The Good Cop and the Bad Cop: Complementarities between Debt and Equity in Disciplining Management[*]

Alexander Gümbel

Saïd Business School

University of Oxford

Lucy White

Nuffield College

University of Oxford

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Abstract

In this paper we examine how the quantity of information generated about firm prospects can be improved by splitting a firm's cash flow into a 'safe' claim (debt) and a 'risky' claim (equity). The former, being relatively insensitive to upside risk, provides a commitment to shut down the firm in the absence of good news. This commitment provides the latter a greater incentive to collect information than the aggregate claimant would have. Thus debt and equity are shown to be complementary instruments in firm finance. Moreover, we investigate the role of stock markets

Correspondence address: Alexander Guembel, Lincoln College, Oxford, OX1 3DR, U.K. Tel: (+44) 1865 279 782. Fax: (+44) 1865 279 802.
email address: alexander.guembel@sbs.ox.ac.uk

in transmitting information from equity to debt holders. This provides a novel argument as to why information contained in stock prices affects the real value of a corporation. It also allows us to make empirical predictions regarding the relation between shareholder dispersion, market liquidity and capital structure.

1. Introduction

Corporate finance theory has long recognized the role of capital structure in affecting managerial incentives (e.g. Jensen and Meckling, 1976). Over the years this approach to capital structure has evolved to take into account not only incentives for managers resulting from their claim on the firm, but also the incentives of providers of capital in affecting a firm's prospects. The incomplete contracts approach, for example, recognizes that providers of capital have differing incentives regarding the choice of project risk and that this choice should optimally be allocated contingent on past firm performance (Aghion and Bolton, 1992, Dewatripont and Tirole, 1994, Hart, 1995). In these papers debt performs the role of being a tough claim that allows the firm to be shut down in bad states of the world.

One important feature that much of this literature shares is that providers of capital are largely portrayed as being passive agents when it comes to information on which their decisions are based (see, however, Tirole, 2001, for a discussion of active monitoring). Either information is contained in publicly observable variables (such as past cash flows) or arrives as a signal about future prospects at no cost. Clearly, information production about firm prospects is an extremely important and costly activity, as witnessed by the resources allocated to financial analysis by investment banks, rating agencies etc. This paper focuses on the incentives of providers of capital to engage in information production about the future prospects of their firm. The main point we make in this paper is easily summarized: we show that debt and equity are complementary instruments in firm finance. When it is sometimes necessary for a provider of capital to take a 'tough' decision, such as firm shut-down, a claimant needs to have a 'flat(ish)' payoff structure

1

like debt, in order to be willing to take this action. Such a claimant, however, will have little incentive to produce information. Hence, the payoff sensitive equity claim provides an incentive to monitor the firm and provide the precise information subsequently used by the creditor.

In our set-up managers are subject to a moral hazard problem and ultimately care only about remaining in the job; they derive no utility from monetary incentives. Precisely because managers derive utility from incumbency, they must be motivated to work by the threat that the firm may be shut down. This means that someone must be given a senior claim with incentives to shut the firm down, even though it may be a going concern. This must be a flat(tish) "debt" claim in order that the claimant is not sensitive to the extra profits that could be gained by continuing (Dewatripont and Tirole, 1994). But almost by definition, such a claimant does not have the correct incentives to collect information about how large the profits to be gained from continuing are, i.e. about whether the manager has worked or not.

Thus we also require a claimant whose claim is sensitive to future returns, and who therefore has an incentive to collect information about these. Otherwise, although the debt-holder's decisions will be 'tough', they will also be random; not based on accurate performance measures, and so will do nothing to motivate the manager. The monitoring claim must clearly be equity-like, i.e. profit-sensitive, though its exact form will depend on what it is possible to make the contract of this 'monitor' contingent on. Thus debt and equity are complementary instruments in firm finance. If the manager has worked, the value of the monitor's claim will be high, and the monitor will be very keen for the firm to continue. The claimant charged with the continuation decision will use the information thus revealed in making his decision. Therefore the manager will care very much about what the value of the equity claim is - more than he cares about fundamental profits - because it is this that determines whether the firm will continue operating.

The most closely related paper to our own is Laux (2001), which explores how the headquarters of a company can use the financial structure of a subsidiary to commit to increased monitoring of the subsidiary manager's performance. His setting is somewhat different from ours because he assumes that the headquarters has a soft budget constraint, i.e. it would always want to continue the subsidiary even if returns are low. Specifically,

the subsidiary must issue debt which becomes void if the subsidiary's project is closed, but which must be paid off if the subsidiary's project continues even if it has negative profits. In simple terms, headquarters - which retains equity and control - deliberately creates a debt overhang problem to reduce its willingness to continue the subsidiary's project and hence its incentive to monitor the quality of that project. This differs from our result in several ways. First, in our paper, debt has the more plausible feature that it must always be paid off (or rolled over) if there are sufficient funds available in the project, and there is limited liability otherwise. Second, at the optimum, we find that the debtholder should be given control at the interim date, because - contrary to the Laux result, which seems to be driven by the strange form taken by his debt - the equity-holder would always wish to continue. Third, and perhaps most importantly, Laux does not explore at all the implications of equity trading and market liquidity in this context, as we do in the second half of our paper.

We examine the role of stock prices in transmitting information from equity holders to debt holders who may act on this information. A number of papers have attempted to explain why information contained in stock prices may be useful (Diamond, 1967, Hirshleifer, 1971, Leland, 1992, Holmstrom and Tirole, 1993). In this paper we provide a new theory that may help explain why firms and managers care about their share price: since debt holders do not have the incentives to produce information, their decisions are based on information contained in the stock price. Thus the real value of a firm is affected by its share price.

We model this by introducing a market in which cash-flow rights can be traded with noise traders. We show that the introduction of such a market enhances the monitoring incentives of the aggregate claimant (because gathering information allows him to make trading profits), so there is less need to split claims. Nevertheless, splitting claims can be helpful in further increasing information generation. In this case, one mechanism for the equity-holder to reveal credibly his information to the debt-holder is by buying shares in the firm when he receives positive information. Then the debt-holder bases his closure decision on how high the share price is, so the manager cares about the share price, as described above. We show that in this case, softening the creditor slightly by giving him risky debt can be optimal, since it generates additional trading profits and hence

information generating incentives for the equity holder. We thus predict that dispersed ownership and higher liquidity should be associated with higher gearing ratios.

The role of stock market liquidity has been investigated in the context of shareholder activism (Bhide, 1993, Bolton and von Thadden, 1998, Khan and Winton, 1998, Maug, 1998). These papers focus on the incentives of large blockholders to take costly actions to improve firm performance. Since an active shareholder who takes such a costly action faces a free rider problem from other, passive shareholders, a trade-off between ownership concentration and liquidity exists.

In contrast to these papers we consider the incentives of a shareholder to acquire information. As described above information is valuable since it improves resource allocation and mitigates agency problems. Since the shareholders of a geared firm do not maximize overall firm value, they may have an incentive to affect resource allocation by manipulating the share price and therefore available information. We show that when liquidity is high, manipulation becomes more costly, because the manipulator needs to take on a larger position to move the price. Small shareholders have a lower incentive to manipulate the stock price, because the impact on their exisiting stake is less important. We would therefore expect stock prices to function well as a transmitter of information when ownership dispersion is high and markets are liquid.

A number of papers have looked at the role of monitoring incentives for the providers of capital. Rajan and Winton (1995) investigate the role of covenants and collateral in providing monitoring incentives for creditors. Like our paper, Repullo and Suarez (1998) point out that the disciplining role of a termination threat may be limited by the lack of credibility of termination. However, they focus on the role of multiple creditors and show that a combination of informed and uninformed debt optimizes the trade-off between the cost of monitoring and the lack of a termination threat. Von Thadden (1995) examines monitoring in the context of short-term versus long-term debt contracts. Both of the above papers share a set of assumptions that is in line with much of the existing literature in this area; see for example also the costly state verification models of debt finance (Tonwsend, 1979, Gale and Hellwig, 1985). They assume that the monitor commits to a monitoring strategy and that it is publicly observable whether or not monitoring has taken place. Importantly, monitoring is typically not interim incentive compatible. In contrast to the

4

above papers, we focus on the problem of interim incentive compatible monitoring choices. Lastly, Winton (1993) looks at the role of monitoring incentives in the context of unlimited liability by equity holders.

