resulting equilibrium, it is thus enough to compare the wealth terms of the inside shareholders under each policy.

Insider's wealth depending on the payout policy is as follows

With no payout:

$$\beta N p_{NA} + \gamma \frac{C}{2} = \beta N \bar{\alpha} \left(i - \frac{c}{2} \right) + \gamma N \frac{c}{2} \tag{36}$$

With a dividend of C:

$$\beta N \left(\bar{\alpha} \left(i - c \right) + c \right) \tag{37}$$

With a repurchase program (in a repurchase equilibrium):

$$\beta N E[p_2] + \gamma N \frac{c}{4} \tag{38}$$

Note the differences between these terms and the wealth terms of outside shareholders (15)–(17). In the case of no payout, the term $(1 - \beta)$ is replaced by β and benefits from waste $\gamma N \frac{c}{2}$ are added. In the case of dividend the only difference is that the term $(1 - \beta)$ is replaced by β. In the case of repurchase, the term $(1 - \beta)$ is replaced by β, benefits from waste are $\gamma N \frac{c}{4}$ reflecting incomplete waste prevention, and there is no term for trading losses because insiders do not trade their own shares at $t = 1$.

Proposition 1 still holds when insiders are in control, however it does not dictate insiders choice between dividend and no payout because insiders have private benefits from waste. Comparing the wealth terms (36) and (37) insiders prefer dividend over no payout if

$$\beta N \bar{\alpha} \left(i - \frac{c}{2} \right) + \gamma N \frac{c}{2} < \beta N \left(\bar{\alpha} \left(i - c \right) + c \right)$$

or

$$\gamma N \frac{c}{2} < \beta N c \left[1 - \frac{\bar{\alpha}}{2} \right]$$

This condition is more restrictive than condition $\bar{\alpha} < 2$ set by the outside shareholders. That is, the expected return above which insiders prefer no payout over dividend is lower than that set by outside shareholders. This is in turn because when insiders chose to payout dividends, they give up benefits from waste.

Comparing the wealth terms (36) and (38) insiders prefer dividend over no payout if

$$\beta N \frac{1}{4} \alpha_2 (i-c) \frac{c}{p-c} < \gamma N \frac{c}{2}$$

which can be rearranged to (27), which always holds according to Lemma 3. Thus, Proposition 3 holds also when insiders are in control. Namely whenever a repurchase equilibrium exists insiders will prefer to announce a repurchase over no payout.

Last, compare the wealth terms of insiders (37) and (38) to the wealth terms of outsiders (16) and (17). With dividends insiders get the same as outsiders (after factoring by ownership $\beta/(1-\beta)$). However, with repurchase in comparison to outsiders, insiders have benefits from waste $\gamma N \frac{c}{4}$ while they do not have trading losses $Q(E[p_2]-p)$. Thus, when both dividends and repurchases are feasible, insiders are more likely to prefer a repurchase over dividend in comparison to outsiders.

To conclude, when insiders are in control, other things equal, one would expect less dividend payout and more repurchase payouts.

