Financing Pecking Orders with Relationship or Dominant Investors

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Abstract

We model a firm in which an early investor gains a dominant position in new financing rounds due to his privileged information relative to outsiders. In this setting, firms issue equity and do not co-invest previously hoarded cash: the "pecking order" is reversed. Firms, anticipating underinvestment triggered by this dependence, issue debt and raise excess cash. This strategy creates countervailing incentives to those underpinning future adverse selection. Long-term credit lines are an alternative, but only for small investments. The effect of dominant/relationship investors on capital structure and cash hoarding could help explain the mounting evidence contradicting the "pecking order."

Keywords: financial contracting, relationship financing, pecking order, security design, financial flexibility

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1 Introduction

Recent empirical work has led many to question one the pillars of modern corporate finance—the so-called pecking order theory (Myers and Majluf, 1984). This theory postulates that informationally opaque firms should first resort to internal financing, and then preferably to debt to finance new investments. While these predictions seem to hold for the largest of firms (Shyam-Sunder and Myers, 1999), they frequently fail for smaller and informationally opaque firms (Frank and Goyal, 2003; Leary and Roberts, 2010)—the very firms for which they should best apply.

We approach this puzzle by building on the simple idea that a small and informationally opaque firm's capital structure is affected by the fact that some investors could develop a dominant position. This could be due to a lack of bank development or competition (Rice and Strahan, 2009; Amore et al., 2013; Cornaggia et al., 2014) or to firms developing relationships with their investors. With information frictions, such relationships could confer certification and, thus, bargaining power to existing investors in new financing rounds (Rajan, 1992). Yet firms often readily engage in them, as they help raising initial financing in times of considerable doubt about the firm's viability. Such relationships are of first-order importance even in competitive capital markets, with relationship banking and venture capital financing probably being the best-known examples (Boot, 2000; Gompers, 2000).

In this paper we take the perspective of an informationally opaque firm that invests repeatedly and may have to deal with an investor who develops bargaining power due to his privilaged information relative to outsiders stemming from earlier involvements with the firm. Key to our results is that firms anticipating a capture with a dominant investor will design their initial capital structure in anticipation of later investment inefficiencies. One result is that in early investment rounds, such firms will raise debt financing and cash in excess of what they need for investment. The key advantange of this strategy is that this generates countervailing incentives to those triggering underinvestment due to adverse selection in follow-up financing rounds. In such rounds, investors that have gained a dominant position will push for equity finance as this allows them to capture informational rents, and the firm will not co-invest previously hoarded cash. Again the pecking order is violated. Based on our results, we derive implications for how competitive equity markets and relationship lending mutually stimulate each other, how the type of venture capital financing depends on VC's bargaining position in new financing rounds, and how cash and credit lines complement each other.

We develop these ideas in a model in which investors are uncertain whether they are

facing an A- or a B-rate entrepreneur (e.g., Myers and Majluf, 1984).[1] In this setting, investment opportunities and information asymmetry about them arise and are revealed over time: Firms are initially better informed about the likelihood that the firm turns out to be defunct. Early investors observe this at some interim stage, but by then managers of non-defunct firms are better informed about the profitability of making a new investment. In this setting, firms build up financial flexibility to deal with the investment inefficiencies emerging from investing and potentially raising financing in stages. Before casting this model into our concrete empirical applications, we present the main insights stemming from it.

First, the starting point of our analysis is that the pecking order is reversed if investors can dictate the terms of financing: When managers are better informed about the firm's prospects, levered equity allows investors to extract the maximum information rent. This follows the opposite logic to that of the pecking order, where debt allows entrepreneurs to keep more of their information rent. The investor's bargaining power in our setting is derived from his prior relationship with the firm, which (unlike new investors) allows him to judge whether it is defunct or not. This gives the initial investor certification power, absent which the firm might be unable to raise external financing at competitive terms. We show that if the initial investor enjoys such certification power, he steers the firm towards equity financing regardless of whether it comes from him or from new investors. When financing is from the same investor, initial contracts are replaced for new ones; when financing is from new investors, the proceeds are used to repay or make existing (debt) claims more secure.

An important problem in our setting, which will define many of our results, is that managers of non-defunct firms would sometimes see new financing as too expensive, resulting in underinvestment. This is because these firms are viable also without undertaking a new investment round. Thus, underinvestment will be especially pronounced in firms for which the new investment round does not lead to too large improvements. However, the extent to which a firm will be affected, depends also on its initial capital structure.

The second main contributions of our paper is to show that the firm could design its initial capital structure and cash policy in a way that provides countervailing incentives to those triggering the underinvestment problem. The reason for these incentives is that, just like the firm's investment opportunity, the value of its outstanding claims equally depends on whether it is inherently good or bad. Specifically, underinvestment is due to the inability of the investor to "price"-discriminate among viable firms and to the fact that

[1] To emphasize the importance of entrepreneur's quality, investors in start-up firms can be often heard saying that they'd rather invest in an "A team with a B idea than a B team with an A idea."

some of these firms reject too expensive financing offers. In such a setting, outstanding financing contracts and cash hoarding determine how much the manager will benefit from raising new financing.

Specifically, it is optimal for the firm to initially finance itself with debt, as then the manager's payoff depends more strongly on the existing business' success. Thus, the role of debt is to make the manager more eager to later raise new equity financing despite the associated reduction of her upside participation. This strategy not only reduces, but it could sometimes completely solve the underinvestment problem. Thus, when a firm enters a relationship with an investor, it uses up early its debt capacity, which builds up "equity capacity" for future rounds under asymmetric information. This is the opposite to what could be expected from the pecking order theory—i.e., firms issuing equity in anticipation of future debt issues.

Raising excess cash offers firms another way to build up financial flexibility. Our novel insight in this context is that excess cash could be raised in both initial and in new financing rounds despite asymmetric information. However, this cash is hoarded, and not co-invested, as this boosts the countervailing incentives arising in new financing rounds. The reason for this is that the way excess cash is distributed among the owner-manager and investors determines the extent to which the owner-manager's payoff is determined by a fixed cash component or by a risky security exposing her to making the correct new investment decision.

Our third main insight qualifies when firms are likely to issue equity in new investment rounds by analyzing when, instead, long-term credit-line types of arrangements will prevail. The problem with this type of financing, however, is that, having access to excess cash, a manager of a firm that turns out to be defunct has incentives to overinvest. Fixing a long-term financing strategy could, thus, prove to be prohibitively expensive if the subsequently needed financing amount is large and if there is substantial information asymmetry about the likelihood that the firm turns out to be defunct. If this is not the case, the contracts arising in equilibrium take, indeed, the form of long-term credit-line type of arrangements.

These results give rise to a number of novel empirical implications. First, we derive conditions under which the standard pecking order will hold and when it will be reversed when raising financing under asymmetric information. Specifically, firms will issue equity if they cannot raise financing at competitive terms or when they need certification from a relationship investor to do so. This in line with the evidence that it is mostly smaller and informationally opaque firms that violate the pecking order (Frank and Goyal, 2003; Leary and Roberts, 2010). Second, our theory highlights that, rather than limiting, competitive equity markets can increase the role of relationship lenders. This is because relationship

lenders can cash in large profits when they steer firms towards issuing equity to repay or make existing debt more secure. Indeed, debt repayment has been shown to be one of the main reasons for firms to issue equity (Leone et al., 2007). Furthermore, the evidence shows that receiving certification from relationship lenders is crucial for IPOs or SEOs (Schenone, 2004; Duarte-Silva, 2010) and that relationship banks use their certification power to impose expensive financing prior to the equity offerings (Schenone, 2010). Our implication is that all this makes relationship lenders more willing to provide cheap credit in the first place, which we also show to be the optimal security contract for firms entering such relationships. A third novel implication of our paper is that it shows that the convertible preferred equity contract predominantly used in U.S. VC financing (Kaplan and Strömberg, 2003) could be motivated with firms and investors trying to deal with information asymmetry in multiple investment rounds. This departure from the standard argument, which is based on effort incentive problems (e.g., Schmidt, 2003), could help explain why U.S. VC contracts are not common outside the U.S. (Kaplan et al., 2007), where weak investor protection deters even relationship investors from developing a strong bargaining position in new financing rounds. Fourth, we show that small and informationally opaque firms will resort to credit lines rather than relationship financing only for small and more certain investments, which is in line with recent of evidence by Robb and Robinson (2014). Finally, we show that when such firms issue equity, they will not co-invest previously hoarded cash. While this runs again contrary to prior theory, in which cash is hoarded as precaution and to avoid a funding gap (e.g., Bolton et al., 2011), it is commonly observed in practice (xxxx,xxxx). Our theory has concrete predictions when this should occur in firms dependent on relationship investors. It also shows that credit lines and cash are not substitutes, as credit lines are used for investments as documented by Lins et al. (2010), while cash is hoarded towards repaying investors.

In our model, the anticipation of future investment inefficiencies entails implications for how firms raise finance, preserve financial flexibility, and adjust leverage. Our analysis when firms should build up equity capacity complements the standard focus in the literature on building up debt capacity (Myers and Majluf, 1984). It also expands our understanding of how underinvestment could be dealt with in the presence of a relationship investor by showing that using up debt capacity can help mitigate future underinvestment. This is the opposite prediction to Myers' (1977) debt overhang problem.

More generally, our paper falls into the large literature on capital structure choice and security design under asymmetric information. Our model endogenizes also firms' existing capital structure that is chosen so as to mitigate future inefficiencies from asymmetric information. The initial financial structure creates countervailing incentives through so-

called type-dependent reservation values (e.g., Lewis and Sappington, 1989), as private information relates to the firm's prospects both with and without new investment. Other recent papers that explore the role of (type-dependent) outside options for financing, albeit in different contexts, are Tirole (2011) and Burkart and Lee (2011).

This focus on countervailing incentives arising under asymmetric information distinguishes our analysis of contract (re)negotiations from that in the literature on incomplete contracting (Hart and Moore, 1988). This literature deserves mentioning also because it has investigated the option-like reversal of financing over time in venture capital financing (e.g., Schmidt, 2003) and the hold-up problem in the heart of the literature on relationship lending (e.g., Rajan, 1992). However, relying on a different mechanism (countervailing incentives), we obtain a more flexible framework, allowing us to motivate fundamental differences in financing contracts and their change, depending on the negotiating and certification power of investors.

Our paper also relates to the discussion of whether long-term financial contracts can help reduce investment inefficiencies (Stulz, 1990; von Thadden, 1995). We add to this literature by analyzing a setting in which information asymmetry arises and is revealed in stages. In this setting, if the potential for overinvestment inherent to long-term contracts is sufficiently large, the firm is better off with financing that resembles on-the-spot financing that gives investors little bargaining power or discretion over the use of excess cash, despite the resulting threat of underinvestment. These insights also differentiate our contribution from Axelson et al. (2009), in which private information also arises over time. Moreover, we show that the pecking order is reversed if the bargaining power shifts to the investor.[2]

Finally, a growing body of research studies the dynamics of a firm's optimal capital structure focusing on dynamic trade-off explanations (cf., Hennesy and Whited, 2005; Miao, 2005), on problems of moral hazard (DeMarzo and Sannikov, 2006), and the trade-off between debt capacity and risk (Rampini and Viswanathan, 2010). We contribute to this literature by analyzing adverse selection arising and revealing itself over time. While our dynamics are simpler, as they are captured with a stylized three-period model, this framework is sufficient to derive our main results. Our contribution is to show how outstanding claims and existing capital structure create countervailing incentives when fresh financing must be raised under asymmetric information and to show that the pecking order in which firms raise financing crucially depends on whether they are facing investors

[2] Though DeMarzo and Duffie (1999) and Biais and Mariotti (2005) also consider a two-stage game, the security in their models is designed before private information is revealed, and ultimately only a single security is issued. Interestingly, DeMarzo et al. (2005) show that payments in levered equity help sellers extract more information rent in auctions, but there are no inefficiencies in their model.

with a weak or a strong bargaining position.

The rest of this paper is organized as follows. Section 2 describes the model. Section 3 shows the reversal of the pecking order in the presence of a strong investors. Section 4 discusses ways to mitigate investment inefficiencies arising from future asymmetric information. We present applications and empirical implications of our model in Sections 6. Section 7 concludes. All proofs are in the Appendix.

2 The Model

We envisage a firm run by a penniless owner-manager that needs to raise financing to make an investment in $t = 1$, requiring $K_1 \geq 0$. At $t = 2$, the firm could make an additional investment, requiring $K_2 > 0$, which, however, is profitable only sometimes. Cash flows are realized in the final period, $t = 3$. Both the owner-manager and investors are risk neutral, and we abstract from discounting.

The firm's verifiable cash flow at $t = 3$ can take on two values: $x_l \geq 0$ or $x_h > x_l$, where $\Delta x := x_h - x_l$. The assumption of only two cash flows is for more transparency only. In the working paper version we have shown that our results fully extend to a setting with a continuum of cash flows, following a standard extension of the investment technology (e.g., Nachman and Noe, 1994; see also footnote 5). The likelihood $p_{d\theta}$ of realizing high cash flow depends both on whether the additional capital investment in $t = 2$ is made, $d = \{Y, N\}$ ("Yes" and "No"), and on the firm's underlying profitability θ.

The firm's profitability can take on three values. We refer to these as a good, bad, and defunct state, $\theta = \{G, B, D\}$. The difference among these states is simple: If the firm is in the defunct state, it produces x_l in $t = 3$ regardless of whether it undertakes new financing (i.e., $p_{dD} = 0$). Instead, if the firm is not defunct, it has a chance of producing more than that. The difference between the good and the bad state is that the new investment in $t = 2$ is socially optimal only in the good state. Our key assumptions in what follows concerns how private information about these states arises and is revealed over time:

- Our first main assumption is that both the owner-manager and an investor engaged with the firm learn whether the firm is defunct with certainty in $t = 2$. However, in the initial period $t = 1$, the owner-manager is better informed about the likelihood $1 - \gamma$ of being defunct ($\theta = D$), whereas the investor only knows the distribution of γ. This information structure will have two implications: On the one hand, if the owner-manager has insufficient capital to undertake the new investment round, she is dependent on the initial investor's certification to do so, as we assume that outside

investors do not observe whether the firm is defunct in $t = 2$ (Sections 3–4). On the other hand, if the firm turns out to be defunct and the owner-manager has enough cash to make the second investment round, she might threaten to sink this capital rather than liquidating the firm. We introduce more structure to this argument in Section 5.2.