Also related to our paper is a literature starting with Boot and Thakor (1993) (and more recently Fulghieri and Lukin, 2001) that emphasizes the role of security design on monitoring incentives in the context of trade on private information. Like our paper, this literature identifies equity as the information sensitive instrument and therefore argues that firm value may be increased by levering a firm with debt, and provide 'informational leverage'. This literature requires the existence of frictions in financial markets in the form of borrowing constraints; an assumption we do not make.

The plan of the paper is as follows. In section 2, we set up the basic model where information collection generates hard information and show that when all the cash-flow rights are held by the same claimant, it may be impossible to commit to enough monitoring to motivate the manager to work. We show how splitting the cash flow rights into a safe debt claim and an equity claim can improve upon this situation. We also show how this basic result is robust to renegotiation between claimants. In section 3, we demonstrate that the same result can be obtained when the information collected by the monitor is soft. We investigate the role of semi-strong form efficient stock markets as a means of credibly transmitting information in this context. Section 4 summarises results and concludes.

2. The Basic Model: Hard Information

There are three dates $t = 0, 1, 2$. There are two possible date 2 values R_ω of the firm, depending on the realization of a random variable $\omega \in \{l, h\}$, where $R_h > R_l$. At $t = 0$, the manager of the firm chooses effort $e \in \{\underline{e}, \overline{e}\}$. $\overline{e}$ denotes high effort, which accrues a cost γ to the manager, while low effort $\underline{e}$ comes at zero cost. If effort is high, the probability of the high state is given by $\overline{e}$, and if effort is low, the probability of the high state is $\underline{e}$. Moreover, the manager receives a private benefit from control given by b in the second period $t = 2$. There is a monitoring technology, which can be used at date 1 to provide a signal $s \in \{l, h, \emptyset\}$ about the future state of the world at date 2. If the monitor exerts costly effort $c(\theta)$, he will learn the true state of the world ($\{l\}$ or $\{h\}$)

with probability θ. Otherwise he receives no signal ($\emptyset$) and cannot update his prior. The function $c(\theta)$ is convex and increasing in θ.

The advantage of gaining information at the interim date $t = 1$ is that a controlling stakeholder can then choose an action C (continue operations) or S (stop). Action S corresponds to terminating the project and liquidating the firm. Doing so yields the liquidation value L, and implies that the manager will not receive his private benefit from continuation. Choosing action C means that instead, firm returns will be realised at date 2, R_h or R_l according to the state of the world, and the manager receives b. We assume that the manager's presence is essential for the continuation of the firm, i.e. the firm cannot be continued without him, for example because he has project specific skills. We denote by $A : \{l, h, \emptyset\} \rightarrow \{C, S\}$ a mapping from the signal realization onto the liquidation decision, i.e. $A(s)$ specifies a signal contingent liquidation strategy. We assume that $R_h > L > R_l + b$ so that it is efficient for liquidation to occur in the low state but not in the high state.

We are interested in a setting where production is actually worthwhile undertaking if the manager has worked. Thus we assume:

$$\overline{e}R_h + (1 - \overline{e})R_l > I > L. \tag{1}$$

where I is the initial investment required to start up the firm. Note that this also implies that the aggregate claimant would choose to continue the firm rather than liquidate it if he anticipates that the manager has worked and learns nothing more about firm prospects at $t = 1$. We also suppose that it is not profitable ex ante to finance the firm if it is anticipated that the manager will not work:

$\max \theta : \underline{e}R_h + (1 - \underline{e})[(1 - \theta)R_l + \theta L] - c(\theta) < I.$

Thus if the firm is to be financed, the manager must be induced to work. We assume further that it is efficient for the manager to work, i.e. $(\overline{e} - \underline{e})(R_h - R_l) > \gamma$. Suppose to simplify things that the manager is not responsive to monetary incentives and hence expected utility consists of the expected private benefit of running the project, minus the cost of effort. We conjecture that this assumption could be relaxed without changing the results at the cost of considerable additional complexity (see the analysis of Dewatripont and Tirole 1994).[1] Then the only inducement for the manger to work is the idea that

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[1]We conjecture that extending the model to consider wage contracts for managers who care about

if he does not work, the investor may decide to close the firm down after one period. However, as noted above, because the firm is ex ante profitable, the investor will never close the firm down if he thinks the manger has worked, unless he has received further information that the state is bad. Thus to provide the manager with an incentive to work, the investor must credibly commit to monitoring the interim value of the firm in order that he sometimes learns ahead of time that the outcome will be R_l, so he chooses to close the firm.

A. The Aggregate Claimant

If the investor owns all the cash flow rights to the firm, his incentive to monitor is:

$$\max \theta : \qquad V^* = \theta(\overline{e}R_h + (1-\overline{e})L) + (1-\theta)(\overline{e}R_h + (1-\overline{e})R_l) - c(\theta),$$

where we have used the fact noted above that if the investor learns nothing he cannot credibly commit to shut the firm when he learns nothing. Notice that if the difference between L and R_l is small, the investor has very little incentive to monitor. Let θ^* be the solution to the investor's first order condition, given by:

$$(1-\overline{e})(L - R_l) - c'(\theta) = 0 \qquad\qquad (2)$$

The manager's incentive constraint, on the other hand, is given by:

$$\theta\overline{e}b + (1-\theta)b - \gamma > \theta\underline{e}b + (1-\theta)b \qquad\qquad (IC_{manager})$$

So that, as remarked above, the manager works only if there is enough monitoring: $\theta > \gamma/(\overline{e} - \underline{e})b$. The interesting case occurs when $\theta^* < \gamma/(\overline{e} - \underline{e})b$, so that the investor holding all the cash flow rights to the firm cannot commit to obtaining enough information to make the manager work. To simplify things, we make the stronger assumption that: $\theta^{**} < \gamma/(\overline{e} - \underline{e})b$ where $\theta^{**}(> \theta^*)$ is defined by: $\underline{e}(R_h - L) - c'(\theta^{**}) = 0$. In other words,

monetary incentives as well as obtaining private benefits from continuation will not affect the qualitative results. If the manager can be motivated by monetary rewards, and is informed about the state of the world it is conceivable that he could be induced to report truthfully to the decision-maker. However, we conjecture that if private benefits of control are large enough, it will still be cheaper to hire an equity-holder manager, since the private benefits represent an additional bias in favour of reporting favourable information that the equity holder does not have. This means that it will be more expensive to illicit the truth from the manager (especially if he is cash-constrained) than from the equity-holder.

the monitor would not find it worthwhile to monitor enough even if the manager did not work. This assumption rules out mixed equilibria in which the manager sometimes works. Thus the manager always finds it optimal to exert low effort, in the anticipation that the investor will always want to continue anyway when he is uninformed, which is most of the time. Given the anticipated choice of $\underline{e}$ by the manager, investment in the firm is not profitable, so the enterprise cannot be financed. We now look at how splitting the claim can help improve information production.

B. Debt and equity with hard information

The purpose of this section is to illustrate that splitting the aggregate claim into a debt and equity claim can increase firm value. Doing so allows the providers of capital to pose a credible threat of project termination in the absence of good information. Interestingly, in our model, this threat does not directly motivate the manager, whose incentive compatibility constraint will be as before. (Notice from ($IC_{manager}$) above that whether the firm is closed or not when the monitor is uninformed does not affect the manager's incentive to work since this decision is independent of whether he works.) Instead, the threat of closure will motivate the equity claimant to collect more information at the interim date than would be optimal for the aggregate claimant. This more informed decision-making will then provide an incentive to the manager to exert the value-enhancing high effort level $\overline{e}$. This effect occurs because the debt holder has a flat claim and is therefore willing to liquidate the firm, when the aggregate claimant might not be. This role of debt has been recognized by Dewatripont and Tirole (1994). The novelty of our analysis is to show that equity plays a complementary role to debt in such a setting, because monitoring is a costly activity. Only someone with an information sensitive claim, such as equity, has an incentive to undertake costly monitoring. Moreover, the debt-holder's threat of liquidation motivates the equity-holder to acquire more information than the aggregate claimant would choose to do.

Suppose that the monitor's information is hard information by which we mean the following. If an agent claims a particular piece of information, this information is verifiable by other parties. However, an agent does not have to claim to have any information, i.e. he can conceal information from others. This assumption will be relaxed in the next

section where we investigate the case of soft (non-verifiable) information. Suppose also, that the firm is financed with debt of principal value D and equity (which has rights to any surplus income after paying the debt-holder).