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Figure 1: Time line

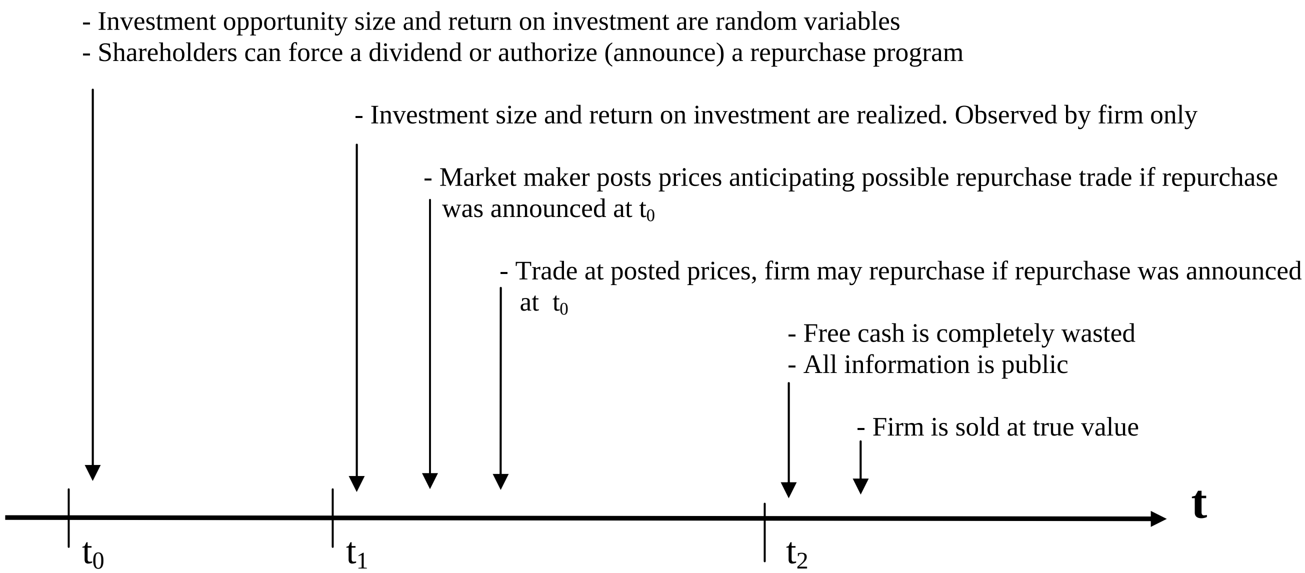

Figure 2: Feasibility of repurchase as a function of the ratio between insiders' ownership and benefits from waste β/γ. This figure demonstrates how existence of a repurchase equilibrium depends on the ratio β/γ. In the numerical example, we change the ratio β/γ in the range [0, 2.5], holding all other parameters fixed. The lower horizontal line represents the price p, and the upper horizontal line represents $E[p_2]$. Both lines are horizontal because both p and $E[p_2]$ do not vary with β/γ. Feasibility of a repurchase equilibrium requires that the no-free-riding condition $p < E[p_2]$ holds, i.e., that the line p is below the line $E[p_2]$. Under the parameter values chosen in this example the figure shows that this condition is always met.

The two diagonal lines that start at the origin represent the limits on p in the insider participation condition (10). Namely, the lower diagonal line represents the term $(\beta/\gamma)\alpha_1(i\text{-}c)+c$ and the upper (steeper) diagonal line represents the term $(\beta/\gamma)\alpha_2(i\text{-}c)+c$. Feasibility of repurchase equilibrium also requires that the insider participation condition (10) holds, i.e., that the line p will be between the diagonal lines. The figure indicates that for values of β/γ below 0.75, the line p is above the diagonal lines. Namely, the condition $p<(\beta/\gamma)\alpha_2(i\text{-}c)+c$ does not hold. For values of β/γ in the range [0.75, 1.8], the price p is between the diagonal lines so that the firm will repurchase only in state {SH} and hence a repurchase equilibrium exists. For values of β/γ above 1.8 the line p is below the diagonal lines. Namely, the condition $p>(\beta/\gamma)\alpha_1(i\text{-}c)+c$ does not hold and hence in this range a repurchase equilibrium cannot hold.