- Conditional on not being defunct, which happens with probability γ, the firm's probability that it is in stage $\theta = G$ is given by $0 < \widehat{q} < 1$. Our second main assumption is that this likelihood is common knowledge for the owner-manager and potential investors in the initial period $t = 1$. However, the owner-manager privately learns the true likelihood of $\theta = G$ between $t = 1$ and $t = 2$. Hence, when the decision about the new financing round in $t = 2$ must be made, she has again an information advantage over the investor. Based on this private information in $t = 2$, the owner-manager's posterior belief regarding $\Pr(\theta = G)$ is q. We refer to the owner-manager's private information q as her "type" at $t = 2$. It is a priori distributed according to the CDF $F(q)$ over $q \in [0, 1]$.[3]

As noted, next to θ, the second factor that affects the probability $p_{d\theta}$ of achieving the high cash flow state is whether there is a new investment round in $t = 2$. We call state G the good state, as we assume that $p_{dG} > p_{dB}$ holds for all $d \in \{Y, N\}$. In what follows, we are interested in a setting in which new investment in the good state is not less efficient than in the bad state—i.e., if new investment increases the success probability by a factor of β_θ, we have

$$\beta_G \geq \beta_B, \tag{1}$$

where β_θ can be stated equivalently as $\beta_\theta := p_{Y\theta}/p_{N\theta}$.[4] Observe that this implies that $p_{YG} - p_{NG} > p_{YB} - p_{NB}$. To limit trivial case distinctions, we suppose that the new investment round is efficient only in $\theta = G$, and is a negative NPV investment in both states B and D:

$$K_2 < (p_{YG} - p_{NG})\Delta x. \tag{2}$$

This implies that there exists a cutoff $0 < q_{FB} < 1$ so that a new investment round in $t = 2$ increases the joint surplus only if the firm is not defunct and the owner-manager's type

[3] Clearly, we have $\widehat{q} = \int q dF(q)$. Alternatively, we may, instead, stipulate that the owner-manager privately observes some signal ϑ, which is generated by the CDFs $\Psi_\theta(\vartheta)$. We can then generate q as well as $F(q)$ by using Bayes' rule.

[4] Assuming instead that $\beta_G < \beta_B$ could (if β_B was sufficiently larger) cause the incentives we discuss below to invert—i.e., instead of being better off in the good state, the owner-manager would be better off in the bad state)—leading respectively to inverse results. However, a setting with such "inverse" incentives seems to be a less relevant assumption for healthy (and growing) firms.

(the probability of being in G) is above q_{FB}.[5] In a nutshell, our analysis will be about how asymmetric information arising over time affects the decision d to raise new financing.

Contracting and Discussion of Information Structure Period $t = 2$ in our model extends the canonical model of financing under asymmetric information. The key difference in our model is that private information arises and is revealed over time. This has two implications. On the one hand, the owner-manager could try to mitigate the information asymmetry problem that arises in $t = 2$ by appropriately designing the financing contract in $t = 1$. On the other hand, the initially designed contract might not be robust to renegotiations in $t = 2$. Specifically, we need to consider two cases. In the first case, the firm has raised $K_1 + K_2$ or more in the initial period (or it has obtained the unconditional right to raise additional financing, allowing it to do the second period investment). In this case, if the firm turns out to be defunct, the owner-manager could demand a payment from the initial investor in return for not sinking the additional capital. We give more structure to this argument in Section 5.2. In that section, we analyze when raising so much capital is optimal, and we derive the renegotiation-proof contract that can be interpreted as a long-term credit line.

In the second case, which is the central one for our analysis, the firm raises less than $K_1 + K_2$ in $t = 1$ or, respectively, the investor has the right to withhold the additional financing needed to make the second period investment. This case gives rise to the well-known problem that the initial investor could hold up the firm when it seeks additional financing by threatening to portray it as defunct to outsiders and refuse financing (Rajan, 1992). In line with the literature, we assume that this certification power allows the initial investor to force renegotiations of the existing contract in return for offering a new financing round.

To characterize financial contracting in this case in an intuitive way and with the minimum use of notation, we break it up in two by presenting it as raising financing in

[5]Generalizing our results to a setting with a continuum of cash flows requires slightly more structure similar to that in the related security design literature (e.g., Nachman and Noe, 1994), without leading to material new insights. Precisely, denoting with $H_d(x|\theta)$ the distribution function over cash flows for all combinations $d = \{Y, N\}$ and $\theta = \{G, B\}$, we can first generalize $p_{d\theta}(x) := 1 - H_d(x|\theta)$. Following Nachman and Noe (1994), assume that the distribution for G dominates that for B in terms of conditional stochastic dominance (CSD): $p_{dG}(x'|z) \geq p_{dB}(x'|z)$ for $x', z \in X$, where $p_{d\theta}(x|z)$ is the conditional probability $1 - \Pr(x' \leq x \leq x' + z)$. This implies that high cash flows are increasingly more likely in state G compared to state B: $\frac{\partial}{\partial x}\left(\frac{p_{dG}(x)}{p_{dB}(x)}\right) \geq 0$. More efficient refinancing means again shifting more probability mass to the high cash flow states–i.e., $\beta_G(x) \geq \beta_B(x)$, where as before $\beta_\theta(x) := \frac{p_{Y\theta}(x)}{p_{Y\theta}(x)}$. We have shown in a working-paper version how these assumptions jointly ensure that our subsequent results and predictions hold.

stages (Sections 3–4). After deriving the respective optimal contracts for each stage, we also give an alternative interpretation in terms of a single renegotiation-proof contract. Specifically, we denote the contract signed in $t = 1$ with its stipulated payments in $t = 3$ by $R^1(x)$. This contract is offered to investors in return for raising P. In case $P > K_1$, the owner-manager can hoard c^1 out of the excess cash until $t = 3$. Such hoarding, or respectively, payouts $P - c^1$ prior to $t = 3$ can be made part of the initial contract. In case of a new financing round, the initial financing contract is replaced by the new contract $R^2(x)$, and we denote the cash hoarded until $t = 3$ with c^2.[6]

Following the literature, we make the following assumptions: $0 \leq R^t(x) \leq x + c^t$ and both $R^t(x)$ and $x + c^t - R^t(x)$ are non-decreasing, where c^t is the respective hoarded cash level until $t = 3$ depending on whether the firm has raised a new financing round or not. According to the first assumption, the security can only distribute the cash flows that are realized by the firm. As the owner-manager is assumed to be penniless, the seemingly more restrictive condition is that $R^t(x) \geq 0$: The security cannot specify a "wage" that is paid to the owner-manager over and above the firm's cash flow. This restriction is not binding in $t = 1$, but it may be binding in $t = 2$. We relax and discuss this restriction in Section 5.1, where we also show that it does not change our qualitative results.[7] The timing of our contracting game is presented in Figure 1.

INSERT FIGURE 1 ABOUT HERE

Summarizing, the owner-manager's problem in $t = 1$ is to design security (or a menu of securities) R^1 and cash hoarding strategy c^1 to maximize her ex ante expected payoff

$$\gamma U\left(R^1, R^2, c^1, c^2\right) + (1-\gamma)\, U_D\left(R^1, R^2, c^1, c^2\right) + P - c^1 - K_1 \tag{3}$$

where $U(R^1, R^2, c^1, c^2)$ and $U_D(R^1, R^2, c^1, c^2)$ are the owner-manager's expected payoffs if the firm is not defunct and defunct, respectively. This program is maximized subject to the security design restrictions from above, incentive compatibility in $t = 1$ (which we discuss in Sections 4), and the investor's ex ante break even condition

$$\widehat{\gamma} V\left(R^1, R^2, c^1, c^2\right) + (1-\widehat{\gamma})\, V_D\left(R^1, R^2, c^1, c^2\right) \geq P, \tag{4}$$

[6] Furthermore, we allow for R^1 and R^2 to be a menus seeking to discriminate among different γ-types in $t = 1$ and, repsectively, among different q-types in $t = 2$. We stick to the simple notation $R^t(x)$, as we show that such menus will not arise in equilibrium.

[7] The other restrictions that $R^t(x)$ and $x - R^t(x)$ are nondecreasing are also standard. Otherwise, either party could have an incentive to "destroy" cash flow by obstructing the operations of the firm.

which in a competitive capital market will be satisfied with equality. In this constraint, $V(R^1, R^2, c^1, c^2)$ and $V_D(R^1, R^2, c^1, c^2)$ are the investor's expected payoffs if the firm is not defunct and defunct, respectively, and $\widehat{\gamma}$ is the investor's ex ante belief about γ. Furthermore, the program is maximized anticipating the financing contracts R^2 and the hoarding c^2 following new negotiations and financing in $t = 2$ (respectively, we can also interpret $\{R^1, R^2, c^1, c^2\}$ as a single renegotiation-proof contract, which converts from $\{R^1 c,^1\}$ to $\{R^2, c^2\}$ upon raising new financing in $t = 2$). To make this problem tractable, we focus first on financial contracting R^1 and R^2 in Sections 3 and 4. We discuss raising excess cash and hoarding in Section 5.1. In Section 5.2, we analyze financial contracting when raising all of $K_1 + K_2$ in $t = 1$ or when, respectively, obtaining the uncoditional right to raise the necessary additional financing in $t = 2$.

3 Financing from a Strong Investor

The central case in our paper is when the owner-manager has less than K_2 at her disposal at $t = 2$ and must approach the investor for a new financing round. As we argued above, in this case the investor has bargaining power vis-à-vis the (locked-in) firm and can, thus, make a take-it-or-leave-it offer at $t = 2$. In Section 6, we discuss in detail how such bargaining power could arise naturally when small firms raise financing from a relationship investor, such as a house bank, or a specialist investor, such as a venture capitalist.

We proceed backwards and solve, first, the investment problem at $t = 2$. We extend our results to financing from new investors in Section 3.2. Recall that in $t = 2$, though both the initial investor and the owner manager know whether the firm is defunct, the owner-manager has new informational advantage, as she knows her type q. After solving the game, we plug in the equilibrium outcome into the initial problem at $t = 1$ (Section 4).

To ease exposition, we use the following short-hand notation: $R_l^t := R^t(x_l)$ denotes the repayment for low cash flows and $\Delta R^t := R^t(x_h) - R^t(x_l)$ the investor's upside. Let

$$p_d(q) := p_{dB} + q(p_{dG} - p_{dB}) \text{ for } d = \{Y, N\} \tag{5}$$

denote the expected probability of the high cash flow, conditional on the type q as well as the decision whether to undertake the investment or not. The gross expected profits for $d = \{Y, N\}$ are

$$s_d(q, c^t) = x_l + c^t + p_d(q)\Delta x.$$

Under some security R, these profits are shared so that the investor realizes

$$v_d(R^t, c^t, q) = R_l^t + p_d(q)\Delta R^t$$

and the owner-manager, consequently,

$$u_d(R^t, c^t, q) = s_d(q) - v_d(R^t, c^t, q).$$

To ease notation, we suppress c^t in the function arguments when it does not cause confusion.

3.1 Financing under Asymmetric Information in $t = 2$

In this section, we assume that the financing terms at this stage are dictated by the initial investor, so that the owner-manager must agree to a new contract, R^2, proposed by this investor. Otherwise, no new capital is injected, and the original contract stays in place. The second period investment requires a cash outlay of K_2. To focus on the effect of security design, we assume initially that the owner-manager raises K_2 from the investor even if she has hoarded some cash from $t = 1$ (i.e., $c^2 = c^1$). We show that this is without loss of generality in Section 5.1, where we also discuss raising excess cash in $t = 2$.

Denote the set of all types q for whom it is profitable to accept the offer with $A \subseteq [0, 1]$—i.e., $u_Y(R^2, q) \geq u_N(R^1, q)$ for $q \in A$. Then, the investor's expected payoff at $t = 2$ is given by

$$V\left(R^1, R^2, c^1, c^2\right) = \int_A \left[v_Y(R^2, c^2, q) - K_2\right] dF(q) + \int_{[0,1]/A} v_N\left(R^1, c^1, q\right) dF(q), \tag{6}$$

and his objective is to maximize this payoff.

First-best Contract. The investor's profits are highest when the investment decision is made efficiently and when he can extract all of the thereby generated surplus. Facing an investor with such objective, the owner-manager's natural incentives would be to try to convince him that too expensive financing would make a new investment round unprofitable to her—i.e., the incentives are to understate her type. The investor can deal with this incentive by making an offer for which each owner-manager type $q \in A$ is exactly indifferent between accepting and rejecting:

$$u_Y(R^2, q) = u_N(R^1, q) \ \forall q \in [0, 1]. \tag{7}$$

The left-hand-side of (7) is increasing in the owner-manager's type q as long as she participates in the firm's upside. Thus, an offer R^2 satisfying (7) would not be possible in the canonical one-shot model where, absent an initial financial structure, the right-hand side of (7) would be constant. However, our setting explicitly takes into account that the a firm that does not undertake a new investment round still generates positive payouts. In particular, the higher the owner-manager's type, the better also her outside option from not making the new investment round. Thus, financing cannot be too expensive, as it will put off the owner-manager from making the new investment. This generates countervailing incentives to those discussed above, as the owner-manager's willingness to to convince the investor that her outside option is higher creates an incentive to overstate her type.

Our key insight here is that the outstanding financial claim R^1 determines to what extend the owner-manager benefits from the firm's potential success absent new investment. In particular, the lower the owner-manager's cushion in case the firm's cash flows turn out to be low, the more willing she would be to go for a new investment round. If this effect is sufficiently strong, the investor can offer a security $R^2 = \widehat{R}$ that satisfies (7). In this case, the countervailing incentives generated by the owner-manager's stake in the firm fully neutralize the effect of asymmetric information and allow to achieve first-best investment.

Formally, for given R^1, security $\widehat{R}$ is defined by

$$\begin{aligned} \Delta\widehat{R} &= \Delta x - \left(\frac{p_{NG} - p_{NB}}{p_{YG} - p_{YB}}\right)\left(\Delta x - \Delta R^1\right), && (8) \\ \widehat{R}_l &= R_l^1 - p_{NB}\left(\Delta x - \Delta R^1\right) + p_{YB}\left(\Delta x - \Delta\widehat{R}\right). && (9) \end{aligned}$$

This new security $\widehat{R}$ gives the investor a higher participation on the upside, $\Delta\widehat{R} > \Delta R^1$, and less protection on the downside, $\widehat{R}_l < R_l^1$.[8] The intuition for this is that it makes the owner-manager's residual claim following a new investment round *less* sensitive to her type q. This is necessary, as the new investment is more efficient in state G. Thus, by taking off the edge of how type-dependent the owner-manager's payoff is to her type, the investor can make this payoff resemble more closely the owner-manager's outside option of not making the new investment round.

Second-best Contract. When the countervailing incentives provided by initial financing are not sufficiently strong, a new security that extracts all surplus would violate the condition that it cannot offer a "negative repayment" to the investor in the low state. For

[8] To see the latter, plug (9) into (8).

this case, denote the unique point of intersection of $u_Y(R^2, q)$ and $u_N(R^1, q)$ by q^*:[9]

$$u_Y\left(R^2, q^*\right) = u_N\left(R^1, q^*\right). \tag{10}$$

The set of owner-manager types who accept a refinancing offer with R^2 in $t = 2$ becomes, thus, $A = [q^*, 1]$: The owner-manager prefers to accept R^2 if and only if $q \geq q^*$ and strictly so if $q > q^*$. All types $q > q^*$ who accept R^2 now receive an *information rent* of size

$$u_Y(R^2, q) - u_N\left(R^1, q\right). \tag{11}$$

Following the same intuition as above, this rent is minimized when the owner-manager's residual claim becomes least sensitive to her private information. The latter is achieved by narrowing the difference between her payoff in the low and high cash flow states as much as possible, subject to the constraint that $R_l^2 \geq 0$.