Moreover, suppose the debt holder has control rights, i.e. the right to choose action A at date $t = 1$ after observing signal s, which is collected by the equity holder.[2] This could be because the creditor can decide not to roll over short-term debt after date $t = 1$. Effectively, this gives him uncontingent control over the liquidation decision at $t = 1$. (For the moment we do not allow the equity-holder to provide additional capital at $t = 1$, i.e. refinance the firm. We will look at this possibility later when we consider renegotiation between the two claim-holders at $t = 1$.) The debt-holder takes the liquidation decision based on (hard) information available from the equity-holder's report of the outcome of his monitoring activity. Remember that the equity-holder cannot lie about the signal which he receives, but he can conceal a bad signal l by reporting instead that he received no signal, $\emptyset$, "Don't know". The equity claim will be designed so as to provide an *ex ante* incentive to monitor, while the debt claim will be designed to provide an incentive to take the *ex ante* efficient continuation decision at the interim stage. We now prove the following proposition.

Proposition 1 *Supposing that the manager works, splitting the claim into safe debt $D = L$ and equity results in more monitoring than under the aggregate claim.*

Proof. The debt holder trivially wishes to continue operations after receiving good news and to stop after receiving bad news; in the light of the above discussion, his claim must be designed such that he prefers to stop when no signal is received. Note that there is no way to get the equity holder to report bad news since he can conceal information; so from the debt holder's point of view, these two possibilities are indistinguishable.[3] Anticipating that the manger has worked, the debt holder wishes to stop operations when

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[2]In contrast to Dewatripont and Tirole (1994) the allocation of control rights in our setting is not contingent on the realisation of a random variable, but rests with the debt-holder instead. This is due to our assumption that our date 1 signal is non-verifiable. If the signal were verifiable, the same outcome could be achieved by allocating control to the equity holder when the signal is good and to the debt-holder otherwise. But this is essentially no different from what is done here. Note that even with a verifiable signal, cash-flow rights would still have to be divided to achieve the high monitoring outcome.

[3]In fact, the equity-holder is indifferent about reporting bad news in this simple model with perfectly

9

the equity holder reports "don't know" (which may in fact be either bad news or don't know) if:

$$q\left(\theta\right)\min\{D,R_h\} + \left(1 - q\left(\theta\right)\right)\min\{D,R_l\} \lessgtr \min\{D,L\}, \tag{3}$$

where $q\left(\theta\right) \equiv prob(\omega = h|s = h) = \frac{(1-\theta)\overline{e}}{1-\theta\overline{e}}$. Note, that inequality (3) is weakly satisfied for all levels of riskless debt: $D \lessgtr R_l$. For risky debt, the debt holder strictly prefers to stop as long as $L > D > R_l$, regardless of signal quality. For $L \lessgtr D \lessgtr R_h$, the debt-holder will be content to stop if and only if $q^h\left(\theta\right) \lessgtr \frac{L-R_l}{D-R_l} \equiv \phi$. In other words, he will be willing to stop if the probability that the monitor is informed is high enough, $\theta > \frac{\overline{e}-\phi}{\overline{e}-\phi\overline{e}}$, or if his claim is steep enough. Supposing that these conditions are satisfied, the equity-holder's incentive to monitor is:

$\max\theta: V^{*equity} = \overline{e}\theta(R_h - D) + (1-\theta)\max\{L - D, 0\} - c(\theta)$

Yielding first order condition:

$\overline{e}(R_h - D) - \min\{L - D, 0\} - c'(\theta^{*equity}) = 0$

It is easy to see that safe debt D equal to the firm's liquidation value L maximises the equity-holder's incentives to monitor. Moreover, in this case, the debt-holder's incentive to monitor is zero, so there will be no duplication of monitoring. In this case we have: $\overline{e}(R_h - L) = c'(\theta^{*equity})$, which (from above) implies more monitoring than the aggregate claim if $\overline{e}(R_h - L) > (1-\overline{e})(L - R_l)$, which is true since $L < \overline{e}R_h + (1-\overline{e})R_l$. Under this continuation policy, it turns out that the manager's IC looks the same as before, and he can be induced to work if $\theta^{*equity} > \frac{\gamma}{(\overline{e}-\underline{e})b}$. ∎

Corollary 1 *Splitting financial claims into safe debt and equity will increase the manager's effort relative to the aggregate claim if: $c'^{-1}[\overline{e}(R_h - L)] > \frac{\gamma}{(\overline{e}-\underline{e})b} > c'^{-1}[(1 - \overline{e})(L - R_l)]$. Thus splitting the aggregate claim into debt and equity can achieve the high effort level when this is not attainable with ungeared equity.*

It is less clear that splitting the claim will actually increase firm value, however, for two reasons. Firstly, since the firm is shut down more often under split claims, it is not clear whether it is still efficient for the manager to work under this more stringent

informative signals, so in this special case one could also assume that he truthfully reports bad news. Which assumption is made will not be important for our results here.

closure policy. However, it is straightforward to realize that if monitoring is sufficient to induce the manager to work, it must be socially valuable for him to do so since he does not internalize all the benefits from his working. (Formally, managerial effort is socially efficient given the closure rule if $\theta^{*equity} > \frac{\gamma}{(\overline{e}-\underline{e})(R_h - L + b)}$.) Secondly, under the new closure policy, the investors have to commit to an inefficient shutdown rule: they shut the firm down when they do not observe a signal, which reduces firm value if the manager has worked. However, it turns out that under the assumptions made above, it is indeed the case that splitting claims improves value.

Proposition 2 *Given* $c'^{-1}[\overline{e}(R_h - L)] > \frac{\gamma}{(\overline{e}-\underline{e})b} > c'^{-1}[(1-\underline{e})(L - R_l)]$, *splitting the claim increases firm value.*

Proof. Firm value under split claims is: $V^{split} = \theta^{*equity}\overline{e}(R_h + b) + (1 - \overline{e}\theta^{*equity})L - c(\theta^{*equity}) - \gamma$. Firm value under the aggregate claim, if there is continuation after a null signal $\emptyset$, is:

$$V^{agg}_{continue} = \underline{e}(R_h + b) + (1 - \underline{e})(\theta^{**}L + (1 - \theta^{**})(R_l + b)) - c(\theta^{**})$$

$$= \{\theta^{**}\underline{e}(R_h + b) + (1 - \underline{e}\theta^{**})L - c(\theta^{**})\}$$
$$+ (1 - \theta^{**})[\underline{e}(R_h + b) + (1 - \underline{e})(R_l + b) - L].$$

By the assumption that the firm has negative social value if the manager does not work, the term in square brackets is negative, implying that the best thing in this case would be to shut down the firm when the null signal is received. Thus the value of the firm under the optimal shutdown policy with the aggregate claim, V^{agg} is simply equal to the term in curly brackets. Moreover, $\theta^{*equity} = \arg\max \theta\overline{e}(R_h - L) - c(\theta)$
$$= \arg\max \theta\overline{e}(R_h) + (1 - \overline{e}\theta)L - c(\theta),$$
and by assumption $\theta^{*equity} > \theta^{**}$ (since the former induces more effort than the latter). Therefore $\theta^{*equity}\overline{e}(R_h + b) + (1 - \overline{e}\theta^{*equity})L - c(\theta^{*equity}) - \gamma$
$$> \theta^{**}\overline{e}(R_h + b) + (1 - \overline{e}\theta^{**})L - c(\theta^{**}) - \gamma$$
$$> \theta^{**}\underline{e}(R_h + b) + (1 - \underline{e}\theta^{**})L - c(\theta^{**}).$$

The last inequality being due to fact remarked upon above that it still is efficient for the manager to exert effort under the more stringent closure rule. Thus the value of the first term in curly brackets, V^{agg}, is also less than V^{split} and we are done. ∎

Two observations are noteworthy at this stage. Firstly, though we have focussed here on the case of 'safe debt' $D = L$ for simplicity, any $D \leq L$ could work equally well, provided the creditor sticks to the ex ante efficient liquidation rule of $A(\emptyset) = S$. (When debt is truly riskless ($D \leq R_l$), the creditor is always indifferent between continuing and liquidating the firm. When this is the case one would have to suppose the creditor nevertheless takes the ex ante efficient liquidation decision for truly riskless debt to perform as well, which may not be realistic.[4]) This being the case, the equity-holder would have exactly the same monitoring incentives as before (he sets $c'(\theta) = \overline{e}(R_h - D) - \overline{e}(L - D) = \overline{e}(R_h - L)$). In other words, regardless of the level of riskless debt $D \leq L$, gearing *per se* does not affect monitoring, it is the induced change in the closure rule that affects monitoring.[5]

Secondly, for risky debt $D > L$, the creditor is not always willing to liquidate the firm after a null report from the monitor: he has too much at stake in the profitability of the enterprise. He will be willing to liquidate if $D \leq \frac{L - (1 - \overline{e})R_l}{\overline{e}}$. As observed by Dewatripont and Tirole (1994), it is always easier to induce a stakeholder with a 'flattish' claim such as risky debt to take the 'tough' action of liquidation. Moreover setting $D > L$ directly takes away some of the monitoring incentive from the equity holder, so risky debt is never optimal in this simple setting. Note that even if debt must for some reason be risky, firm value might be increased by splitting the claim, although the second best cannot be achieved.