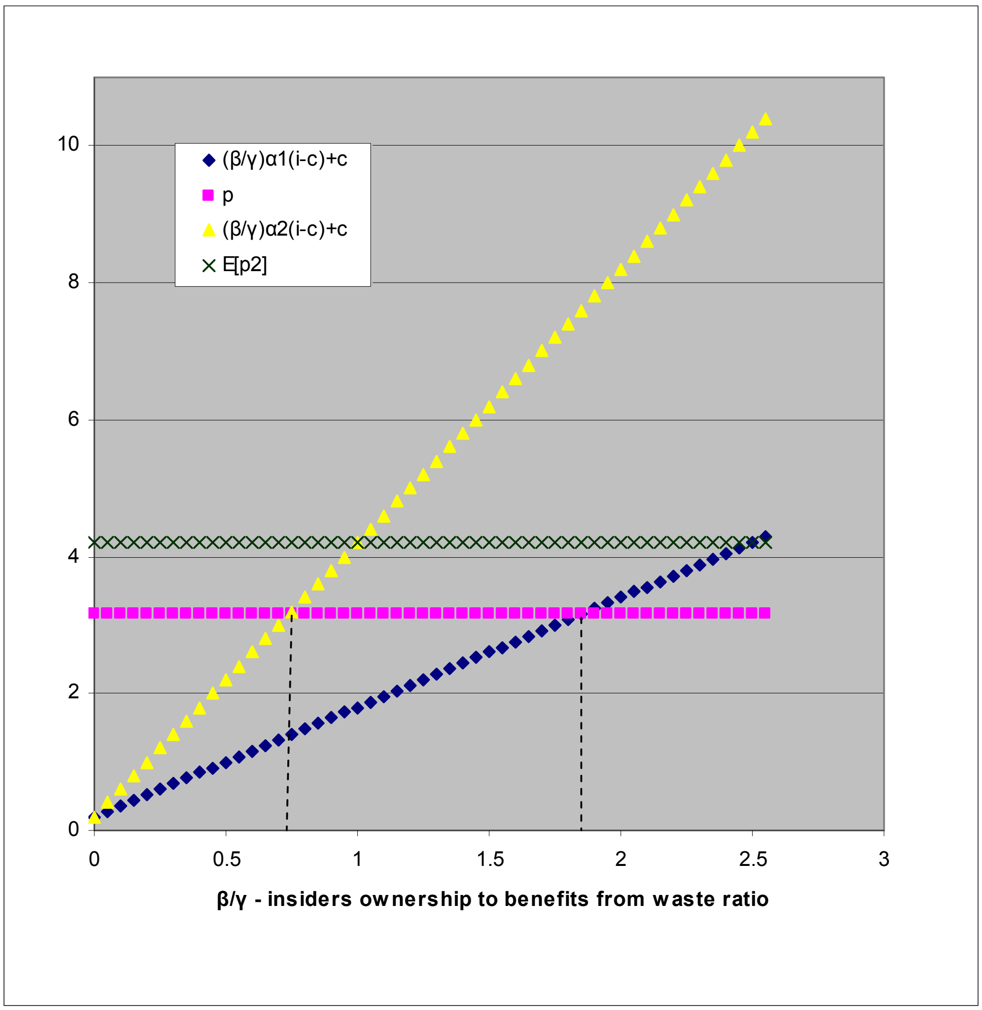

Figure 3: Feasibility of repurchase as a function of variability in free cash c. This figure demonstrates how existence of a repurchase equilibrium depends on variability in free cash c (equivalently, the variability in the size of investment opportunity). In the numerical example, we change the parameter c=C/N in the range [0, 1], holding all other parameters fixed. The lower and the upper diagonal lines that meet at c=1 represent the limits $(\beta/\gamma)\alpha_1(i\text{-}c)+c$ and $(\beta/\gamma)\alpha_2\ (i\text{-}c)+c$ in the insider participation condition (10), respectively. The concave diagonal line is $E[p_2]$, and the convex line is p. Feasibility of a repurchase equilibrium requires that the line p be below the line $E[p_2]$ and between the lines $(\beta/\gamma)\alpha_2\ (i\text{-}c)+c$ and $(\beta/\gamma)\alpha_2\ (i\text{-}c)+c$. The figure demonstrates that in the range c<0.38 repurchase is feasible. Namely, the line p is between the lines $(\beta/\gamma)\alpha_2\ (i\text{-}c)+c$ and $(\beta/\gamma)\alpha_2\ (i\text{-}c)+c$, and below the line $E[p_2]$. For c>0.38, the condition $p<(\beta/\gamma)\alpha_2\ (i\text{-}c)+c$ is violated and repurchase equilibrium cannot hold. For values c>0.6 the condition $p<E[p_2]$ also does not hold.