What this implies for the investor's contract is as follows: For a given initial contract R^1, it is optimal to set R_l^2 to its minimal value of 0, in exchange for increasing the investor's participation on the upside—an arrangement that can be interpreted as levered equity. Thus, whenever condition (12) does not hold, levered equity (with $R_l^2 = 0$) is the uniquely optimal security at the refinancing stage.[10]

Proposition 1 *With a strong investor at the refinancing stage, the investor offers a security R^2 that increases his upside participation and decreases his downside protection compared to R^1: $R_l^2 \leq R_l^1$ and $\Delta R^2 \geq \Delta R^1$ (the inequalities being strict if initially $R_l^1 > 0$ or $\Delta R^1 < \Delta x$). There is refinancing if and only if $q \geq q^*$. Furthermore:*
(i) If

$$R_l^1 \geq \left(\frac{p_{YG}p_{NB} - p_{YB}p_{NG}}{p_{YG} - p_{YB}}\right)\left(\Delta x - \Delta R^1\right), \tag{12}$$

the first-best security $R^2 = \widehat{R}$, as characterized in (8)-(9), is feasible and uniquely optimal, in which case the refinancing decision is always efficient: $q^* = q_{FB}$.
(ii) Otherwise, if (12) does not hold, the new security is levered equity with $R_l^2 = 0$, and there is underinvestment as $q_{FB} < q^* < 1$.

Proof. See Appendix.

Though in principle, the investor could try to offer a menu of contracts to discriminate among different types q, he would not find it optimal to do so, but will offer a simple pooling

[9]By optimality for the investor, such point will always exist. In fact, we show that $q^* \geq q_{FB}$.
[10]We discuss condition (12) after characterizing also the initial security R^1.

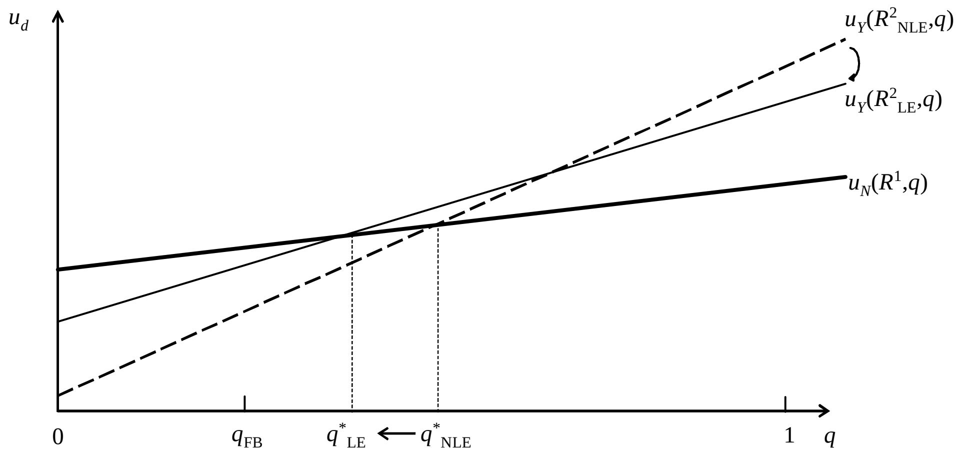

Figure 1: Financing under asymmetric information in the strong investor case.

levered equity contract R^2 to the owner-manager. The reason is that any non-degenerate menu of contracts would have to include also a flatter security than levered equity (the flatter security will be taken up by lower types). However, these flatter securities will leave the owner-manager with a higher information rent than a pooling levered equity contract and are, thus, not optimal for the investor.

The underinvestment problem in the second part of Proposition 1 is an important insight from our model. It arises, as the strong investor trades off maximizing surplus with reducing the owner-manager's information rent. While the countervailing incentives of the owner-manager mitigate this problem, they are not strong enough to help the investor extract the full surplus. To pin down $q^* > q_{FB}$, we substitute $A = [q^*, 1]$ into the investor's objective function (6) and use that $R^2_l = 0$ from Proposition 1. We also use that from the owner-manager's indifference condition (10), we can obtain ΔR^2 as an increasing function of the induced cutoff q^*. Intuitively, giving the investor more of the upside makes new financing less attractive for the owner-manager. Differentiating the investor's expected profit (6) with respect to q^*, the following first-order condition applies:

$$-\left[s_Y(q^*) - s_N(q^*)\right] f\left(q^*\right) + \frac{d\Delta R^2}{dq^*} \int_{q^*}^{1} \frac{dv_Y(R^2, q)}{d\Delta R^2} dF\left(q\right) = 0. \tag{13}$$

The second term in (13) captures the benefits from reducing the information rent for all $q > q^*$ while the resulting loss in surplus as q^* increases is captured by the first term in (13). Expression (13) implies immediately that $q^* > q$.

Figure 2 graphically illustrates the intuition behind Proposition 1 and its proof. The

bold solid line represents the owner-manager's expected payoff $u_N(R^1, q)$ under some outstanding claims R^1. The dotted line represents her payoff for some second-period security R^2_{NLE}, which is not levered equity. The intersection of the two curves yields the cutoff $q^* = q^*_{NLE}$, so that under this security there will be new financing and investment for types $q \geq q^*_{NLE}$. The figure illustrates why any such non-levered equity contract could not have been optimal for the investor. First, by offering a levered equity contract, which implements the same cutoff q^*_{NLE}, the investor would extract more information rent, as it would lead to a clock-wise rotation of $u_Y(R^2_{NLE}, q)$. Effectively internalizing more of the social surplus, the investor will offer a levered equity contract R^2_{LE}, which not only leads to such clock-wise rotation, but also to a lower, more efficient cutoff $q^*_{LE} < q^*_{NLE}$.

The underinvestment problem arising from private information is conceptually quite different from an underinvestment problem that would arise when holders of outstanding (debt) claims would free-ride on the value creation by new investors. As we show next, our results extend also to raising new financing from new investors. Moreover, in contrast to debt-overhang settings, the inefficiency will be *mitigated* when the outstanding initial security R^1 is debt (Section 4).[11]

3.2 New Investors

It is straightforward to extend our results to raising financing from a new investor at $t = 2$. In case the firm raises more than K_2 to repay its existing investor, we denote the cash paid to the initial investor with V. Note that such cash repayment could also be interpreted as a safe debt claim with a face value of V. In line with our underlying assumption that the initial investor has all the bargaining power, we assume that it is him who steers the firm towards the type and amount of new financing to be raised. Allowing for the general case that new financing includes replacing the initial investor's claim for a new one, cash, or (equivalently) safe debt, we denote the fresh risky claims of the new and the old investor at $t = 2$ by R^2_{New} and R^2_{Old}, and the combined outstanding risky claim by $R^2 = R^2_{Old} + R^2_{New}$.[12] Again, financing is obtained for all types $q \geq q^*$ with $u_Y(R^2, q^*) = u_N(R^1, q^*)$. To be acceptable for the new investor, the new investor's

[11] Our key innovation is to analyze how shifting bargaining power and countervailing incentives from the initial capital structure affect optimal security design. These two aspects differentiate our second-period underinvestment problem from that discussed in papers, such as Myers and Majluf (1984), where information asymmetry affects only the value of existing assets, which are unrelated to the value of new opportunities, there are no outstanding securities, and the owner-manager has all bargaining power.

[12] Observe that the old investor retaining R^1 is the special case in which R^2_{old} is the same as R^1.

securities must pay

$$\int_{q^*}^{1} \left[v_Y \left(R^2_{New}, q \right) - K_2 - V \right] \frac{dF(q)}{1 - F(q^*)} \geq 0. \tag{14}$$

If certification can guarantee access to a competitive market for fresh financing, this participation constraint holds with equality.[13] If either the owner-manager or the new rejects the respective offer, no refinancing takes place.

We can see now that our characterization results fully survive also when K_2 is raised from new investors. Using conditions (14) to plug into the (strong) initial investor's objective function, we obtain

$$\begin{aligned} & \int_0^{q^*} v_N \left(R^1, q \right) dF(q) + \int_{q^*}^1 \left[v_Y \left(R^2_{old}, q \right) + V \right] dF(q) \\ = & \int_0^{q^*} v_N \left(R^1, q \right) dF(q) + \int_{q^*}^1 \left[v_Y \left(R^2, q \right) - K_2 \right] dF(q) \end{aligned}$$

which is identical to that in Section 3. Thus, regardless of whether the initial investor stays with the firm obtaining a safe debt claim with face value V, cashes out V, or obtains a new (risky) claim R^2_{old} (or any combination of these alternatives), the problem and the results from Proposition 1 remain unchanged.

Proposition 2 *Consider the case where at $t = 2$ the owner-manager raises K_2 from a new investor. Regardless of whether the old investor cashes out or stays invested, the previous characterization of (total) outstanding risky claims R^2 still fully applies.*

One interpretation of Proposition 2 we will pursue later is that our results are consistent with the firm raising levered equity financing from new investors, while making its initial debt investor's claim more secure (his risky debt claim R^1 becomes a safe debt with face value V) .

4 Choice of Financial Structure in $t = 1$

We now solve the owner-manager's problem at $t = 1$. Recall that information asymmetry arises in stages in our model. While at $t = 1$ the owner-manager is not yet better informed than investors about q, she is better informed about the likelihood γ that the firm turns

[13] To focus on the security design aspect, we do not explicitly model monitoring or how certification works. Still, note that for the certification to be credible, it may be necessary that the initial investor retains some "skin in the game" and stays at least partially invested in the firm.

out to be defunct. In what follows, we assume initially that the problem at this stage is to maximize the owner-manager's payoff. The forces at play if we would allow the bargaining power to shift towards the investor also in $t = 1$ are related to those discussed in Proposition 1 (see also Section 5.3).

As now the privately informed owner-manager makes the offer, we face a game of signaling. A candidate for an equilibrium of the signaling game where each type γ plays a pure strategy is a triple of functions $(R^1(\gamma), \widehat{\gamma}, P)$: $R^1(\gamma)$ is the security issued by type γ; $\widehat{\gamma}$ is the investor's posterior belief, which maps the proposed security contract into the set of probability distributions over the type set $\gamma \in [0, 1]$; and P represents the investor's decision how much financing to offer in return for R^1. Our equilibrium concept is that of a Perfect Bayesian Equilibrium. We rule out the use of safe debt by assuming that $K_1 > x_l$.

We characterize, first, the equilibrium in which the manager raises $P < K_1 + K_2$ in $t = 1$. This analysis, thus, builds on Section 3 in which we characterized the raising a new round of financing and investing in $t = 2$ when the owner-manager has insufficient cash and faces a strong investor. In Section 5.2, we derive then the conditions under which we can also support an equilibrium in which the owner-manager secures at least $K_1 + K_2$ in $t = 1$, so that she does not rely on certification by the initial investor at the interim stage.

The owner-manager's problem at $t = 1$ is to design security (or menus of securities) R^1 to maximize (3) subject to incentive compatibility, the investor's break even constraint (4) at $t = 1$, and the expectation of second period financing will be (re-)negotiated as described in Section 3—i.e., expecting that how q^* and R^2 are potentially determined at the interim stage.[14]

In what follows, we argue that the unique equilibrium in $t = 1$ is that all types offer the same debt contract. The key novel insight from our analysis of this stage is that pooling debt financing is optimal in $t = 1$ because it maximally exploits the countervailing incentives arising in $t = 2$. This allows the firm to maximize efficiency, when it expects to issue levered equity in $t = 2$. We expand on this intuition in two steps. First, we show that debt maximizes the value of the non-defunct firm. Second, we show that debt would, indeed, arise as equilibrium financing in $t = 1$.

Suppose initially that we could take P as given and we aimed at deriving the period-one security that maximizes the owner-manager's expected payoff $U(R^1, c^1)$ if the firm turns out to be non-defunct. The source of inefficiency in $t = 2$ is that information asymmetry

[14]Note that, to simplify the exposition, we have presently assumed that, for given R^1, the investor chooses a pure strategy in $t = 2$, so that R^2 and q^* are pinned down uniquely. As we show in the proof of Proposition 4, this must indeed hold in equilibrium, even though the investor's program at $t = 2$ may not be strictly quasiconcave.

about q forces the investor to trade off rent extraction from the owner-manager with efficiency. This trade-off can be mitigated in at least two ways: by the choice of the security in $t = 2$ and $t = 1$. In the previous section, we showed that levered equity financing leads to a more efficient refinancing decision.

Efficiency is even higher if the countervailing incentives generated by the initial financing structure are stronger. This is the case if the residual claim of the owner-manager is more sensitive to her type. In Figure 2, this corresponds to making $u_N(R^1, q)$ steeper in q, which then makes it easier to design a second period security that minimizes the owner-manager's interim information rent and maximizes interim inefficiency. Thus, to achieve greater efficiency in $t = 2$, the initial security R^1 should leave the owner-manager as much of the upside as possible, implying that the investor should be offered a debt contract.

Somewhat loosely speaking, the consequence of issuing debt in $t = 1$ is that it improves the firm's equity capacity in $t = 2$. Though the owner-manager's information rent in $t = 2$ is reduced, she is compensated for this with cheaper financing in $t = 1$. Crucially, the prospect of reducing underinvestment implies that the cost-reduction effect is amplified by the higher likelihood that the initial investor makes additional profits from a new financing round.

Proposition 3 *Suppose that the owner-manager raises P in $t = 1$ and hoards c^1 until $t = 3$. (i) If the firm anticipates underinvestment ($q^* > q_{FB}$) in $t = 2$, the security that maximizes the owner-manager's payoff in $t = 1$ in case the firm is not defunct is debt financing with $R_l^1 = x_l + c^1$. (ii) The first-best investment outcome ($q^* = q_{FB}$) in $t = 2$ is obtained if*

$$\begin{aligned} & x_l + c^1 \\ \geq\ & \frac{p_{NB}p_{YG} - p_{YB}p_{NG}}{(p_{YG} - p_{YB})p_N(\widehat{q})}(S_{FB} - K_1) + \frac{(p_{NG} - p_{NB})p_Y(\widehat{q})}{(p_{YG} - p_{YB})p_N(\widehat{q})} \max\left(0, S_{FB} - K_1 - p_N(\widehat{q})\Delta x\right), \end{aligned} \tag{15}$$

where $S_{FB} := \int_0^{q_{FB}} s_N(q)\, dF(q) + \int_{q_{FB}}^1 [s_Y(q) - K_2]\, dF(q)$ denotes the maximum feasible joint surplus, gross of the initial outlay K_1. If condition (15) is not met, there is underinvestment with $q^* > q_{FB}$.

Proof. See Appendix.