C. Renegotiation

Given our assumptions it seems clear that whenever the monitor receives no information from monitoring in the proposed high effort equilibrium, the debt and equity holder can collectively gain from renegotiating to the choice of action C from the debt-holder's chosen

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[4]Strictly speaking even a debt level of $D = 0$ would work. All that is needed for the proposition to go through is an 'arbitrator' to whom the continuation decision is credibly delegated. In practice, however, it does not seem very realistic to delegate to someone who has no stake in the enterprise.

[5]In this respect our analysis differs crucially from Boot and Thakor (1993): as long as debt is riskless, monitoring incentives are unaffected by the introduction of debt in our setting, because the *slope* of the equity payoff remains the same.

action S.[6] For example, if the equity holder holds any wealth, then he has an incentive to try to buy the debt claim (refinance the firm if short-term debt is not rolled over) from the debt-holder. Thus the equilibrium derived above will not be renegotiation-proof. We model the renegotiation game as follows. After the equity holder makes his report at $t = 1$, with probability α, the equity-holder will have an opportunity to make a take-it-or-leave-it offer to the debt-holder to buy out his debt. With complementary probability $1 - \alpha$, the debt-holder makes a take-it-or-leave-it offer to sell his debt to the equity holder. Finally, whoever is holding the debt after this round of bargaining chooses an action C or S, returns are realised, and all parties receive the payoffs associated with their claims. We assume that if at this stage the debt-holder is indifferent to continuation, she chooses action C. For simplicity we will treat only the case when the debt-holder's debt is safe at $t = 1$, i.e. $D = L$. It should be clear how the logic of the other cases will be similar.

Note first that if the equity holder makes the report 'h' whoever is holding the debt after renegotiation will be willing to continue since $R_h > L$, so there is no risk to continuing. Therefore there is no inefficiency associated with the claim structure and no particular need for renegotiation. We can thus assume without loss of generality that the bargaining offers made are null offers, i.e. no claims or money will change hands. On the other hand, when the equity-holder reports '$\emptyset$', then without renegotiation, the debt-holder would choose S, and so the parties will wish to bargain to reach efficiency. If the equity holder makes an offer, he will offer the debt-holder the value of the debt in the absence of renegotiation, i.e. L. However, if the debt-holder makes an offer to the equity-holder, he knows that the latter stands to gain $\overline{e}(R_h - L) + (1 - e)R_l$ from continuation holding the debt plus equity, and so he can extract this by demanding this in exchange for giving up his debt. Thus the equity-holder's total payoff is given by:

$$\max \theta \quad : \quad \overline{e}[\theta\,(R_h - L) + (1 - \theta)(\alpha\,(R_h - L) + (1 - \alpha)0)] \tag{4}$$
$$+ (1 - \overline{e})(1 - \theta)\alpha(R_l - L) - c(\theta)$$

with first order condition: $\overline{e}(1 - \alpha)\,(R_h - L) + \alpha(R_l - L)(1 - \overline{e}) - c'(\theta) = 0$. By comparison with equation (2), this will represent strictly (weakly) more monitoring than the

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[6]We assume that the manager does not take part in this renegotiation (even though he too gains from continuation) because he has no wealth and his private benefit is inalienable. However, based on Dewiatripont and Tirole 1994, it is easy to see how our results would extend to the more general case.

aggregate claim whenever $\alpha < (6)1$. Thus our result is robust to renegotiation between claim-holders as long as the equity-holder does not have full bargaining power at $t = 1$. Intuitively, if the equity-holder has full bargaining power at $t = 1$, he internalises all the benefits of his monitoring and thus acts exactly like the aggregate claimant.

3. Soft information and trade

So far it has been assumed that the equity-holder's (the monitor's) information is publicly available. The following section deals instead with the case where the monitor's signal is non-verifiable (soft) information. If the firm is held by an aggregate claimant (unlevered equity) this will make no difference to the analysis of the previous section, since the monitor is also the decision-maker. However, if the claim is split into debt and equity, a mechanism is required to transmit information from the equity holder (monitor) to the creditor who acts on the information. A simple mechanism would be to require the equity holder to 'put his money where his mouth is'. This could take the form of a contract, requiring the equity holder to make a payment if he announces 'good news', and the bad outcome R_l occurs. This is quite similar to buying more shares in the firm if the signal $s = h$ is received. In general, however, buying shares in the market may provide an additional incentive to monitor, due to the profits that may result from trade on private information (Maug, 1998, Kahn and Winton, 1998). In this section we explore under what conditions it is optimal to design claims on the firm to take advantage of this additional monitoring incentive.

This section develops a simple trading model with semi-strong form efficient prices. We do this first in the context of an aggregate claimant (unlevered equity) who is allowed to trade. This will illustrate the mechanics of the trading model, and confirm the intuition that liquid markets increase monitoring effort. We then show that splitting the claim can increase firm value, even if information is soft, and examine the role of trade in this context.

The type of information that we have in mind in this setting is not insider information (to which trading restrictions apply in most countries).[7] That is, we are not thinking of

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[7]There is a growing literature that deals with the question of the desirability of insider trading, for example Leland (1992), Khanna, Slezak, and Bradley (1994) and Bhattacharya and Nicodano (2001).

superior information that an insider may receive costlessly by virtue of the fact of holding a particular post in relation to the firm. Instead we have in mind information that can be arrived at by analyzing publicly available information, e.g. by engaging in an in-depth market analysis etc. While it is costly to carry out such an analysis, in principle anyone can decide to expend the corresponding effort.

Suppose now that at $t = 1$ there is a market for equity. There is a large block holder who owns a fraction β of the firm's equity and a continuum of households of measure one who hold the remainder $1 - \beta$. For the time being this allocation is taken as given but will be endogenized below. The households are passive investors who hold their shares until liquidiation. For simplicity, households are assumed to be unable to monitor.[8] In addition there are noise traders, who demand a random quantity $d_n \in \{-n, 0, n\}$ at $t = 1$, with $prob(d_n = 0) = 1 - \eta$, and $prob(d_n = -n) = prob(d_n = n) = \eta/2$. The unit of n is the percentage of total equity outstanding. The monitor can also trade and his demand is denoted by d_m.

All orders are submitted simultaneously to a risk-neutral market maker who sets a price and meets order flow imbalances out of his inventory (see Kyle, 1985). The price is determined by the condition that the market maker breaks even in expectation, given the information contained in order flow. In this paper using a market maker mechanism for price determination and trade serves two purposes. Firstly, it is a convenient (and by now standard) way of modelling price formation in a semi-strong form efficient market. Secondly, the market maker provides liquidity by absorbing the slack after all market orders have been executed. This is important, because it allows market liquidity to be

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[8]One way to justify this assumption is to say that equity is widely held and that β constitutes the largest block of shares. In this case smaller shareholders may have no incentive to acquire information. Suppose for example that equity holder 1 has a larger stake than equity holder 2. Suppose also that for a monitoring effort $\theta_i > \theta_j$ signals are correlated in the following way: $prob(s_i \neq \emptyset | s_j \neq \emptyset) = 1$ and $prob(s_j \neq \emptyset | s_i \neq \emptyset) < 1$, i.e. the higher effort monitor i always receives a signal when monitor j does, but not vice versa. The smaller equity holder has a lower incentive to monitor, even if the per share value of monitoring were equal for either monitor and therefore he would only ever receive a signal when the larger equity holder receives a signal also. His signal is therefore useless in affecting the continuation decision. In addition if the larger equity holder also trades on his information by submitting orders of size n, the smaller equity holder cannot make a trading profit and therefore has no incentive to acquire information.

independent of ownership concentration. Hence, for the moment it is assumed that there is no trade-off between block size and market liquidity.

It is well known that ownership concentration may be detrimental to liquidity, for example due to transactions costs leading to limited participation in financial markets (Pagano, 1989, Allen and Gale, 1994). A number of papers have analysed the relation between ownership concentration, liquidity and monitoring incentives (e.g. Bolton and v. Thadden, 1998, Maug, 1998, Kahn and Winton, 1998). The results below are derived for given block sizes and liquidity. Section 5 extends the treatment to the case when increased block size reduces liquidity and derives implications for optimal ownership concentration.