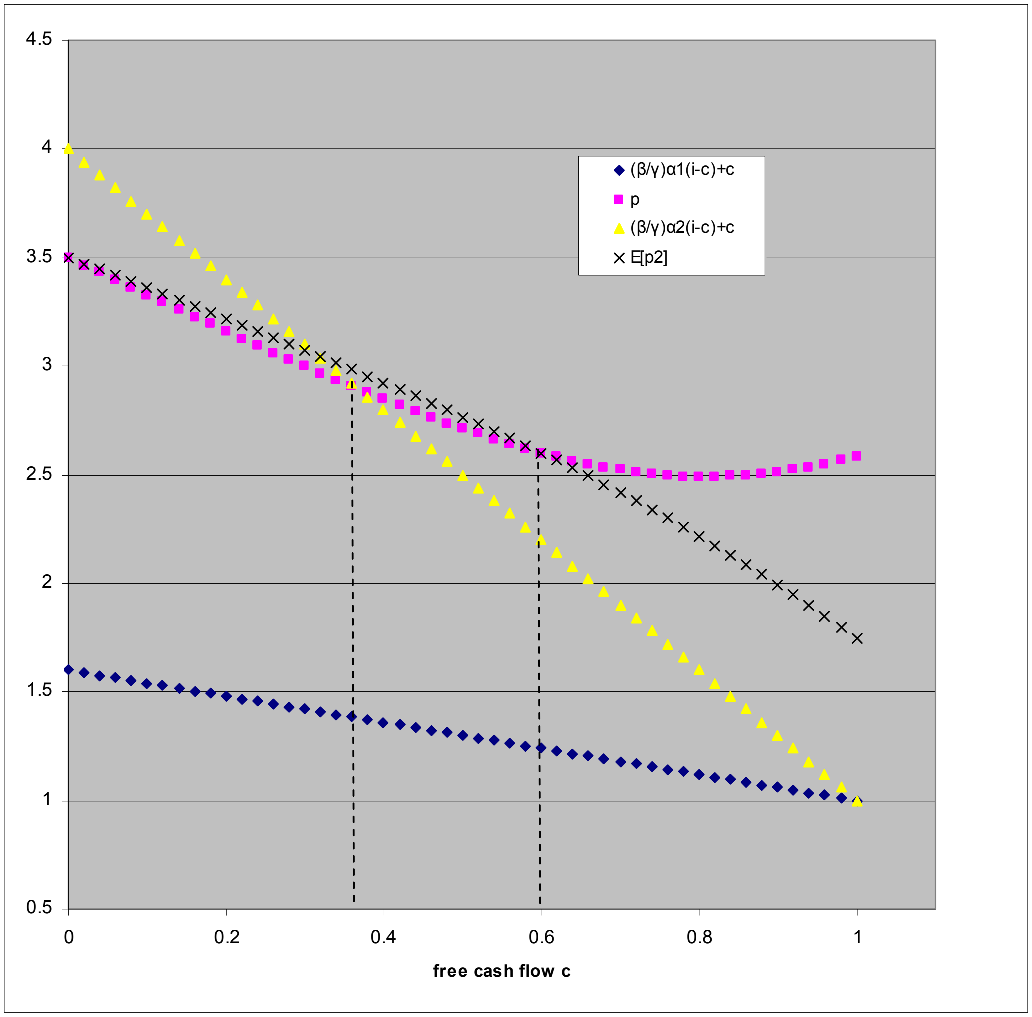

Figure 4: Feasibility of repurchase as a function of variability in return on investment α. This figure demonstrates how existence of a repurchase equilibrium depends on variability in return on investment α. In the numerical example, we let α_2 vary in the range [2, 5] and hold all other parameters fixed. The horizontal line at level 1.5 represents the term $(\beta/\gamma)\alpha_2(i\text{-}c)+c$ in condition (10) and the diagonal line that meets this horizontal line at $\alpha_2=2$ represents the term $(\beta/\gamma)\alpha_2(i\text{-}c)+c$ in condition (10). The two upper diagonal lines are p and $E[p_2]$. Feasibility of repurchase requires that the line p be below the line $E[p_2]$ and between the lines $(\beta/\gamma)\alpha_2(i\text{-}c)+c$ and $(\beta/\gamma)\alpha_2(i\text{-}c)+c$. When α_2 is low, a repurchase equilibrium is not feasible. Indeed the line p is above the line $E[p_2]$ and above both the lines $(\beta/\gamma)\alpha_1(i\text{-}c)+c$ and $(\beta/\gamma)\alpha_2(i\text{-}c)+c$. For $\alpha_2>2.15$ the condition $p<E[p_2]$ holds and for $\alpha_2>3.8$, the condition $p<(\beta/\gamma)\alpha_2(i\text{-}c)+c$ also holds. Thus, for $\alpha_2>3.8$, a repurchase is feasible.