The second part of Proposition 3 derives the condition when first-best efficiency can be achieved, using that from condition (12) an efficient outcome in $t = 2$ is feasible only if

R_l^1 is sufficiently high.[15] The intuition for condition (15) is simple. If x_l is large enough, the owner-manager can ensure that the investor just breaks even with a security that leaves most of the upside from the non-refinanced firm to the owner-manager, making the countervailing incentives in $t = 2$ sufficiently strong (cf. (7)).

Our key new insight from this section is that debt would be the firm's preferred way of building up financial flexibility even absent asymmetric information in $t = 1$. Naturally, considering such asymmetry only strengthens the argument for using debt financing. Stipulating that all proceeds from a defunct firm go to the investor, helps to relax the investor's ex ante break even condition (4), as it makes $U_D(R^1, c^1)$ minimal.[16] There is a multiplicity of debt equilibria that could be supported if the investor's out-of-equilibrium beliefs are allowed to be arbitrary. We deal with this multiplicity by using the standard refinement D1, which requires that the investor restricts his out-of-equilibrium beliefs only to the type(s) most likely to make the deviation (see Lemma 1 in the Appendix). This refinement leaves debt financing in $t = 1$ as the only equilibrium financing candidate. As highlighted above, this is for two reasons. First, debt financing maximizes the owner-manager's payoff of a non-defunct because of the countervailing incentives it provides in $t = 2$. Second, it minimizes her payoff if the firm turns out to be defunct. Thus, high γ-types benefit most from a debt issuance, implying that financing with debt will be the only equilibrium candidate from which these types will not be able to successfully deviate. Also here, a menu of securities will be dominated, as such menus will include non-debt contracts and, thus, ultimately make financing more expensive for the owner-manager. We formalize this intuition in the following proposition.

Proposition 4 *Pooling debt financing in* $t = 1$ *is the unique equilibrium that satisfies D1.*

Proof. See Appendix.

We have interpreted so far raising capital in stages as approaching investors and negotiating financing terms separately in $t = 1$ and $t = 2$. An alternative way to interpret the contracts derived in Propositions 1-4 is in the context of a single renegotiation proof security. Under this interpretation, the owner-manager issues initially a debt-like contract,

[15] Note that we now relegate to the proof the characterization of the initial security in case subsequent refinancing can be made first best, as this is obtained immediately from substituting the respective security $R^2 = \widehat{R}$, together with $q^* = q_{FB}$, into the binding break-even constraint (4).

[16] Without loss for our financial contracting results, we are focusing on the case in which the defunct firm produces x_l with certainty, implying that $U_D\left(R^1, c^1\right) = 0$. If x_l were stochastic also for a defunct firm, U_D would be positive, but still minimal for debt. However, positive values of U_D would then lead to raising less excess cash in $t = 1$ (as we discuss in footnote 17).

which gives her the right to raise new financing in $t = 2$ upon which the initial contract converts to levered equity. We elaborate on this interpretation in more detail in Section 6.

5 Extensions

5.1 Raising Excess Cash

Deriving the equilibrium in $t = 1$ also raises the question whether the owner-manager should raise more than K_1 in $t = 1$. Observe, first, that if the owner-manager raises cash in excess of K_1, this additional cash will not be paid out. The intuition is that such payouts are more beneficial for low-γ types who are more likely to be in charge of a defunct firm. Thus, high types are those most likely to deviate from such payouts and the only remaining equilibrium candidate can be with all excess cash being hoarded until $t = 3$. There are multiple such equilibria with debt financing and cash hoarding that survive D1.

Proposition 5 *The equilibrium that maximizes the owner-manager's payoff features raising $P > K_1$. There are no payouts between $t = 1$ and $t = 2$ and the excess cash raised in $t = 1$ is hoarded until $t = 3$.*

Proof. See Appendix.

Raising excess cash is costly for high $\gamma-$types of managers, which fear underpricing when mixed with low $\gamma-$types. This cost of underpricing is higher, the higher the payment $U_D\left(R^1, c^1\right)$ a defunct firm can extract for itself. However, raising more than K_1 while there is still symmetric information about q (making the pricing or R^1 with regard to q "fair"), could help to mitigate with the underinvestment problem in $t = 2$. Intuitively, when the investor holds a higher claim on the firm's cash flows, he internalizes a higher proportion of social surplus. This leads to more efficient refinancing in $t = 2$ and cheaper initial financing in $t = 1$. Thus, the equilibrium offer $\{R^1, c^1\}$ that maximizes the owner-manager's payoff will trade off the cost of underpricing with maximizing q^*, subject to the constraint in this section that $P < K_1 + K_2$.[17] The latter constraint is especially important: As we show in Section 5.2, raising (weakly) more than $K_1 + K_2$ gives rise to a different problem.

[17]When the defunct firm has a zero probability of producing high cash flows, we have $U_D\left(R^1, c^1\right) = 0$ and the trade-off is resolved easily, as there is no underpricing. Otherwise, it has a stronger bite and increasing P will reflect the underpricing concerns of the highest $\gamma-$type. Clearly, adding a cost of hoarding as is standard in the literature (e.g., Bolton et al., 2011) would further lower P.

Discussion: Excess Cash in $t = 2$ and Paying the Manager a Wage An interesting aspect of cash hoarding is that excess cash raised in $t = 1$ will not be co-invested in $t = 2$, but hoarded until $t = 3$. This is a straightforward extension of Proposition 1: Since a co-investment of c^1 by the owner-manager could equivalently be represented as posing c^1 as a collateral to be paid to the investor in $t = 3$, such co-investment is equivalent to setting $R_l^2 = c^1$, contradicting Proposition 1. Intuitively, such "collateral pledges" make it more difficult to extract information rent from the owner-manager, as they make the owner-manager's expected payoff $u_Y(R^2, q)$ more exposed to the firm's success (i.e., information sensitive) and, thus, more difficult to bring down every owner-manager type q to her outside option $u_N(R^1, q)$.

Proposition 6 *Excess cash raised in $t = 1$ will not be co-invested, but it will be hoarded until $t = 3$.*

Absent the no-wage restriction ($R_l^t \geq 0$), Proposition 6 could be extended to show that it would be optimal to raise excess cash in $t = 2$, which goes one-to-one towards the manager's payoff in the low cash flow state. However, raising additional cash ζ is formally equivalent to making $R^2 = -\xi < 0$. Intuitively, since the owner-manager receives this money regardless of the firm's success, it is equivalent to buying off the owner-manager in $t = 2$. Thus, raising excess cash in $t = 1$, which leads to leveraging up the firm has very different implications from raising cash in $t = 1$, which implies siding out the owner-manager. Thus, the standard motivation for restricting to $R_l^t \geq 0$ is to prevent such siding out and turning the owner-manager into a wage-receiving employee unconcerned with the firm's success.[18] However, it is straightforward to verify that also absent the no-wage restriction our security design results remain qualitatively unchanged. The period-one securities we have derived above remain optimal and uniquely minimize the necessity for raising excess cash in $t = 2$. Furthermore, it continues to hold that the firm's leverage decreases following new financing in $t = 2$, as the investors receive a greater upside participation and lower (here even negative, after paying the wage) downside protection.

5.2 Securing all Financing in $t = 1$

An alternative to raising financing in stages and, respectively, to securing financing for less than $K_1 + K_2$ is that the owner-manager raises K_1 in $t = 1$, while obtaining the unconditional right to raise K_2 or more in $t = 2$. The advantage of such a contract is that

[18] Though outside of our model, this assumption could be endogenized with introducing an effort incentives problem.

it could deal away with the underinvestment problem we described above. Specifically, the owner-manager could design $\{R^1, R^2, c^1\}$ for which converting from R^1 to R^2 is optimal for all $q \geq q_{FB}$ without having to consider being held up by the investor in $t = 2$ forcing R^2 to be renegotiated in a way that leads to underinvestment as in Section 3. However, the disadvantage is that it leads to a different problem: that of potential overinvestment. In particular, if the firm turns out to be defunct, but the owner-manager has the right to draw on additional cash in excess of K_2, she could threaten to undertake the second investment round and sink the excess cash. Though this would not improve the profitability of the firm, we make the standard assumption that this would allow the owner-manager to enjoy some form of private benefits amounting to a fraction $\tau > 0$ of the sunk excess cash. To stay consistent with the notation in the previous sections, let P denote the cash that the owner-manager secures in $t = 1$ and let c^1 denote the hoarded cash until $t = 2$.

Suppose that the firm turns out to be defunct. Two observations follow immediately. First, it must be that the owner-manager's expected payoff in the low cash flow state is as low as possible. This makes sure that the investor can recover as much as possible if the firm turns out to be defunct. Second, renegotiation proofness imposes a restriction: Though the defunct state is not verifiable, it is observable both to the owner-manager and her initial investor. Thus, they would renegotiate the initial contract unless not investing gives the owner-manager at least τc^1 more in the low cash flow state than investing.[19]

Observe, next, that if such an equilibrium exists, there will be no payouts before $t = 3$ and the owner-manager will secure financing for at most $P = K_1 + K_2$. The intuition is similar to before. Payouts before $t = 3$ benefit types who are more likely to be in charge of a defunct firm. Thus, high $\gamma-$types would successfully deviate from such equilibrium candidates. By the same token, raising more than $K_1 + K_2$ cannot be an equilibrium, as it increases the bribe that a defunct firm would require in order not to sink the excess cash c^1—something that again high γ-types value less than lower types, making a successful deviation possible.

It remains to characterize when an equilibrium with $P = K_1 + K_2$ will exists. This boils down to asking whether the potential underinvestment problem due to raising less than $K_1 + K_2$ is less costly to the owner-manager compared to the costs of not being able to commit not to cash in anything (due to having access to K_2) if the firm turns out to be defunct. Clearly, the latter is less of a problem if K_2 is small and the likelihood of facing a non-defunct firm ($\widehat{\gamma}$) is high.

[19]We assume that receiving τc^1 would be sufficient for the entrepreneur not to sink c^1. However, our analysis naturally extends also to larger "bribes."

Proposition 7 *(i) The owner-manager never raises more than $P = K_1 + K_2$. (ii) An equilibrium involving $P = K_1 + K_2$ exists only if raising financing in stages leads to underinvestment, if $\widehat{\gamma}$ is high, and K_2 is small. In this equilibrium K_2 is financed from P, and the (renegotiation-proof) financing contracts feature $R_l^1 = x_l + (1 - \tau) K_2$ and $R_l^2 = x_l$.*

5.3 Discussion: Financing Pecking Orders Under Asymmetric Information

The focus of our paper is on explaining how firms raise financing under asymmetric information when they (expect to) find themselves in a situation in which the investor will be dictating the terms of financing. One of our main results is to show when firms will issue equity in this context and how they could ameliorate the investment inefficiencies connected with such issues. In this section we briefly deviate from this focus to relate to an well-known intuitive argument bringing equity in connection with the pecking order—namely, issuing equity as means of building up debt capacity. In what follows, we want to bring more structure to this argument by highlighting the role of countervailing incentives also in this more standard setting. At the same time, we point to the fact that the intuition will largely expand on that in Proposition 7. In this proposition, the firm issues debt in the new investment round, but pays the owner-manager a dividend-like payment absent such round in order to deal with the overinvestment problem endemic to settings in which the owner-manager has the upper hand in negotiations.

Specifically, to expand on this argument, suppose that a non-defunct does not have all necessary cash to invest K_2, but contrary to our baseline assumption, can still make a take-it-or-leave it offer to investors in $t = 2$. Following Nachman and Noe (1994), we can show that the unique equilibrium contract in $t = 2$ is debt and that there will be overinvestment, as predicted by the pecking order result (Myers and Majluf, 1984). The way countervailing incentives in $t = 2$ arise in this setting is as follows: On the one hand, the owner-manager would like to overstate her type to receive a cheaper new financing round; on the other hand, she would have incentives to understate her type if raising new financing needs to make sure that the initial investor is not worse off. The reason is that the initial investor's outstanding claim also depends on the owner-manager's type. Incidentally, these effects become even clearer within the context of raising financing from new investors, as then the owner-manager would like to present a different image of the firm to new and old investors.

We argue now that by exploiting these countervailing incentives, the owner-manager can reduce the overinvestment problem in $t = 2$, associated with this setting, by issuing

levered equity in $t = 1$. Here overinvestment results from the cross subsidization of lower types by higher types, where debt financing in $t = 2$ helps to reduce this cross subsidy. We keep the analysis brief just to make the main point, and we refer the reader interested in details to the online appendix. For ease of exposition, we assume that the new investment round is raised from the initial investor.

Proposition 8 *Levered equity financing can help minimize overinvestment when the owner-manager expects to raise debt financing in the future under asymmetric information.*

Levered equity maximizes the sensitivity of the investor's claim to the owner-manager's type under the initial contract R^1. This boosts the countervailing incentives, as the owner-manager's benefit from being (or pretending to be) a higher type when seeking new financing is then more strongly counteracted by the increase in value of the investor's initial claim R^1. At the same time, the flip-side of such an arrangement is that it makes the manager less sensitive to weather the existing business is good or not and, thus, less desperate to raise new financing. Thus, fewer owner-manager types decide to raise new financing, resulting in less overinvestment and less cross-subsidization.

Taking into account this argument implies that the equilibrium financing arrangement in $t = 1$ will not be pure debt as in Proposition 4, but would contain a mix of debt and levered equity. We do not further pursue this discussion here in more detail, not to stray from too much from our baseline model. However, we conclude by summarizing that the financing pecking order crucially depends on the distribution of bargaining power, and that countervailing incentives arising from the initial capital structure can play an important role in designing the optimal financing contracts.

Proposition 9 *(**Financing Pecking Orders**) Firms do not issue pure debt under asymmetric information (i) if they don't have access to competitive financing or need certification from a relationship investor to do so; (ii) or if they have continuous access to competitive financing, but they expect to raise (debt) financing under asymmetric information also in the future.*

6 Empirical Implications

The pecking order theory of raising financing under asymmetric information is probably one of the best-known theories in modern corporate finance, which has found its way even into MBA text books. Recent decades of empirical work have questioned, however, the applicability of this theory in practice. While this theory's simple predictions seem to

hold for the largest of firms (Shyam-Sunder and Myers, 1999), there is mounting evidence that it frequently fails in the case of smaller firms (Frank and Goyal, 2003; Leary and Roberts, 2010; Gomes and Phillips, 2012). This insight is especially disturbing, as such firms are likely to be more informationally opaque and, thus, should be especially susceptible to information asymmetry problems. One of the main insights from our model is that information asymmetry is very well able to explain deviations from this theory. In particular, the stark prediction of the original pecking order theory crucially depends on the assumption that firms have access to competitive financing. We show that these predictions revert if firms don't have access to competitive financing.