It is assumed that the market maker can observe a pair of orders $Q = (d_n, d_m)$, but is unable to distinguish the originator of an order. This is a deviation from the standard set-up as in Kyle (1985), where market makers can observe *total* order flow and has been used for example in Biais and Germain (2002). Whenever order flow D reveals the equity holder's order, the market maker will set the price in equilibrium so that it is equal to the expectation of firm value, conditional on the signal realization. Hence, the equity holder can make a trading profit only if he succeeds in concealing his order from the market maker. In order to hide his order, the informed trader must choose orders of size n.

A. The Low Leverage Firm

In this section, we consider the case where the aggregate claimant can trade in the equity of his firm, the liquidation decision depends on the signal in the same way as before. In fact, the results continue to apply whenever the firm has issued safe debt $D \leq R_l$. In this case, one can assume that the debt-holder is always happy to continue at the interim stage unless the equity-holder prefers otherwise, so all incentives are as if there were no debt issued at all. The fact that information is private does not affect liquidation incentives, because the monitor is also the party in control. Therefore, liquidation still only occurs after bad news $s = l$ has been received.[9] The only change with respect to the model in section 2 is that the privacy of information affects monitoring incentives, because private

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[9]The statement is subject to the qualitifation that the block holder may want to deviate from the proposed equilibrium continuation decision in order to make extra-ordinary gains from trade. This possibility is dealt with explicitly below.

information has value in the stock market.

Consider the following signal contingent trades by the equity holder:

$$d_m(s = h) = n, d_m(s = l) = -n, \text{ and } d_m(s = \emptyset) = 0. \tag{5}$$

This will result in one of the following order flows:

$Q = (n, n)$: the equity holder received a good signal $s = h$ and submitted a buy order $d_m = n$. The noise trader also submitted a buy order and therefore trade is fully revealing leading to a price $p(n, n) = R_h$. The equity holder does not make a trading profit in this state.

$Q = (n, 0)$: *either* the equity holder submitted a buy order and the noise trade did not submit an order, *or* the equity holder did not submit an order and the noise trader submitted a buy order. The equilibrium price is partially revealing and therefore $p(n, 0) < E[V|s = h, A = C]$. The equity holder can thus make a profit from submitting a buy order after receiving good information. This occurs with probability $\theta \bar{e}(1 - \eta)$, which increases with θ.

$Q = (-n, n)$: this state can occur in two different ways. (i) The equity holder submits a buy and the noise trader a sell order, or (ii) the equity holder submits a sell and the noise trader a buy order. From Bayesian updating we get $p(-n, n) = \bar{e}R_h + (1 - \bar{e})L$. Again, the equilibrium price is partially revealing $E[V|s = l, A = S] < p(-n, n) < E[V|s = h, A = C]$, and hence it is profitable to submit a buy (sell) order after receiving good (bad) news. This profitable state occurs with probability $\theta \bar{e}\eta/2$ and $\theta(1 - \bar{e})\eta/2$, respectively. Again, the probability of being in a profitable state is increasing in θ.

$Q = (0, 0)$: Neither noise trader nor equity holder submit an order.

$Q = (-n, 0)$: this case is symmetric to $Q = (n, 0)$ for a sell order instead of a buy order. Again, the price is partially revealing $(p(-n, 0) > E[V|s = l, A = S])$ allowing profitable trade with probability $\theta(1 - \bar{e})(1 - \eta)$.

$Q = (-n, -n)$: this case is symmetric to $Q = (n, n)$. In the proposed equilibrium, the block holder liquidates the firm after receiveing bad news $s = l$ and therefore $p(-n, -n) = L$.

This leads to the following result.

Proposition 3 *The trading strategy (5) is an equilibrium if and only if $\beta > n$. The*

resulting monitoring effort θ^*_{trade} when trade in equity is possible is higher than in the absence of trade, i.e. $\theta^*_{trade} > \theta^*$, which may increase firm value.

Proof: see Appendix.

The fact that monitoring effort increases when trade in equity is possible should not come as a surprise. Private information can be exploited by trading in the (semi-strong form efficient) financial market, which provides an additional incentive to monitor and thus generate private information. It is interesting to note, however, that the trading equilibrium can only be supported for sufficiently large block ownership relative to liquidity. When block size gets too small, the controlling equity holder has a strong incentive to sell after bad news and subsequently continue the firm, rather than liquidating it. Doing so destroys value, which is desirable for the controlling blockholder, if he has a net short position in the firm $(\beta - n < 0)$.

Intuitively, it is plausible that the controlling party should have a large stake in the company in order to take the correct continuation decision. Otherwise the prospect of profitable trade distorts the continuation incentives and renders the proposed equilibrium impossible. In practice, it is doubtful that countries with well enforced insider trading legislation would allow such trades to occur. The trader profits directly from knowledge regarding his own liquidation decision, which might reasonably be viewed as illegal insider trading. If such trades are indeed reliably detected and punished, then this equilibrium can be supported for arbitrarily small β. Notice that the amount of monitoring undertaken by the aggregate claimant then increases in the size of his stake β.

B. The Moderate Leverage Firm

We now consider splitting the aggregate (unlevered) equity claim into a debt and an equity portion, with $D = L$. As in section 2, control rests with the debt-holder who acts on information that the equity-holder produces by engaging in monitoring activities. Since information is soft, an equity-holder who has received a good signal cannot simply report this to the debt-holder, because an equity-holder without information $(s = \emptyset)$ has an incentive to also report 'h'. Instead, equity-holders must indirectly reveal part of their information through their trades and debt-holders make their liquidation decision

contingent on the observed stock price. The distribution of noise trade is assumed to be the same as before.

We show that there is a mechanism that ensures truthful information revelation by the equity-holder. As we saw in section 2, when leverage is moderate, the creditor is *tough*, and will be willing to continue the firm only if he is certain of good news ($s = h$). Therefore in equilibrium the equity-holder's trade must be fully revealing of good news, so that he makes no trading profits. One such trading strategy is described in the following proposition.

Proposition 4 *Let θ^E be the solution to*

$$\beta \overline{e}(R_h - L) - c'(\theta) = 0, \tag{6}$$

and suppose $\theta^E > \gamma/(\overline{e} - \underline{e})b$. For $D = L$ it is then an equilibrium for the equity-holder to submit a buy order $d^E > \beta \frac{\overline{e}}{1 - \overline{e}}$ after receiving $s = h$ and not to submit any order otherwise. Equity prices are given by $p(d_n, d^E) = R_h - L$, $p(d_n, d \neq d^E) = 0$, and the debt holder's continuation decision is $A(p = R_h - L) = C$, and $A(p = 0) = S$.

Proof. In this equilibrium the equity holder chooses a buy order $d^E \neq n$, which fully reveals the equity-holder's position. Therefore, in equilibrium the order flow is fully revealing of the state $s = h$, and $q(p) \equiv prob(\omega = h|p) = 1$ in this case. The debt-holder is willing to continue the firm if $q(p)$ satisfies the following condition: $q(p)D + (1 - q(p))R_l > \min\{D, L\}$. Hence, for $R_l < D \; 6 \; L$, the debt-holder strictly prefers shut-down unless $q(p) = 1$. The debt-holder is thus willing to continue the firm after $Q = (d_n, d^E)$ and the value of total equity is $R_h - L$. In all other states the firm is shut down and the value of equity is zero. The expected value of the monitor's stake is given by

$$\beta E[V^E] = \beta \theta \overline{e}(R_h - L). \tag{7}$$

The order size d^E is determined by the condition that the equity holder not have an incentive to buy in the absence of information (he would never want to buy after receiving bad news, because the value of the firm from continuing is lower in this case than from liquidating it). The expected payoff to the equity holder under the deviation strategy $u(s = \emptyset) = d^E$ is given by

$$\beta[\theta \overline{e}(R_h - L) + (1 - \theta)\overline{e}(R_h - L)] + d(1 - \theta)[\overline{e}(R_h - L) - p(d_n, d^E)]. \tag{8}$$

Setting $\beta E[V^E]$ higher than (8) yields a minimum level of d^E given in the proposition. ■

Corollary 2 *Splitting the claim when information is soft and equity can be traded may increase firm value.*

This follows directly from Proposition 2, where we can see that for $\beta = 1$, $\theta^E = \theta^{*equity}$. Thus for high β, the moderate leverage firm dominates the low leverage firm.

C. The High Leverage Firm

The previous section illustrated that when information is soft, a mechanism exists that implements the same solution as when information is hard. The fact that the mechanism was implemented using a market on which additional equity could be purchased after receiving good news played no particular role. One could assume alternatively assume that the monitoring equity-holder places an amount $d^E(R_h - L)$ into an account after claiming to receive good news and that access to this account is contingent on a high realized firm value.

However, as remarked above, it may be desirable to use indirect information revelation via a market mechanism since it provides additional monitoring incentives. This has implications for capital structure when the claim is split. It requires a *softer* creditor than previously in order that the firm continues operations even if prices are not fully revealing of good news, i.e. the posterior probability of $\omega = h$ is smaller than one: $q(p) < 1$. Otherwise it is impossible for the equity holder to ever make a trading profit: if the firm is liquidated whenever $q(p) < 1$, there is no profit to be made from short-selling, because the value of the firm ceases to be uncertain. And when $q(p) = 1$, by definition, the price is fully revealing, which means that no trading profit can be made from buying additional equity. From (3) it can be seen that continuation after $q(p) < 1$ can only be achieved through risky debt $D > L$.

Furthermore, when prices are only *partially* revealing, the continuation decision is based on a noisy version of the equity-holder's private information, which increases the likelihood of taking the wrong continuation decision. The noisy continuation decision in turn has the effect of reducing the equity holder's direct monitoring incentive and making

it harder to satisfy the managerial incentive compatibility constraint, because the link between effort, monitoring and firm continuation or shutdown becomes less direct.[10]

Hence, when using the market mechanism to transmit information, there is an inherent tension between the dual role of prices. On the one hand less informative prices provide more trading profits and thus a greater incentive to collect information. On the other, the value of the firm also depends on the quality of the continuation decision, which deteriorates if prices are less informative. In the Appendix we show that when the firm has high leverage, there exists an equilibrium with partially revealing prices. In the next subsection we show that it may yields higher monitoring effort by the equity holder than the degenerate trading equilibrium examined in the previous subsection.

D. Comparison of Capital Structures with Trade

A comparison of the outcomes for firms with moderate and high leverage yields the following.

Proposition 5 *For block size β sufficiently small relative to liquidity n, financing the firm with risky debt $D > L$ increases firm value for a non-empty set of parameter values. For larger block sizes relative to liquidity, 'riskless' debt $D = L$ dominates.*

Proof: see Appendix.

The intuition behind this proposition is the following. When equity-holding is relatively concentrated (β high) the incentive to monitor is mainly provided by the desire to increase the value of the existing stake. Providing trading profits in this case would require a discrete softening of the creditor, reducing the equity-holder's incentives to collect information, and would yield little benefit in terms of extra monitoring for trading profits when n is small. So a moderately leveraged firm is optimal. For more dispersed ownership (β small), however, the direct incentive to monitor is low. Then, if market liquidity is high, the equity-holder's incentive to monitor can be significantly increased by the prospect of earning trading profits on this information. This requires high leverage

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[10] A further disadvantage arises if we relax our assumption that only one agent can hold the monitoring technology. When debt is risky, the debt-holder might otherwise wish to exert some monitoring effort, further sapping the initiative of the equity-holder in monitoring, as in Aghion and Tirole (1997).

(risky debt), which takes away from the direct incentive to monitor, but if the latter is anyway small, this disadvantage is less important.

This implies that one should see moderate leverage in situations of concentrated ownership (large block size) and should expect high leverage in situations of dispersed ownership. When block size is large, we have also shown that the moderate leverage firm dominates the low leverage firm. Thus concentrated holdings should be associated with moderate leverage. By the same token, for a given level of ownership dispersion, we would expect to find highly leveraged firms to be traded in more liquid markets than moderate leverage firms. Interestingly, Rajan and Zingales (1995) in their examination of capital structure in G7 countries do find that the USA, Canada and the UK have a fatter right tail of highly leveraged firms than France, Germany, and Japan. Yet they find that the average leverage in all these countries (except the UK) is similar, suggesting that the more liquid markets in the Anglo-Saxon economies are associated with more dispersion in leverage, which is exactly what our theory predicts.

E. Endogenous Block Size and Liquidity

If the initial owner of the firm can decide what size of block he would like to sell to the monitor in the previous set-up, then he will clearly sell as large a block as possible, as this illicits the highest monitoring effort. This leads to the welfare conclusion that one large blockholder is optimal. One might imagine that this conclusion arises because market liquidity is assumed to be independent of block size. Some models instead incorporate a trade-off between block size and liquidity, which we have not allowed for in the foregoing analysis. A reduced form way of modelling the link between block size and liquidity which is often adopted is to assume that liquidity traders can only trade (aggregate) orders equal to a function of the residual of market capitalisation minus block holding (Kahn and Winton, 1998). In terms of the present model this would imply that $n = \phi(1 - \beta)$. It can be shown that trading profits then become a decreasing function of block size β and overall monitoring effort increases when β falls (see (14)). In other words, when market liquidity is endogenous, the trade-off between liquidity and block size should be solved by sacrificing liquidity to blocksize. To motivate a given monitor, it is best to allocate all the equity to him ex ante and have a moderately leveraged firm than to have a highly

leveraged firm and allocate some of the equity to households in order to provide later trading profits for the monitor. The intuition for this result is that trading profits provide less monitoring incentive, since the profit made in this case is smaller than $R_h - L$, the profit from monitoring in the moderately leveraged firm, and in any case trading profits accrue only half the time (when the noise traders sell). A share in the hand is worth two in the bush, from the point of view of encouraging monitoring!

The robustness of the result that one should encourage block size at the expense of liquidity is perhaps surprising. One way to reinstate the importance of liquidity is to recognise the useful role played by outsiders in generating information about the firm. In the previous section, we implicitly assumed that there was only one possible monitor, the incumbent shareholder. However, it may be that depending on the nature of the information to be collected, different individuals may be skilled at acquiring information.

Let us draw a distinction between information collected by the *incumbent monitor*, an insider or existing shareholder of the firm, and *entrant monitors* - outsiders who start with no stake in the firm and will acquire one only to make trading profits at the interim date in the case that they indeed learn information about the firm. Specifically, suppose that with probability p, the incumbent monitor has the ability to acquire information about the firm's future returns, as before (in previous sections we implicitly set $p = 1$). If the state of the world is such that the incumbent monitor has the ability to acquire information then the incument monitor will exert costly monitoring effort according to the incentives provided by his shareholding and (potentially) by trading profits, exactly as in the previous section. On the other hand, with probability $1-p$ the state of the world is such that the information production technology belongs instead to some outsider who currently has no shareholding in the firm. Notice that in this case, the outsider with the information collection ability has the same incentives to acquire information as an insider with an initial shareholding $\beta = 0$. Thus his *only* motivation to collect information comes from the potential trading profits to be made if he is informed.

We interpret p as a parameter reflecting the opacity of the firm's operations or accounts. If firm's operations and accounts are very opaque, only an insider can learn whether it is desirable to continue or liquidate the firm's operations, so $p \to 1$. Whereas if firm accounts are very transparent, all agents, both insiders and outsiders, are equally

able ex ante to draw conclusions about the firm's prospects. So if, as our model assumes, there is someone with the ability to analyse the firm accounts to produce some private information on which they can make a trading profit, it is equally likely that this is the insider as any one of the many outsiders. In other words, when accounts are entirely transparent, $p \rightarrow 0$.

It is easy to see that as firm accounting becomes more transparent, the advantage of a capital structure which encourages monitoring by outsiders increases, because the chance of the incumbent monitor being the one with ability to generate the crucial information is reduced. Hence, when accounting systems are transparent, one should expect to see highly-leveraged widely traded firms with block size going to zero to increase liquidity. In financial systems where accounts are opaque, on the other hand, one should see instead larger blockholding and moderately leveraged firms.

4. Conclusion

In this paper we have explored the way in which splitting claims on a firm's cash flow can be used to increase the quantity of information generated about the firm's future prospects, and thence enhance managerial incentives. Unless one allows firms to issue securities that are negatively correlated with their own value (which seem to be very rare in practice), it is not obvious a priori how splitting claims can generate more information. Incentives to produce information depend on the sensitivity of returns to profits, and budget balance dictates that the maximum sensitivity of returns to profits is given by the aggregate claim. (In other words, dividing up returns according to the state of the world cannot make anyone's profit increase faster with the state of the world than does aggregate profit unless someone else's return is decreasing in the state of the world). We show that incentives can be increased by dividing up claims in such a way that gives one claim-holder a (credible) incentive to destroy value in the absence of information production.