Implication 1. *Firms raising financing under information asymmetry issue equity if they have no access to competitive financing or if they need their initial investor's certification to gain such access.*

While access to competitive capital markets is usually taken as given, there is recent evidence that this is not the case even in the U.S. for small and informationally opaque firms (Rice and Strahan, 2009; Amore et al., 2013; Cornaggia et al., 2014). This is important, as these firms are those most likely to be financially constrained (Hadlock and Pierce, 2010).

Furthermore, it is well accepted that investor bargaining power is a natural consequence in the context of relationship intermediation (Boot, 2000). In this context, an important implication of our analysis is that, rather than diminishing the role of relationship banking, a competitive equity market can help increase its importance. There are two reasons for this. First, such markets help relationship investors realize a higher benefit off the relationship by allowing them to extract more information rent from the borrower. While this hurts the borrower ex post when she is steered by its relationship lender to seek new equity financing (to repay or make existing debt safer), she strictly gains ex ante by finding a more ready access to cheaper financing when entering this relationship (Proposition 1 and 2). Second, expecting to be pressed to issue equity makes it optimal for firms to seek debt financing in the first place. Indeed, the cheapest way for an informationally opaque firm to raise initial financing, while reducing future underinvestment concerns stemming from asymmetric information, is to use (rather than build) up its debt capacity quickly early on (Proposition 4).

Implication 2. *(i) Active equity markets can help spur relationship financing and opaque firms' access to such financing. (ii) Firms, expecting to issue equity under information asymmetry can ease future financing by using debt early on. It is, thus, optimal*

for firms to use up their debt capacity when entering a relationship with an investor whose certification they would later depend on.

Our analysis adds to Boot and Thakor's (2000) argument that competition in the capital markets is unlikely to mean the end of relationship banking. While we are not aware of other papers making the arguments in the core of Implication 2, there is plenty of empirical evidence pointing to the importance of the effects we are discussing. In particular, as we show in Propositions 1 and 2, our model is consistent with the fact that repaying debt holders is one of the primary reasons for and consequences of equity issues (Leone et al., 2007; Pagano et al., 1998). Though one can argue that IPOs can help reduce firms' dependence on relationship lending (Pagano et al., 1998), our novel insight is that relationship lenders can still benefit, as such repayments are one of the ways lenders cash in on their certification power in equity issues. Indeed, the evidence shows that certification stemming from a relationship investor is crucial for obtaining better pricing when firms issue equity even in the U.S. (Schenone, 2004; Duarte-Silva, 2010), and banks use this power to impose more expensive loan terms on their borrowers prior to their IPOs (Schenone, 2010). Naturally, the firms we have in mind could also issue equity in private placements, which could help explain Gomes and Phillips' (2012) finding that smaller firms issue equity in such placements when information asymmetry is a factor.

Our results also readily extend to venture capital financing, where relationships and certification at new investment rounds is also of first-order importance (Megginson and Weiss, 1991; Cumming, 2008). Our main result in this context is to show that information asymmetry, arriving in stages, readily generates the widely used contract structure used for such financing. Specifically, the contract that is the norm in the U.S. is convertible preferred equity. This contract initially gives venture capitalists a liquidation preference (mimicking our debt contract) and it converts into equity as venture capitalists certify for the firm and take it to the public equity markets (Kaplan and Strömberg, 2003). This is consistent with our results when we interpret the contracts derived in Propositions 1 and 4 as a single renegotiation proof convertible security. Our novel insight here is that venture capital contracts established in the U.S. can help deal not only with effort incentives problem, as they have typically been motivated (e.g., Schmidt, 2003; Cornelli and Yosha, 2003), but also with the first-order problem of whether investors are facing A- or B-rate entrepreneurs.

Implication 3. *Providing a venture capitalists with a liquidation preference and converting this contract to equity can help firms raise both initial as well as new rounds of*

financing in times of strong information asymmetry. However, this contract is only optimal if venture capitalists' certification power provides them with a strong bargaining position in new investment rounds.

Equally important, our analysis could help analyze why such contracts are not so common in countries with weak investor protection (Lerner and Schoar, 2005; Cumming 2005, 2008; Kaplan et al., 2007). In particular, firms switch from debt to equity-like financing in our model if investors have a strong bargaining position in new investment rounds, stemming from their certification power. However, in practice, investors' degree of certification will depend on their involvement and expertise. Furthermore, if investor rights are not well-protected, the entrepreneur could sway negotiations in her favor by threatening to walk away with her inalienable human capital. For example, she might use (intangible) assets of the previous enterprise at a new venture instead of staying committed to grow the business after receiving K_2. Prohibiting such opportunistic behavior contractually in a country with a weak enforcement of (investor) rights might be difficult to enforce, considerably weakening the bargaining position of the investor in new financing rounds.[20] Then, in line with the pecking order, it would be optimal to switch from equity to debt (Proposition 8). Indeed, in countries where enforcement of investor rights is weak—i.e., where even relationship investors are likely to have a weak bargaining position—VC's are more likely to take common equity in first financing rounds. More successful firms then issue more senior securities in later rounds (Kaplan et al., 2007). In a similar vein, consistent with fewer specialized investors and a weaker enforcement of investor/creditor rights in developing markets, Chavis et al. (2011) find that young firms change their leverage strategy as they mature, switching out of informal equity finance toward bank finance. Instead, most start-up firms in the U.S. rely on debt even for first rounds of financing (Robb and Robinson, 2012).[21]

Implication 4. *Relationship investment, such as relationship lending and U.S.-style VC contracts, are less likely to emerge in circumstances in which investors are not (yet) sufficiently experienced (specialist) investors or in which their bargaining power vis-à-vis entrepreneurs is severely restricted by weak enforcement of investor rights.*

[20] Asymmetric information at $t = 2$ constrains us to look at the two opposite scenarios where we grant either the investor or the owner-manager full contracting power, since a more flexible solution concept, such as Nash bargaining, is not generally available when there is asymmetric information.

[21] It is mostly experienced repeat-entrepreneurs who rely on equity in first financing rounds and who switch to debt only in later rounds. To the extent that the advantage of experienced repeat-entrepreneurs is a better bargaining position, this shift in leverage is also consistent with Proposition 8.

Our predictions that firms issue equity in new rounds of financing with a relationship investor depend on several conditions. First, relationship investors should possess privileged information, crucial for assessing the viability of the firms and unavailable to outside investors. Otherwise, firms will turn to debt financing (Propositions 4 and 7). Second, even in such times, equity financing will be used in the case of larger investments. Instead, smaller investments are likely to be financed with credit-line type of arrangements (Proposition 7). This is in line with the recent findings of Robb and Robinson (2014) that show that credit lines are important in freshly created firms, but do not account for a large fraction of external financing.

Implication 5. *Small investments, surrounded by less uncertainty will be financed with debt or credit lines. The equity issues predicted in Implication 1 are more likely for large investments and/or in times surrounded by substantial uncertainty about the viability of the firm—especially absent certification by initial investors.*

Finally, our theory predicts firms dependent on relationship financing will often raise excess cash. However, we highlight that credit lines are not a substitute to cash hoarding, as credit lines are used for investment, while cash is hoarded to supplement payments to insiders and investors. This is in line with Lins et al. (2010) who show that firms use credit lines, rather than hoarded cash, for new investments.

Implication 6. *When firms dependent on relationship financing issue equity, they will raise more than they need for new investment and (continue to) hoard the excess cash. Credit lines, which are used for investment, are not a substitute for cash hoarding in this context.*

7 Conclusion

We develop a theory in which a firm develops a relationship to an investor who can later exert substantial bargaining power in new financing rounds. We show that if the firm cannot raise competitive financing absent the certification of such investor, it will issue levered equity when raising financing under asymmetric information. As such financing is expensive, firms would sometimes avoid it and prefer to stick to their existing business. The key effect that we explore, when analyzing how the firm could deal with the resulting

investment inefficiencies, is that a firm's existing capital structure and cash hoarding strategy can create countervailing incentives to those causing the firm to see new financing as too expensive and eschew new investment. Intuitively, the firm is more eager to raise new financing if, absent such financing, the owner-manager is more exposed to the downside of the existing business. This can be achieved by using up the firm's debt capacity early on, as this maximally leaves the owner-manager exposed to the firm's success. Furthermore, it is optimal for the firm to raise excess cash, which is not co-invested, but hoarded, as this strategy also helps to boost the countervailing incentives when negotiating new financing. Specifically, by adjusting how much the owner-manager's payoff depends on a cash payment and how much on the firm's success with and without a new financing round, it is possible to make the owner-manager more willing to opt for new financing. Our model also analyzes when, instead of raising financing in stages, the firm is better off relying on long-term credit line-types of arrangements. The cost of such financing is that it creates incentives for overinvestment. It is, thus, only optimal when future funding needs are small and investments are relatively certain.

Our theory best applies to small and informationally opaque firms, as such firms are most likely to be financially constrained and to enter relationships with banks or venture capitalists. Our insights could, thus, help explain why small and informationally opaque firms are especially likely to violate the standard pecking order. Furthermore, we argue that the presence of an active equity market can help spur, rather than diminish the role of, relationship banking. Intuitively, being able to steer firms towards issuing equity allows relationship lenders to cash in on existing debt contracts and make them more secure. This makes it easier to offer cheap credit in the first place, which would also be the optimal financing arrangement for entrepreneurs when entering relationship investment. Another novel insight of our setting pertains to venture capital financing. We argue that the common U.S. venture capital contract stipulating debt-like initial financing, which converts to equity as venture capitalists certify for the firms and take them to the public equity markets, can help when financing is raised in stages and investors worry about the quality of the firm's investment opportunities. However, such financing is not optimal if even relationship investors are unlikely to obtain a strong bargaining position in future investment rounds, as it is likely to be the case in countries in which enforcement of investor rights is weak. Some of our further empirical implications relate to the use of credit lines and cash hoarding in small firms. In particular, we argue that these different ways to build up financial flexibility cope with different types of investment inefficiencies and are, thus, not substitutes. Thus, our implications are richer than those derived from most standard theories of security design under asymmetric information, and they are largely in line with

the sometimes contrasting recent evidence in the literature. An interesting avenue for future research would be to generalize our model to a full-fledged dynamic setting.

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Appendix

Proof of Proposition 1. The proof follows from a sequence of auxiliary results.

Claim 1. *The first-best security $\widehat{R}$ is feasible if and only if condition (12) holds.*

Proof. Note first that if the initial security R^1 is feasible, then from $\Delta x - \Delta R^1 \geq 0$ and from the construction of $\Delta \widehat{R}$ in (8) we also have that $\Delta x - \Delta \widehat{R} \geq 0$. Further, as condition (1) implies that $p_{YG} - p_{YB} > p_{NG} - p_{NB}$, we have from (8) that $\Delta \widehat{R} \geq 0$. To see next that $\widehat{R}_l \leq x_l$ holds, we substitute (8) into (9) and obtain

$$\widehat{R}_l = R_l^1 - \left(\frac{p_{YG}p_{NB} - p_{YB}p_{NG}}{p_{YG} - p_{YB}} \right) \left(\Delta x - \Delta R^1 \right). \tag{16}$$

This implies from (1) that $\widehat{R}_l < R_l^1$ and thus also $\widehat{R}_l < x_l$, given that R^1 was feasible. The remaining condition is, thus, that $\widehat{R}_l \geq 0$, which from (16) is just condition (12). From this it also follows that (12) is necessary for $\widehat{R}$ to be feasible. **Q.E.D.**

The next claim establishes that by optimality of R^2, the set of owner-manager types that accepts, $q \in A$, is always characterized by a cutoff q^*. We argue to a contradiction, showing that if there existed a security R^2 so that the owner-manager would prefer acceptance for low but *not* for high q, then the first-best contract $\widehat{R}$ would be feasible, instead. Then, as argued in the main text, it is clearly optimal to offer $\widehat{R}$.

Claim 2. *If a security R^2 satisfying $u_Y(R^2, 0) > u_N(R^1, 0)$ together with $u_Y(R^2, 1) < u_N(R^1, 1)$ is feasible, then also the first-best security $\widehat{R}$ is feasible.*

Proof. Note first that from the assumed inequalities $u_Y(R^2, 0) > u_N(R^1, 0)$ (owner-manager prefers refinancing for $q = 0$) and $u_N(R^1, 1) > u_Y(\widehat{R}^2, 1)$ (owner-manager prefers no-refinancing for $q = 1$), $\Delta \widehat{R} < \Delta R^2$ must hold to ensure that the slope of $u_Y(R^2, q)$ is strictly smaller than that of $u_Y(\widehat{R}, q)$. But then $u_Y(R^2, 0) > u_Y(\widehat{R}, 0)$ implies that $R_l^2 < \widehat{R}_l$. By the assumed feasibility of R^2, we have from this that $\widehat{R}_l > 0$, so that (12) holds strictly. **Q.E.D.**

From Claims 1-2 refinancing takes place whenever $q \geq q^*$ (with $q^* = q_{FB}$ if $\widehat{R}$ is feasible). It is straightforward to rule out optimality of the case $q^* = 1$ (zero probability of refinancing). If $q^* < 1$, then the cutoff is pinned down by the requirement that $u_Y(R^2, q^*) = u_N(R^1, q^*)$ (cf. also (10)).

Claim 3. *Levered-equity with* $R_l^2 = 0$ *is the uniquely optimal security for the investor if the first-best security* $\widehat{R}$ *is not feasible.*

Proof. We argue to a contradiction. Suppose that, so as to induce some $q^* \in [0,1]$, another security R^2 with $R_l^2 > 0$ were optimal. Choose now $\widetilde{R}^2 = (0, \Delta\widetilde{R}^2)$ so that $u_Y(\widetilde{R}^2, q^*) = u_N(R^1, q^*)$, which implies that the owner-manager's acceptance set, $[q^*, 1]$, remains unchanged, while at q^* the investor's *conditional* expected payoff does not change: $v_Y(\widetilde{R}^2, q^*) = v_Y(R^2, q^*)$. However, as $u_Y(\widetilde{R}^2, q^*) = u_Y(R^2, q^*)$ together with $\widetilde{R}_l^2 = 0 < R_l^2$ must imply that $\Delta\widetilde{R}^2 > \Delta R^2$, we have that $v_Y(\widetilde{R}^2, q) - v_Y(R^2, q) > 0$ holds for all $q > q^*$. Thus, provided it is feasible, the investor is indeed strictly better off under the newly constructed contract $\widetilde{R}^2$.