In particular, we have shown that dividing up claims on a firm's cash flow into a (safe) debt claim and a (risky) equity claim can increase monitoring effort, which will sometimes be beneficial to a firm if it induces the manager to exert more effort. The mechanism

through which this occurs is the following. Because the debt-holder's claim is insensitive to high profits, the debt-holder has an inherent bias towards shutdown, which allows him to redeem all his debt with certainty. He will be reluctant to continue unless he receives information which persuades him that the chances of his not being able to redeem all of his debt from the firm at a later date are minimal. Shutting down the firm early destroys value, but the debt-holder is indifferent to this since the cost of early shutdown falls on the equity-holder. This destruction of value, however, gives the equity-holder a disproportionate incentive to collect information, since if he does not do so, the firm will certainly be shut down. This contrasts with the case where all cash flows are due to an aggregate claim, where continuation would be optimal even in the absence of information, so there is very little incentive to collect information. We showed that this analysis was robust to renegotiation between claim-holders.

We also showed how this analysis can be extended to the case of soft information, where the monitor cannot simply report good outcomes to the decision maker (except in the case of the aggregate claim, where these are one and the same). Instead, he must 'post a bond' when he reports that the outcome will be good, which will be redeemed only if the outcome is indeed good. This is equivalent to the equity-holder buying shares in the market place when firm prospects are good. The debt-holder will then look at the firm's stock price in order to determine whether to close the firm or not. This yields the prediction that the manager cares strongly about the firm's share price, even though he cares only about continuation of the firm and not at all about a monetary reward. This is because the share price contains information which the debt-holder can use to make his decision, because the debt-holder himself has no incentive to collect costly information.

We show further that if the amount of liquidity trade in the stock is large relative to the size of the equity holder's blockholding, then it can be optimal to make continuation decisions based on a *noisy* stock price. To achieve this, one must soften the decision maker somewhat by financing the firm using risky debt (rather than safe debt, which is always optimal in the hard information case). The debt holder will then choose to continue as long as the stock price is high enough. The presence of noise trade means that sometimes the firm will be continued when its value is low (but the noise traders have bought), so it is not obvious that this is value-enhancing. Further, it directly reduces the monitor's (and

hence the manager's) incentives, since his information is transmitted only with random error (from the noise-trader trades) to the debt-holder. However, the fact that the firm is sometimes continued when the price is less than fully revealing allows the equity-holder to make a trading profit on his information, giving him more incentive to collect it; and this effect can sometimes dominate.

In writing this paper we highlight a fundamental trade-off which is probably of wider importance than the simple application given here. *Decision makers with good incentives to take tough decisions necessarily have poor incentives to collect information*, because the former requires outcome-insensitive claims whereas the latter requires outcome-sensitive claims. Thus there is a natural division of labour between those who collect information and those who act on it, and the sum of the parts may be more than the whole in this case.

5. Appendix

Proof of Proposition 3. The equilibrium prices are given by Basyesian updating:

$$
\begin{aligned}
p(0, -n) &= \frac{\frac{\eta}{2}(1-\theta)E(R) + \theta(1-\overline{e})(1-\eta)L}{\frac{\eta}{2}(1-\theta) + \theta(1-\overline{e})(1-\eta)}, \\
p(0, n) &= \frac{\frac{\eta}{2}(1-\theta)E(R) + \theta\overline{e}(1-\eta)L}{\frac{\eta}{2}(1-\theta) + \theta\overline{e}(1-\eta)}, \\
p(-n, n) &= \overline{e}R_h + (1-\overline{e})L.
\end{aligned}
$$

In order to prove that the trading strategy described in (5) actually is an equilibrium for any given level of θ, consider first possible deviations after bad news $s = l$ has been received (the case $s = h$ and $\emptyset$ is considered below). The payoff from the equilibrium strategy (sell $-n$ and liquidate the firm) is given by

$$
\beta L - n \left[L - \frac{\eta}{2}L - (1-\eta)p(0, -n) - \frac{\eta}{2}p(-n, n) \right] \tag{9}
$$

Submitting a sell order $d_m = -n$ and deviating to continuing the firm leads to the following payoff.

$$
\beta R_l - n \left[R_l - \frac{\eta}{2}L - (1-\eta)p(0, -n) - \frac{\eta}{2}p(-n, n) \right] \tag{10}
$$

Comparing (9) to (10) yields the following condition for equilibrium

$$
\beta > n.
$$

Suppose for a deviation to a sell order $\neq -n$ the market maker believes that the deviation is due to a block holder who has received bad information, short sells and leaves the firm open. For this belief the correct price is R_l. This strategy leads to a sure loss since the price will be set to R_l, i.e. even if the block holder leaves the firm open after bad news he cannot make a profit on the acquired short position, because the price already reflects this deviation. Deviating to liquidating the firm in this case leads to an even bigger loss since closing out on the short position becomes more costly. Submitting a buy order after receiving bad news clearly leads to a trading loss.

Next, consider possible deviations after $s = h$: submit a (i) buy order $\neq n$, or (ii) submit a sell order. Not trading at all clearly is not preferred since trade results in a positive expected profit. Suppose the out-of-equilibrium belief of the market maker is that any deviation to a buy order $\neq n$ is due to a block holder with $s = h$. Then any buy order other than of size n will result in the fully revealing price of R_h. This destroys trading profits for deviation (i).

Submitting a sell order results in a price $p < R_h$. If the block holder then continues the firm true value will be R_h and he has to close out the short position at a loss. However, since the block holder may shut down the firm (regardless of the state) he may have an incentive to take a short position and then close the firm. If he deviated to a sell order other than of size $-n$, he would get the price R_l. Hence, the deviating block holder would make a loss on the short position of $-n(L - R_l)$ and on the existing block. A deviation to a sell order of size $-n$ would go unnoticed and the following condition characterizes when the deviation is not worthwhile.

$$\beta R_h + n \underset{3}{\overset{3}{R_h}} R_h - \frac{\eta}{2} R_h - (1 - \eta) p(0, n) - \frac{\eta}{2} p(-n, n)$$
$$> \beta L - n \; L - \frac{\eta}{2} R_l - (1 - \eta) p(0, -n) - \frac{\eta}{2} p(-n, n)$$

Hence,

$$\beta \underset{3}{(R_h - L)} \tag{11}$$
$$> n \; -L + \frac{\eta}{2} R_l + (1 - \eta) (p(0, -n) + p(0, n)) + \eta (\overline{e} R_h + (1 - \overline{e}) L) - R_h + \frac{\eta}{2} R_h \tag{12}$$

It can be verified that there exist parameter values for which condition (11) is violated (e.g. when θ close to one and $\overline{e}$ small), i.e. a deviation would occur. However, it can also be verified easily that for any $\beta > n$ (11) is satisfied.

Note that the equity holder does not have an incentive to trade in the absence of information. If he were to trade he would move the price against himself with positive probability and thus incur a trading loss. Since he does not stand to gain from a price movement per se, he will therefore not trade at all. Moreover, selling and shutting down the firm incurs a loss for all $\beta > n$.

Next consider the incentives to monitor. The firm owner maximizes

$$\max_{\theta} E[V^*_{trade}] + E[\pi] - c(\theta).$$

Solving the first-order condition yields a choice of monitoring effort given by:

$$c'(\theta^*_{trade}) = \frac{\partial E[V^*_{trade}]}{\partial \theta} + \frac{\partial E[\pi]}{\partial \theta}$$

As mentioned above, the actual continuation decision is unaffected by trade, which implies that firm value as a function of monitoring effort is the same as in the no-trade case: $E[V^*_{trade}] = E[V^*]$. It follows from the prices and order flows above that increasing monitoring effort θ increases the probability of a state in which trade occurs (but prices are not fully revealing). Therefore, $\frac{\partial E[\pi]}{\partial \theta} > 0$. Since $c(\theta)$ is a convex function, it follows that $\theta^*_{trade} > \theta^*$. Note that it is not required that *equilibrium* trading profits are an increasing function of θ, since those will depend on equilibrium prices, which are more revealing for higher equilibrium values of θ. I.e. it *may* be the case that the equity holder wants to commit to a lower θ in order to increase equilibrium trading profits. However, all that is required here is that trading profits are an increasing function of θ, *given* the pricing function of the market maker. We can therefore remain agnostic as to how equilibrium trading profits depend on θ.