It remains to show that $\widetilde{R}^2$ is feasible. By the assumed feasibility of R^2 and construction of $\widetilde{R}^2$, this is the case if $\Delta\widetilde{R}^2 \leq \Delta x$. (The other feasibility restrictions on $\widetilde{R}^2$ are satisfied by feasibility of R^2.) From $u_Y(\widetilde{R}^2, q^*) = u_Y(R^2, q^*)$ and $\widetilde{R}_l^2 = 0$, we can obtain

$$\Delta\widetilde{R}^2 = \frac{R_l^2}{p_{YB} + q^*(p_{YG} - p_{YB})} + \Delta R^2,$$

so that $\Delta\widetilde{R}^2 \leq \Delta x$ holds whenever

$$0 \leq -R_l^2 + (p_{YB} + q^*(p_{YG} - p_{YB}))\left(\Delta x - \Delta R^2\right). \tag{17}$$

However, (17) is implied by the assumption that the first-best security is not feasible, i.e., that (12) does not hold. To see this, note first that from the definition of q^*, i.e. $u_Y(R^2, q^*) = u_N(R^1, q^*)$, condition (17) is equivalent to

$$0 \leq -R_l^1 + (p_{NB} + q^*(p_{NG} - p_{NB}))\left(\Delta x - \Delta R^1\right). \tag{18}$$

As, by assumption, $\widehat{R}$ is not feasible, it holds from transforming the "first-best condition" (12) that

$$\begin{aligned} 0 &< -R_l^1 + \left(\frac{p_{YG}p_{NB} - p_{YB}p_{NG}}{p_{YG} - p_{YB}}\right)\left(\Delta x - \Delta R^1\right) \\ &< -R_l^1 + (p_{NB} + q^*(p_{NG} - p_{NB}))\left(\Delta x - \Delta R^1\right), \end{aligned}$$

where the last inequality holds for *any* q^*. But this is just what we needed to show (condition (18)). **Q.E.D.**

To conclude the proof of Proposition 1, we solve the investor's program when $\widehat{R}$ is not

feasible. For this observe that from the indifference condition of the owner-manager at q^*, (10), we have that

$$\Delta R^2 = \Delta x - \frac{R_l^2 - R_l^1 + [p_{NB} + q^* (p_{NG} - p_{NB})] (\Delta x - \Delta R^1)}{p_{YB} + q^* (p_{YG} - p_{YB})}, \tag{19}$$

from which we obtain explicitly

$$\frac{d\Delta R^2}{dq^*} = \frac{(R_l^2 - R_l^1) (p_{YG} - p_{YB}) + (p_{NB} p_{YG} - p_{YB} p_{NG}) (\Delta x - \Delta R^1)}{[p_{YB} + q^* (p_{YG} - p_{YB})]^2} > 0, \tag{20}$$

where the inequality follows as $R_l^2 = 0$ when (12) does not hold.

We can next substitute for the acceptance set $A = [q^*, 1]$ into the investor's objective function (6), where q^* is given by the indifference condition for the owner-manager (cf. condition (10)). Differentiating with respect to q^*, we have the first-order condition (cf. also (13))

$$- [s_Y(q^*) - s_N(q^*)] f (q^*) + \frac{d\Delta R^2}{dq^*} \int_{q^*}^1 \frac{dv_Y(R^2, q)}{d\Delta R^2} dF (q) = 0, \tag{21}$$

where the first term follows from $s_d(q) = u_d (R^t, q) + v_d (R^t, q)$ and (10). As $\frac{d\Delta R^2}{dq^*} > 0$,

$$\frac{dv_Y(R^2, q)}{d\Delta R^2} = p_{YB} + q(p_{YG} - p_{YB}),$$

while $s_Y(q^*) - s_N(q^*)$ is strictly increasing and equal to zero when $q^* = q_{FB}$, we have that $q^* > q_{FB}$.

Finally, we show that levered equity not only maximizes the investor's ability to extract rent from the owner-manager, but it also induces him to offer R^2 that leads to a more efficient q^*. To see this, suppose that $R_l^2 = \varepsilon > 0$. The cross-partial of the investor's expected payoff with respect to q^* and ε shows that it is supermodular in these variables

$$\frac{(p_{YG} - p_{YB})}{[p_{YB} + q^* (p_{YG} - p_{YB})]^2} \int_{q^*}^1 \frac{dv_Y(R^2, q)}{d\Delta R^2} dF (q) > 0.$$

Therefore, by monotonic selection arguments, q^* increases in ε. Thus, reducing ε leads to a lower q^*. **Q.E.D.**

Proof of Proposition 3. (i) The proof is by contradiction. Suppose that R^1 with $R_l^1 < x_l$ were optimal and that there is inefficiency at $t = 2$. By Proposition 1, the investor chooses a security $R^2 = (0, \Delta R^2)$ that induces a cutoff $q^*_{old} > q_{FB}$. Note that we

relegate to the end of the proof the argument why, in the equilibrium of the whole game, the investor must always choose the most efficient cutoff from his optimal correspondence and, thus, plays a pure strategy. We proceed in three steps.

Step 1. We start by constructing $\widetilde{R}^1 = (x_l, \Delta\widetilde{R}^1)$ together with $\widetilde{R}^2 = (0, \Delta\widetilde{R}^2)$ so that two conditions are satisfied: The owner-manager is still indifferent at his old cutoff q^*_{old} and, holding this cutoff fixed, the ex ante payoff for both parties stays the same. By construction, it then holds that

$$0 = \int_0^{q^*_{old}} \left[v_N(\widetilde{R}^1, q) - v_N(R^1, q) \right] dF(q) + \int_{q^*_{old}}^1 \left[v_Y(\widetilde{R}^2, q) - v_Y(R^2, q) \right] dF(q), \quad (22)$$

together with $u_Y(R^2, q^*_{old}) = u_N(R^1, q^*_{old})$ and $u_Y(\widetilde{R}^2, q^*_{old}) = u_N(\widetilde{R}^1, q^*_{old})$. To ease exposition, let

$$\begin{aligned} \widehat{p}_N \ &: = p_{NB} + (p_{NG} - p_{NB}) \int_0^{q^*_{old}} q \frac{dF(q)}{F(q^*_{old})}, \\ \widehat{p}_Y \ &: = p_{YB} + (p_{YG} - p_{YB}) \int_{q^*_{old}}^1 q \frac{dF(q)}{1 - F(q^*_{old})}. \end{aligned}$$

Further, let $p_d(q) := p_{dB} + q(p_{NG} - p_{NB})$ be defined as in (5) in the main text. Recall also that, for given q^* and R^1, ΔR^2 is given in (19). Plugging into (22) we have

$$\begin{aligned} 0 \ &= \ \left(x_l - R^1_l + \widehat{p}_N \left(\Delta\widetilde{R}^1 - \Delta R^1 \right) \right) F(q^*_{old}) \\ &\quad + \frac{\widehat{p}_Y}{p_Y(q^*_{old})} \left(x_l - R^1_l + p_N(q^*_{old}) \left(\Delta\widetilde{R}^1 - \Delta R^1 \right) \right) (1 - F(q^*_{old})), \end{aligned}$$

from which we can express $\Delta\widetilde{R}^1$ as

$$\Delta\widetilde{R}^1 = \Delta R^1 - \left(\frac{x_l - R^1_l}{\widehat{p}_N} \right) \left(\frac{p_Y(q^*_{old}) F(q^*_{old}) + \widehat{p}_Y (1 - F(q^*_{old}))}{p_Y(q^*_{old}) F(q^*_{old}) + \frac{p_N(q^*_{old})}{\widehat{p}_N} \widehat{p}_Y (1 - F(q^*_{old}))} \right). \quad (23)$$

Step 2. We now show that, if offered $\widetilde{R}^1$ in the initial period, the investor will actually offer a different security $\overline{R}^2 \neq \widetilde{R}^2$ at $t = 2$ that implements a strictly lower cutoff. For this purpose we look at the expected payoff of the investor at $t = 2$ when he is faced with R^1 or $\widetilde{R}^1$, respectively, and then apply monotone comparative statics.

As the second security is levered equity with $R^2_l = \widetilde{R}^2_l = 0$, the indifference condition of the owner-manager at a cutoff q^* gives the respective value ΔR^2 as a unique function of

R^1 and q^* only (cf. (19)). We use $\Delta R^2\left(q^*, R^1\right)$ and $\Delta R^2(q^*, \widetilde{R}^1)$, making thereby explicit that $\Delta R^2(\cdot)$ presently denotes a function. Next, we define the investor's expected payoff at $t = 2$ for some q^* and an initial contract R^1 by

$$V\left(q^*, R^1\right) := \int_0^{q^*} v_N\left(R^1, q\right) dF(q) + \int_{q^*}^1 \left(v_Y\left(R^2, q\right) - K_2\right) dF(q). \tag{24}$$

Defining $V(q^*, \widetilde{R}^1)$ accordingly, we now show that the difference $V(q^*, \widetilde{R}^1) - V\left(q^*, R^1\right)$ is decreasing in q^*. (Importantly, note that q^* is *not* an optimal selection from the investor's optimization problem at this point.) After some transformations we have

$$\begin{aligned} & \frac{d}{dq^*}\left[V(q^*, \widetilde{R}^1) - V\left(q^*, R^1\right)\right] \qquad (25) \\ = & \int_{q^*}^1 p_Y(q)\left(\frac{d\Delta R^2(q^*, \widetilde{R}^1)}{dq^*} - \frac{d\Delta R^2\left(q^*, R^1\right)}{dq^*}\right) dF(q). \end{aligned}$$

Next, using (20) and (23), we obtain an explicit expression for the second term under the integral in (25). Importantly, observe that $\widetilde{R}^1$ is defined as a function of q^*_{old} and *not* q^*. We have

$$\begin{aligned} & \frac{d\Delta R^2(q^*, \widetilde{R}^1)}{dq^*} - \frac{d\Delta R^2\left(q^*, R^1\right)}{dq^*} \\ = & -\frac{\left(x_l - R_l^1\right)\left(p_{YG} - p_{YB}\right) + \left(p_{NB}p_{YG} - p_{YB}p_{NG}\right)\left(\Delta\widetilde{R}^1 - \Delta R^1\right)}{p_Y(q^*)^2} \\ = & \frac{-\left(x_l - R_l^1\right)\left(p_{YG} - p_{YB}\right)}{p_Y(q^*)^2} \\ & \times\left(1 - \frac{\left(p_{NB}p_{YG} - p_{YB}p_{NG}\right)}{\left(p_{YG} - p_{YB}\right)\widehat{p}_N} \frac{p_Y(q^*_{old})F\left(q^*_{old}\right) + \widehat{p}_Y\left(1 - F\left(q^*_{old}\right)\right)}{p_Y(q^*_{old})F\left(q^*_{old}\right) + \frac{p_N(q^*_{old})}{\widehat{p}_N}\widehat{p}_Y\left(1 - F\left(q^*_{old}\right)\right)}\right) \\ < & \frac{-\left(x_l - R_l^1\right)\left(p_{YG} - p_{YB}\right)}{p_Y(q^*)^2}\left(1 - \frac{\left(p_{NB}p_{YG} - p_{YB}p_{NG}\right)}{\left(p_{YG} - p_{YB}\right)\widehat{p}_N}\right) < 0, \end{aligned}$$

where for the first inequality we use that $p_N\left(q^*_{old}\right)/\widehat{p}_N > 1$, and for the second inequality we use that $\widehat{p}_N > p_{NB}$. From (25), it follows, therefore, that

$$\frac{dV(q^*, \widetilde{R}^1)}{dq^*} < \frac{dV\left(q^*, R^1\right)}{dq^*}.$$

Thus, the difference $V(q^*, \widetilde{R}^1) - V\left(q^*, R^1\right)$ decreases in q^*. By standard monotone selection

arguments, strictly decreasing differences imply the following: Any optimal cutoff q^*_{new} that the investor chooses given $\widetilde{R}^1$ is lower than any optimal cutoff q^*_{old} that he selects given R^1, so that $q^*_{new} < q^*_{old}$.

Step 3. In this step we show that the owner-manager is indeed better off with the considered deviation. Observe first that by construction both the owner-manager and the investor are ex ante indifferent between (R^1, R^2) and $(\widetilde{R}^1, \widetilde{R}^2)$, when holding $q^* = q^*_{old}$ constant. But as $q^*_{new} < q^*_{old}$, it follows from (20) ($d\Delta R^2/dq^* > 0$) that for the new optimal second-period contract, which implements some q^*_{new}, we have that $\Delta R^2(q^*_{new}, \widetilde{R}^1) < \Delta R^2(q^*_{old}, \widetilde{R}^1)$. Denote this contract by $\overline{R}^2$. Hence, $u_Y(\overline{R}^2, q) > u_Y(\widetilde{R}^2, q)$ holds for all q, and the ex ante expected payoff of the owner-manager with $(\widetilde{R}^1, \overline{R}^2)$ is strictly higher than with either $(\widetilde{R}^1, \widetilde{R}^2)$ or (R^1, R^2), respectively. To finish this step, note that by optimality of $\overline{R}^2$ the investor is also at least weakly better off with $(\widetilde{R}^1, \overline{R}^2)$ than with $(\widetilde{R}^1, \widetilde{R}^2)$, so that $(\widetilde{R}^1, \overline{R}^2)$ satisfies the investor's break-even condition. Taken together, this contradicts the optimality of R^1.

To conclude the proof, we can make use of the preceding results to show that, as asserted in the main text, in equilibrium the *investor* chooses a pure strategy and, thereby, implements the most efficient (i.e., lowest) q^* in case his optimal contractual choice at $t = 2$ is not uniquely determined. Given a debt security at $t = 1$, one can use the indifference condition (10) to express the second-stage levered equity security R^2 as a function of ΔR^1 and q^*. We can, thus, write $V(q^*, \Delta R^1)$ instead of $V(q^*, R^1)$ (cf. expression (24)). Further, we use $Q^* = \arg\max V(q^*, \Delta R^1)$ to denote the optimal choice correspondence subject to (4). Observe now that given R^1, $V(q^*, \Delta R^1)$ is strictly submodular in q^* and ΔR^1 :

$$\frac{\partial^2 V(q^*, \Delta R^1)}{\partial q^* \partial \Delta R^1} = -\frac{(p_{NB}p_{YG} - p_{YB}p_{NG})}{p_Y(q^*)^2} \int_{q^*}^{1} p_Y(q)\, dF(q) < 0.$$

Therefore, again by monotonic selection arguments, relaxing the investor's ex ante participation constraint by increasing ΔR^1 results in a lower set Q^*. Since Q^* is monotonic, it must be almost everywhere a singleton and continuous. Then, while the investor's payoff is continuous in ΔR^1 everywhere, the owner-manager's expected payoff is continuous a.e. and, where Q^* is not a singleton, the owner-manager strictly prefers the lowest (most efficient) value $q^* = \min Q^*$. Consequently, analogously to a tie-breaking condition, by optimality for the owner-manager the investor must choose $q^* = \min Q^*$ with probability one in equilibrium.