If $\theta^*_{trade} > \frac{\gamma}{b(\overline{e}-\underline{e})} > \theta^*$ then firm value increases because monitoring by the aggregate claimant is now sufficiently high to ensure that the manager exerts a high level of effort. Even if $\theta^* > \frac{\gamma}{b(\overline{e}-\underline{e})}$, firm value may increase once trade is allowed, because the probability of shutting down the firm in bad states is increased. ∎

Proof of Proposition 5. Suppose θ^E given by the solution to (6) is smaller than $\frac{\gamma}{(\overline{e}-\underline{e})b}$, i.e. the equity holder's monitoring effort is too small to satisfy the manager's incentive compatibility constraint. Firm value in that case is zero, because the investment project will not be undertaken. Risky debt then increases firm value if it renders high

28

managerial effort choice an equilibrium outcome. In the following we show that this may be the case.

Consider now the following equilibrium in which profitable trading occurs and the debt holder continues the firm at a belief $q < 1$. Suppose the equity holder employs the same trading strategy as before, i.e. $d(s = h) = n$, $d(s = l) = -n$, and $d(s = \emptyset) = 0$.

The posterior $q(n, 0)$ is given by

$$q(n, 0) = \frac{\overline{e}^{\pounds}\theta(1 - \eta) + (1 - \theta)\frac{\eta}{2}}{\overline{e}\theta(1 - \eta) + (1 - \theta)\frac{\eta}{2}} \tag{13}$$

It follows that $q(n, 0) > q(n, -n) \iff 1 > \overline{e}$. Therefore, debt can be designed such that the debt holder has an incentive to continue the firm after $Q = (n, 0)$, but wishes to shut it down after $Q = (n, -n)$, i.e. the continuation strategy as outlined in the table maximizes the value of debt given D sufficiently low (see below for the design of debt).

$s \in$	u	$\mathbf{e}$	Q	A	$p(Q)$	$E[V_{equity}|s, A]$	$prob$
h	n	n	n, n	C	$R_h - D$	$R_h - D$	$\theta\overline{e}\frac{\eta}{2}$
h	n	0	$n, 0$	C	$q(n, 0)(R_h - D)$	$R_h - D$	$\theta\overline{e}(1 - \eta)$
h	n	$-n$	$n, -n$	S	0	0	$\theta\overline{e}\frac{\eta}{2}$
$\emptyset$	0	n	$n, 0$	C	$q(n, 0)(R_h - D)$	$\overline{e}(R_h - D)$	$(1 - \theta)\frac{\eta}{2}$
$\emptyset$	0	0	$0, 0$	S	0	0	$(1 - \theta)(1 - \eta)$
$\emptyset$	0	$-n$	$-n, 0$	S	0	0	$(1 - \theta)\frac{\eta}{2}$
l	$-n$	n	$n, -n$	S	0	0	$\theta(1 - \overline{e})\frac{\eta}{2}$
l	$-n$	0	$-n, 0$	S	0	0	$\theta(1 - \overline{e})(1 - \eta)$
l	$-n$	$-n$	$-n, -n$	S	0	0	$\theta(1 - \overline{e})\frac{\eta}{2}$

Table 1 shows signal contingent trading strategy, resulting order flows and the continuation decision depending on order flow. Resulting firm value and associated probabilities are also given.

The expected payoff to the monitoring equity holder is given by $E[V] = \beta E[V_{trade}^{*equity}] + E[\pi_{trade}^{*equity}] - c(\theta)$, where

$$E[V_{trade}^{*equity}] = \overline{e}^{\mathsf{h}}\theta(1 - \eta + \frac{\eta}{2}) + (1 - \theta)\frac{\eta}{2}^{\mathsf{i}} (R_h - D)$$

$$E[\pi_{trade}^{*equity}] = n\theta\overline{e}(1 - \eta)(R_h - D - p(n)).$$

Taking the first order condition gives $\theta_{trade}^{*equity}$ as the solution to

$$c'(\theta) = \overline{e}(1 - \eta)(R_h - D)\left[\beta + n(1 - q(n, 0))\right] \tag{14}$$

Several features of this equilibrium are noteworthy. Firstly, in order to effect continuation by the debt holder after $Q = (n, 0)$, it is necessary to set $D > L$. This follows from the fact that $q(n, 0) < 1$. In particular, the minimum amount of debt can be calculated using (3): $D_{\min} = \frac{1}{q(n,0)}(L - R_l) + R_l$. Since $q(n, 0) > \overline{e}$ it is easier to induce continuation after $q(n, 0)$ than it is to do so after $\overline{e}$. By assumption the aggregate claimant continues after a belief $\overline{e}$. Therefore, $D_{\min} < R_h$, i.e. there always exists a gearing ratio that can implement the proposed continuation strategy in equilibrium.

Secondly, note that $\frac{\partial E[V_{trade}^{*equity}]}{\partial \theta} = (1 - \eta)\frac{R_h - D}{R_h - L} \cdot \frac{\partial E[V^E]}{\partial \theta} < \frac{\partial E[V^E]}{\partial \theta}$ for $\eta < 1, D > L$, i.e. the monitoring incentive due to increasing the value of the equity holder's existing stake is reduced, because (i) of noisy prices and, (ii) because by making the debt claim more risky, the equity claim becomes less risky and therefore less sensitive to monitoring effort. Monitoring effort is higher in the non-degenerate trading equilibrium ($\theta_{trade}^{*equity} > \theta^E$), when

$$\overline{e}(1 - \eta)(R_h - D_{\min})\left[\beta + n(1 - q(n, 0)\right] > \beta\overline{e}(R_h - L) \tag{15}$$

Note that an increase in n increases $\theta_{trade}^{*equity}$ as a first order effect. An increase in θ has two second order effects. Firstly, from (13) it can be seen that it increases $q(n, 0)$, i.e. equilibrium equity prices become more revealing and reduce trading profits *per unit traded*. Secondly, an increase in $q(n, 0)$ reduces $D_{\min}$ which makes the equity claim steeper and increases monitoring incentives. Similarly, an increase in β moves the monitoring incentive in the same direction. It is thus possible to reduce β and increase n in such a way as to leave $\theta_{trade}^{*equity}$ unchanged, i.e. the effects just offset each other. Such a change has an unambiguously decreasing effect on θ^E. It is thus possible to find values of β and n such that (15) is satisfied.

Thirdly, the manager's incentive compatibility constraint changes to

$$\overline{e}\left[\theta\left(1 - \eta + \frac{\eta}{2}\right) + (1 - \theta)\frac{\eta}{2}\right]b - \gamma > \underline{e}\left[\theta\left(1 - \eta + \frac{\eta}{2}\right) + (1 - \theta)\frac{\eta}{2}\right]b.$$

When the continuation decision is based on noisy prices, it becomes harder to satisfy the manager's incentive compatibility constraint:

$$\theta > \theta_{trade}^{IC} = \frac{\gamma}{b(\overline{e} - \underline{e})\left[1 - \frac{\eta}{2}\right]}. \tag{16}$$

Since $\theta_{trade}^{*equity} - \theta^E$ is an increasing function of n, we can choose n and β such that $\theta_{trade}^{*equity} > \theta_{trade}^{IC} > \theta^{IC} > \theta^E$.

Finally, it needs to be verified that this equilibrium is implementable, i.e. that the equity holder does not want to deviate from this trading equilibrium. In particular, the equity holder may want to ensure firm continuation after receiving no signal: $d(s = \emptyset) = n$. Such a deviation leads to an increased probability of firm continuation and therefore increases the value of the equity holder's stake. At the same time, it imposes a trading loss on the equity holder. The payoff from deviating to $d(s = \emptyset) = n$, is given by

$$
\begin{aligned}
E[V^{u(s=\emptyset)=n}] \;=\; & (R_h - D)\beta\overline{e}\left[1 - \eta + \frac{\eta}{2}\right] \\
& + (R_h - D)\left[n\theta\overline{e}(1 - \eta)(1 - q(n,0))\right] \\
& - (R_h - D)\,n(1 - \theta)\left[\frac{\eta}{2}(1 - \overline{e}) + (1 - \eta)(q(n,0) - \overline{e})\right].
\end{aligned}
\tag{17}
$$

This yields the following incentive compatibility constraint:

$$
n\left[(1 - \overline{e})\frac{\eta}{2} + (1 - \eta)(q(n,0) - \overline{e})\right] > \beta\overline{e}(1 - \eta).
\tag{18}
$$

Again, since we choose n to be large relative to β there is a set of parameter values for which the condition (18) is consistent with this trading equilibrium.

Moreover, after receiving $s = l$, the equity holder is indifferent between submitting $d = 0$ and $d = -n$. In either case he does not derive a trading profit, and in either case the value of the equity stake is zero. However, $d(s = l) = 0$ cannot be an equilibrium, because in that case demand $Q = (n, -n)$ would be fully revealing of $d = n$, which would provide an incentive to deviate from $d(s = l) = 0$ to $d(s = l) = -n$. ∎

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