(ii) We now derive the condition for achieving first-best financing at $t = 1$. Recall from

Proposition 1 that if the investor induces q_{FB}, then $u_N(R^1, q) = u_Y(\widehat{R}, q)$ holds for all $q \in [0,1]$. Using this and the identity $s_d(q) = v_d(R^t, q) + u_d(R^t, q)$ to plug into (4), if the investor just breaks even at $t = 1$, one can express ΔR^1 as

$$\Delta R^1 = \Delta x - \frac{S_{FB} - K_1 - (x_l - R_l^1)}{p_N(\widehat{q})}. \tag{26}$$

A first-period security that satisfies (26) is feasible if

$$\begin{aligned} x_l &\geq R_l^1 \geq 0, \\ \Delta x &\geq \Delta R^1 = \Delta x - \frac{S_{FB} - K_1 - (x_l - R_l^1)}{p_N(\widehat{q})} \geq 0, \\ R_l^1 &\geq \left(\frac{p_{NB}p_{YG} - p_{YB}p_{NG}}{p_{YG} - p_{YB}}\right) \frac{S_{FB} - K_1 - (x_l - R_l^1)}{p_N(\widehat{q})}, \end{aligned}$$

where the last inequality is just condition (12) from Proposition 1. These three conditions can be rewritten as follows:

$$\begin{aligned} &\min\left(x_l, x_l + p_N(\widehat{q})\Delta x - S_{FB} - K_1\right) \\ \geq\ & R_l^1 \geq \max\left(x_l - S_{FB} - K_1, \frac{p_{NB}p_{YG} - p_{YB}p_{NG}}{(p_{NG} - p_{NB})p_Y(\widehat{q})}\left(S_{FB} - K_1 - x_l\right)\right). \end{aligned}$$

Since the left-hand side must be greater than the right-hand side, it must be that

$$\begin{aligned} x_l \geq\ & \max\left(x_l - S_{FB} - K_1, \frac{p_{NB}p_{YG} - p_{YB}p_{NG}}{(p_{NG} - p_{NB})p_Y(\widehat{q})}\left(S_{FB} - K_1 - x_l\right)\right) \\ & + \max\left(0, S_{FB} - K_1 - p_N(\widehat{q})\Delta x\right). \end{aligned}$$

Simple transformations yield condition (15). If (15) holds, by optimality for the owner-manager we then have that $q^* = q_{FB}$: The optimal security R^1 then maximizes joint surplus and, by making the investor just break even, achieves the maximum feasible payoff for the owner-manager. Thus, by Proposition **1,** it follows that if the owner-manager has all bargaining power in $t = 1$, there is first-best-efficiency in $t = 2$ only if (1) is satisfied. **Q.E.D.**

Lemma 1 *Consider an equilibrium candidate in which more than one $\gamma-$types, including the lowest, offer R^1. A necessary condition for this equilibrium candidate to survives D1 is that there is no deviation from offering R^1 for which conditions (27)-(30) below are satisfied.*

Proof of Lemma 1. In what follows, to ease notation, we suppress R^2 and c^2 in the function arguments when it does not lead to confusion. In our context, D1 can be defined as follows. Let P_γ denote the lowest price for which type γ is better off offering the deviating contract $\widetilde{R}^1$ than offering R^1 on the equilibrium path

$$\begin{aligned} & \gamma\left(U(\widetilde{R}^1,\widetilde{c}^1)-U_D(\widetilde{R}^1,\widetilde{c})\right)+U_D(\widetilde{R}^1,\widetilde{c}^1)+P_\gamma-\widetilde{c}^1 \\ \geq \; & \gamma\left(U\left(R^1,c^1\right)-U_D\left(R^1,\, c^1\right)\right)+U_D\left(R^1,\, c^1\right)+P-c^1. \end{aligned} \tag{27}$$

Then, D1 dictates that the investor should place probability one on the deviation coming from the type(s) with the lowest P_γ. Since

$$\frac{dP_\gamma}{d\gamma}=-\frac{U(\widetilde{R}^1,\widetilde{c}^1)-U_D(\widetilde{R}^1,\widetilde{c}^1)-U\left(R^1,c^1\right)+U_D\left(R^1,c^1\right)}{\frac{\partial}{\partial P_\gamma}\left(\gamma U(\widetilde{R}^1,\widetilde{c}^1)+(1-\gamma)\,U_D(\widetilde{R}^1,\widetilde{c}^1)+P_\gamma-\widetilde{c}^1\right)}$$

and the denominator is always positive, this derivative is either positive or negative for all γ-types offering R^1. If $\frac{dP_\gamma}{d\gamma}<0$, D1 dictates that the investor's out-of-equilibrium beliefs should be at least as high as the highest type in the pool who benefits from deviating. Instead, if $\frac{dP_\gamma}{d\gamma}>0$, D1 stipulates that the investor's beliefs should be at most as high as the lowest type in the pool who benefits from deviating.

Observe now that any equilibrium candidate must involve partial pooling in which positive NPV γ-types cross-subsidize the lowest γ-type(s). (This is because the lowest type is always better off raising financing (potentially mimicking) compared to her zero profits from no financing, and because the investor will never finance the lowest type if she knew her type.) This implies that in any equilibrium candidate involving the lowest γ-type, deviations for which $\frac{dP_\gamma}{d\gamma}$ is positive are never successful, since the investor always rejects the deviation for beliefs placing probability one on the lowest γ-type.

Thus, we can use the following conditions to judge whether a deviation to security $\widetilde{R}^1$ which raises P_γ, satisfying (27), is successful. First, by D1, the highest type (in a pool) is most likely to deviate if $\frac{\partial P_\gamma}{\partial\gamma}<0$, for which it is necessary and sufficient that

$$U(\widetilde{R}^1,\widetilde{c}^1)-U_D(\widetilde{R}^1,\widetilde{c}^1)>U(R^1,c^1)-U_D\left(R^1,c^1\right). \tag{28}$$

When (27) holds with equality, this is equivalent to verifying that

$$U_D(\widetilde{R}^1,\widetilde{c}^1)+P_\gamma-\widetilde{c}^1<U_D\left(R^1,\, c^1\right)+P-c^1. \tag{29}$$

Second, the investor accepts the deviation if he at least breaks even for out-of equilibrium

beliefs $\widetilde{\gamma}$

$$\widetilde{\gamma}V(\widetilde{R}^1,\widetilde{c}^1)+(1-\widetilde{\gamma})\left(\underbrace{x_l+c_1-U_D(\widetilde{R}^1,\widetilde{c}^1)}_{V_D(\widetilde{R}^1,\widetilde{c}^1)}\right)\geq P_\gamma$$

which is convenient to be stated as (cf. (4))

$$\begin{aligned}0 \leq\ & P-(1-\widehat{\gamma})\left(x_l+c^1\right)-\left(P_\gamma-(1-\widetilde{\gamma})\left(x_l+\widetilde{c}^1\right)\right)-\left(U_D(\widetilde{R}^1,\widetilde{c}^1)-U_D\left(R^1,c^1\right)\right) \\ &+\widetilde{\gamma}\left(V(\widetilde{R}^1,\widetilde{c}^1)+U_D(\widetilde{R}^1,\widetilde{c}^1)\right)-\widehat{\gamma}\left(V\left(R^1,c^1\right)+U_D(R^1,c^1)\right)\end{aligned} \quad (30)$$

where this condition uses that in equilibrium for beliefs $\widehat{\gamma}$ the investor just breaks even. We have two types of equilibrium candidates: One in which the owner-manager raises $P<K_1+K_2$ (Propositions 4 and 5) and one in which the opposite is true (Proposition 7). **Q.E.D.**

Proof of Propositions 4 and 5. Consider an equilibrium candidate in which the manager raises $P<K_1+K_2$. Any such equilibrium candidate must take into account that any initial contract (or menu of contracts) will be renegotiated as described in Proposition 1, unless it stipulates that new financing leads to conversion of the initial contract into the contract derived in that proposition. We show the proof in three steps.

Step 1. *In any candidate equilibrium, the security R^1 issued by the pool containing the lowest type must be debt with $R_l^1=x_l+c^1$.* Suppose to a contradiction that this were not the case and consider a deviation to $\widetilde{R}_l^1=R_l^1+\varepsilon$, where the manager hoards the same amount of cash $\widetilde{c}^1=c^1$. Note that this construction implies that

$$U_D\left(R^1,c^1\right)-U_D(\widetilde{R}^1,\widetilde{c}^1)=x_l+c^1-R_l^1-\left(x_l+\widetilde{c}^1-\widetilde{R}_l^1\right)=\varepsilon>0. \quad (31)$$

Thus, condition (28) can be stated as

$$U(\widetilde{R}^1,\widetilde{c}^1)-U(R^1,c^1)>-\varepsilon.$$

which is always satisfied if $U(\widetilde{R}^1,\widetilde{c}^1)\geq U\left(R^1,c^1\right)$. Note that for this ε, (27) can be stated as

$$P-P_\gamma=\gamma\left(U(\widetilde{R}^1,\widetilde{c}^1)-U\left(R^1,c^1\right)\right)-(1-\gamma)\,\varepsilon. \quad (32)$$

Observe now that since $\widetilde{c}^1=c^1$ and $\widetilde{R}_l^1>R_l^1$, Proposition 1 implies that it is possible to

construct $\Delta\widetilde{R}^1$ such that

$$V(\widetilde{R},\widetilde{c}^1) \geq V\left(R,c^1\right) \text{ and } U(\widetilde{R},\widetilde{c}^1) > U\left(R,c^1\right) \tag{33}$$

implying that (29) is satisfied and, by D1, it must be that $\widetilde{\gamma} \geq \overline{\gamma} > \widehat{\gamma}$, where $\overline{\gamma}$ is the highest type in the pool containing the lowest γ type. Subtracting now the RHS from the LHS of (30), we obtain that if the investor offers $P_{\overline{\gamma}}$ following the deviation, where $P_{\overline{\gamma}}$ satisfies (32) for type $\overline{\gamma}$, we have

$$\begin{aligned}
& P-(1-\widehat{\gamma})\left(x_l+c^1\right)-\left(P_{\overline{\gamma}}-(1-\widetilde{\gamma})\left(x_l+\widetilde{c}^1\right)\right)-\left(U_D(\widetilde{R}^1,\widetilde{c}^1)-U_D\left(R^1,c^1\right)\right)\\
& +\widetilde{\gamma}\left(V(\widetilde{R}^1,\widetilde{c}^1)+U_D(\widetilde{R}^1,\widetilde{c}^1)\right)-\widehat{\gamma}\left(V\left(R^1,c\right)+U_D(R^1,c^1)\right)\\
\geq\ & P-(1-\widehat{\gamma})\left(x_l+c^1\right)-\left(P_{\overline{\gamma}}-(1-\overline{\gamma})\left(x_l+\widetilde{c}^1\right)\right)-\left(U_D(\widetilde{R}^1,\widetilde{c}^1)-U_D\left(R^1,c^1\right)\right)\\
& +\overline{\gamma}\left(V(\widetilde{R}^1,\widetilde{c}^1)+U_D(\widetilde{R}^1,\widetilde{c}^1)\right)-\widehat{\gamma}\left(V\left(R^1,c^1\right)+U_D(R^1,c^1)\right)\\
\geq\ & P-P_{\overline{\gamma}}+(1-\overline{\gamma})\,\varepsilon+(\overline{\gamma}-\widehat{\gamma})\left(V\left(R^1,c^1\right)+U_D(R^1,c^1)-x_l-c^1\right)\\
=\ & \overline{\gamma}\left(U(\widetilde{R}^1,\widetilde{c}^1)-U\left(R^1,c^1\right)\right)+(\overline{\gamma}-\widehat{\gamma})\left(V\left(R^1,c^1\right)+U_D(R^1,c^1)-x_l-c^1\right)>0
\end{aligned}$$

where for the first inequality we use that the investor's expected payoff is (weakly) higher for $\widetilde{\gamma}$ than for $\overline{\gamma}$, the second inequality follows from the first part of (33), the equality follows from (32), while the last inequality follows from the second part of (33) and from the fact that the second term is equal to $(\overline{\gamma}-\widehat{\gamma})\,\frac{P-x_l-c^1+U_D\left(R^1,c^1\right)}{\widehat{\gamma}}>0$ from the investor's break even condition (4). Thus, (30) is satisfied as well, leading to the desired contradiction.

Step 2. *There is no equilibrium with payouts before $t=3$ and there are no (semi-) separating equilibria.* From Step 1, the period one security is debt and, thus, $U_D\left(R^1,c^1\right)=0$. We, first, show that in any equilibrium candidate involving the lowest type it must be that there are no payouts before $t=3$, i.e., $c^1=P-K_1$. Suppose to a contradiction that $c^1<P-K_1$ and consider a deviation to another debt contract $\widetilde{R}^1$ for which the owner-manager hoards ε more in $t=1$: $\widetilde{c}^1=c^1+\varepsilon$. Thus, we have $U_D\left(R^1,c^1\right)-U_D(\widetilde{R}^1,\widetilde{c}^1)=\varepsilon$ just as in (31), implying that we can express (27) again as (32). From $\widetilde{c}^1=c^1+\varepsilon$, we have again (33), implying that we can follow the same steps as in Step 1 to show that there will be a successful deviation.

We show next that the preceding result implies that there is no semi-separating equilibrium in which type $\overline{\gamma}$ (who is in the pool with the lowest type) offers a different contract $\{\overline{R}^1,\overline{c}^1,\overline{P}\}$ than higher types. Since information about q is symmetric in $t=1$, two con-

tracts R^1 and $\overline{R}^1$ are different if $U\left(R^1, c^1\right) \neq U(\overline{R}^1, \overline{c}^1)$ and/or $P - c^1 \neq \overline{P} - \overline{c}^1$. To see the claim, observe that if there were a semi-separating equilibrium, by incentive compatibility it must hold

$$\begin{aligned}
\overline{\gamma} U(\overline{R}^1, \overline{c}^1) &\geq \overline{\gamma}\left(U\left(R^1, c^1\right) - U_D\left(R^1, c^1\right)\right) + P - c^1 - K_1 + U_D\left(R^1, c^1\right) \\
\gamma U(\overline{R}^1, \overline{c}^1) &\leq \gamma\left(U\left(R^1, c^1\right) - U_D\left(R^1, c^1\right)\right) + P - c^1 - K_1 + U_D\left(R^1, c^1\right)
\end{aligned}$$

where $\{R^1, c^1\}$ is offered by a higher type $\gamma > \overline{\gamma}$. These conditions can be rewritten as

$$\begin{aligned}
& \overline{\gamma}\left(U(\overline{R}^1, \overline{c}^1) - U\left(R^1, c^1\right) + U_D\left(R^1, c^1\right)\right) \\
\geq\ & P - c^1 - K_1 + U_D\left(R^1, c^1\right) \\
\geq\ & \gamma\left(U(\overline{R}^1, \overline{c}^1) - U\left(R^1, c^1\right) + U_D\left(R^1, c^1\right)\right)
\end{aligned}$$

The first inequality implies that $U(\overline{R}^1, \overline{c}^1) \geq U\left(R^1, c^1\right) - U_D\left(R^1, c^1\right)$, which gives a contradiction.

Step 3. *Existence:* To show existence, we first show that all equilibrium debt candidates with zero payouts in $t = 1$ survive deviations from $c^1 = P - K_1$. To see this, observe that a deviation from any equilibrium candidate with $P - c^1 = K_1$ must also feature $P_\gamma - \widetilde{c}^1 \geq K_1$. Thus, (29) can be satisfied only if $U_D(\widetilde{R}^1, \widetilde{c}^1) < U_D\left(R^1,\ c^1\right) = 0$, which is impossible. Thus, any deviation will be rejected, as setting probability one on the deviation coming from the highest type is consistent with with D1 (i.e., the refinement has no bite here). Note that by the same token, we can rule out deviations to non-debt equilibria, as all such equilibria would feature $U_D(\widetilde{R}^1, \widetilde{c}^1) > U_D\left(R^1,\ c^1\right)$. **Q.E.D.**

Proof of Proposition 7. Consider an equilibrium candidate $\{R^1, R^2, c^1\}$. With some abuse we borrow the notation from the previous section, as the only conceptual difference is that the manager raises $P \geq K_1 + K_2$ in $t = 1$. Given that the owner-manager does not have to raise money twice, we focus without loss on the interpretation of raising a single renegotiation proor contract. Specifically, such equilibria face a different form of potential renegotiations in $t = 2$. If the firm turns out to be defunct, the manager can offer to give back the money she has not sunk in return for a cash payment, compensating her for her outside option of sinking the hoarded cash c^1 (of which the owner-manager enjoys private benefits τc^1). Thus

$$U_D\left(R^1, R^2, c^1\right) = \max\left[x_l + c^1 - R_l^1, x_l + \left(c^1 - K_2\right) + \tau c^1 - R_l^2\right],$$

and in a renegotiation-proof contract, the first part of the max-term will be (weakly) higher than the second term. Furthermore, there would be again a cutoff q^* so that only types $q \geq q^*$ find it optimal to invest in period $t = 2$ exchanging their initial security R^1 for R^2—i.e., $u_Y(R^2, q) \geq u_N(R^1, q)$ for $q \geq q^*$. Clearly, the best the owner-manager can have in $t = 1$ is that $q^* = q_{FB}$. Note that, just as before, the lowest $\gamma-$type will be in a pool with some higher type.

Step 1. *In every equilibrium candidate the owner-manager receives at most τc^1 in the low cash flow state in case of a new investment and zero in the low cash flow state in case of no investment.*

Observe first that the difference between what the manager receives in the low cash flow state in case of a new and, respectively, no new investment must be at least τc^1, as she would otherwise press the investor for this amount in return for not sinking c^1 from which she can appropriate the fraction τ. Thus, the proof boils down to showing that the manager's payoff should be minimal in the low cash flow state (both with and absent a new investment), implying also that U_D should be minimal. To see this, suppose that this was not the case and $U_D(R^1, R^2, c^1) > \tau c^1$. Consider a deviation to a contract for which $U_D(\widetilde{R}^1, \widetilde{R}^2, \widetilde{c}^1) = \tau c^1 < U_D(R^1, R^2, c^1)$, where this is achieved by increasing $\widetilde{R}^1_l = R^1_l + \delta$ or respectively $\widetilde{R}^2_l = R^2_l + \varepsilon$ (depending on which security affects U_D). Apart from this, the deviation contract sets the same hoarding policy, $\widetilde{c}^1 = c^1$, and is constructed to achieve the same level of interim efficiency q^* and the same expected payoff for the owner-manager in case the firm is not defunct $U(\widetilde{R}^1, \widetilde{R}^2, \widetilde{c}^1) = U(R^1, R^2, c^1)$.[22] Note that this would also imply that $V(\widetilde{R}^1, \widetilde{R}^2, \widetilde{c}^1) = V(R^1, R^2, c^1)$. With this construction, (28) is satisfied and, by D1, this deviation will be attributed at least to type $\overline{\gamma}$ (the highest type in the pool containing the lowest type) and, thus, $\widetilde{\gamma} \geq \overline{\gamma} > \widehat{\gamma}$. For such beliefs, accepting the deviations

[22] Formally, this would require an appropriate change in ΔR^1 and/or ΔR^2, such that

$$\begin{aligned} \int_0^{q^*} u_N(R^1, q)\, dF(q) + \int_{q^*}^1 u_Y(R^2, q)\, dF(q) &= \int_0^{q^*} u_N(R^1, q)\, dF(q) + \int_{q^*}^1 u_Y(R^2, q)\, dF(q) \\ u_N(R^1, q^*) &= u_Y(R^2, q^*) \end{aligned}$$

Note that we have four variables for two equations, implying that this construction can always be satisfied without hitting any feasibility restrictions.

while offering in return $P_{\overline{\gamma}}$ is worth it for the investor, as it satisfies (30):

$$\begin{aligned}
& P-(1-\widehat{\gamma})\left(x_l+c^1\right)-\left(P_{\overline{\gamma}}-(1-\widetilde{\gamma})\left(x_l+\widetilde{c}^1\right)\right)-\left(U_D(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)-U_D\left(R^1,R^2,c^1\right)\right) \\
& +\widetilde{\gamma}\left(V(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)+U_D(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)\right)-\widehat{\gamma}\left(V\left(R^1,R^2,c^1\right)+U_D\left(R^1,R^2,c^1\right)\right) \\
\geq\ & P-(1-\widehat{\gamma})\left(x_l+c^1\right)-\left(P_{\overline{\gamma}}-(1-\overline{\gamma})\left(x_l+\widetilde{c}^1\right)\right)-\left(U_D(\widetilde{R}^1,\widetilde{R}^2,\overline{\gamma}^1)-U_D\left(R^1,R^2,c^1\right)\right) \\
& +\overline{\gamma}\left(V(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)+U_D(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)\right)-\widehat{\gamma}\left(V\left(R^1,R^2,c^1\right)+U_D\left(R^1,R^2,c^1\right)\right) \\
=\ & (\overline{\gamma}-\widehat{\gamma})\left(V\left(R^1,R^2,c^1\right)+U_D(R^1,R^2,c^1)-x_l-c^1\right)>0
\end{aligned}$$

where the first inequality follows from the fact that the investor's payoff increases in the type he is facing ($\widetilde{\gamma}\geq\overline{\gamma}$); for the equality we use that by construction, $\widetilde{c}^1=c^1$ and that (27) could be stated as

$$P_\gamma-P=(1-\gamma)\left(U_D\left(R^1,\ R^2,c^1\right)-U_D(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c})\right),$$

and for the final inequality we use that the last line is equal to $(\overline{\gamma}-\widehat{\gamma})\,\frac{P-x_l-c^1+U_D\left(R^1,c^1\right)}{\widehat{\gamma}}>0$ from (4).

Step 2. *There is no equilibrium candidate with payouts, and no equilibriu in which the owner-manager raises more than K_1+K_2.*

The proof that there are no payouts is very similar to that of Step 2 in the previous proposition and, thus, omitted. To show that ther is no equilibrium in which $P>K_1+K_2$, we argue again to a contradiction. Suppose that the owner-manager raised more than K_1+K_2. Consider a deviation to a security $\widetilde{R}^1$ by type $\overline{\gamma}$ (the highest type in the pool containing the lowest γ-type). $\widetilde{R}^1$ is such that it implements the same level of interim efficiency q^*, the hoarding policy is the same $c^1=\widetilde{c}^1$, we have $U_D(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)=U_D\left(R^1,R^2,c^1\right)$, but the owner manager is better off if the firm is not defunct, $U(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)>U\left(R^1,R^2,c^1\right)$.[23] Note that (27) becomes

$$P-P_\gamma=\gamma\left(U(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)-U\left(R^1,R^2,c^1\right)\right).$$

Note that by construction, (28) is satisfied, so that by D1 this deviation will be attributed at least to type $\overline{\gamma}$ (the highest type in the pool containing the lowest type) and, thus,

[23] This could be achieved by increasing ΔR^1 and ΔR^2 such that $u_N(\widetilde{R}^1,q^*)=u_Y(\widetilde{R}^2,q^*)$ remains satisfied. Note that such deviation is not possible for $P<K_1+K_2$, as then q^* results from the investor's optimization problem in $t=2$.

$\widetilde{\gamma} \geq \overline{\gamma} > \widehat{\gamma}$. Replying with $P_{\overline{\gamma}}$ is now worth it for the investor, as (30) is satisfied. Following similar steps to Step 1, we have:

$$\begin{aligned}
& P-(1-\widehat{\gamma})\left(x_l+c^1\right)-\left(P_{\overline{\gamma}}-(1-\widetilde{\gamma})\left(x_l+\widetilde{c}^1\right)\right)-\Big(U_D(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)-U_D\left(R^1,R^2,c^1\right)\Big) \\
& +\widetilde{\gamma}\Big(V(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)+U_D(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)\Big)-\widehat{\gamma}\left(V\left(R^1,R^2,c^1\right)+U_D\left(R^1,R^2,c^1\right)\right) \\
> \; & P-(1-\widehat{\gamma})\left(x_l+c^1\right)-\left(P_{\overline{\gamma}}-(1-\overline{\gamma})\left(x_l+\widetilde{c}^1\right)\right)-\Big(U_D(\widetilde{R}^1,\widetilde{R}^2,\overline{\gamma}^1)-U_D\left(R^1,R^2,c^1\right)\Big) \\
& +\overline{\gamma}\Big(V(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)+U_D(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)\Big)-\widehat{\gamma}\left(V\left(R^1,R^2,c^1\right)+U_D\left(R^1,R^2,c^1\right)\right) \\
= \; & \gamma\Big(U(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)-U\left(R^1,R^2,c^1\right)\Big)+(\overline{\gamma}-\widehat{\gamma})\left(V\left(R^1,R^2,c^1\right)+U_D\left(R^1,R^2,c^1\right)-x_l-c^1\right) \\
& +\overline{\gamma}V(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)-\overline{\gamma}V\left(R^1,R^2,c^1\right) \\
= \; & \overline{\gamma}\Big(S(\widetilde{R}^1,\widetilde{R}^2,\widetilde{c}^1)-S\left(R^1,R^2,c^1\right)\Big)+(\overline{\gamma}-\widehat{\gamma})\left(V\left(R^1,R^2,c^1\right)+U_D\left(R^1,R^2,c^1\right)-x_l-c^1\right)
\end{aligned}$$

where $S(\cdot) := V(\cdot) + U(\cdot)$ is by construction unchanged and so the first term in the last line is zero. The second term is positive as in Step 1. Thus, the pool of types containing the lowest type never raise more than $K_1 + K_2$. In what remains, we argue that also higher types do not raise more than that amount.

Specifically, consider now a semi-separating equilibrium candidate in which type $\overline{\gamma}$ (who is in the pool with the lowest type) offers a different contract than higher types. From incentive compatibility, we have

$$\begin{aligned}
& \overline{\gamma}\Big(U(\overline{R}^1,\overline{R}^2,\overline{c}^1)-U_D(\overline{R}^1,\overline{R}^2,\overline{c}^1)\Big)-\overline{\gamma}\left(U\left(R^1,R^2,c^1\right)-U_D\left(R^1,R^2,c^1\right)\right) \\
\geq \; & P-c^1-K_1+U_D(R^1,R^2,c^1)-\Big(\overline{P}-\overline{c}^1-K_1+U_D(\overline{R}^1,\overline{R}^2,\overline{c}^1)\Big) \\
\geq \; & \gamma\Big(U(\overline{R}^1,\overline{R}^2,\overline{c}^1)-U_D(\overline{R}^1,\overline{R}^2,\overline{c}^1)\Big)-\gamma\left(U\left(R^1,R^2,c^1\right)-U_D\left(R^1,R^2,c^1\right)\right).
\end{aligned} \tag{34}$$

However, if higher types than $\overline{\gamma}$ raise more than $K_1 + K_2$, then by the arguments above, the second line in (34) is positive. But then the first and the third line give a contradiction to $\overline{\gamma} < \gamma$.

Step 3. *Existence of pooling equilibria with $P = K_1 + K_2$.* Regardless of the deviation contract offered, the deviation contracts can be grouped depending on whether P_γ is lower or higher than $K_1 + K_2$. Consider, first, deviations for which $P_\gamma > K_1 + K_2$. For such deviations condition (29) cannot be satisfied, as $U_D(R^1, R^2, c^1)$ is already minimal and there are no payouts. Thus, the investor sets probability one on the deviation coming from the lowest type and rejects the deviation.

Consider next, deviations for which $P_\gamma < K_1 + K_2$. In this case, condition (29) can be satisfied, as the difference between the LHS and the RHS can be as large as τc^1 if R^1 is debt. Thus, if (28) is satisfied, the investor should set probability one on the deviation coming from the highest $\gamma-$type. Thus, to show existence, we need to rule out deviations for which $\widetilde{\gamma} = 1$ and for which (30) is satisfied for $P_\gamma < K_1 + K_2$. We do so by arguing to a contradiction.

Observe, first that if $P_\gamma < K_1 + K_2$, the owner-manager faces a problem of underinvestment as described in the previous section. Define ΔS as the difference in social surplus created by the investment when the firm is not defunct and is financed with R^1 and $\widetilde{R}^1$, respectively. That is, taking into account the hoarded cash, it holds

$$\Delta S = S(\widetilde{R}^1, \widetilde{R}^2, \widetilde{c}^1) - \widetilde{c}^1 - S(R^1, R^2, c^1) + c^1.$$

Plugging in now (27) into (30), we now obtain

$$\begin{aligned}
& P - (1-\widehat{\gamma})\left(x_l + c^1\right) - \left(P_\gamma - (1-\widetilde{\gamma})\left(x_l + \widetilde{c}^1\right)\right) - \left(U_D(\widetilde{R}^1, \widetilde{c}^1) - U_D\left(R^1, c^1\right)\right) \\
& +\widetilde{\gamma}\left(V(\widetilde{R}^1, \widetilde{c}^1) + U_D(\widetilde{R}^1, \widetilde{c}^1)\right) - \widehat{\gamma}\left(V\left(R^1, c^1\right) + U_D(R^1, c^1)\right) \\
= \; & \widehat{\gamma}\left(x_l + c^1\right) - \widetilde{\gamma}\left(U\left(R^1, c^1\right) - U_D\left(R^1,\, c^1\right)\right) + \widetilde{\gamma}\left(U(\widetilde{R}^1, \widetilde{c}^1) - U_D(\widetilde{R}^1, \widetilde{c})\right) \\
& -\widetilde{\gamma}\left(x_l + \widetilde{c}^1\right) + \widetilde{\gamma}\left(V(\widetilde{R}^1, \widetilde{c}^1) + U_D(\widetilde{R}^1, \widetilde{c}^1)\right) - \widehat{\gamma}\left(V\left(R^1, c^1\right) + U_D(R^1, c^1)\right) \\
= \; & \widetilde{\gamma}\left(S(\widetilde{R}^1, \widetilde{c}^1) - U\left(R^1, c^1\right) + U_D\left(R^1,\, c^1\right) - \widetilde{c}^1\right) - \widehat{\gamma}\left(V\left(R^1, c^1\right) + U_D(R^1, c^1) - x_l - c^1\right) \\
= \; & \widetilde{\gamma}\left(\Delta S + S(R^1, c^1) - U\left(R^1, c^1\right) + U_D\left(R^1,\, c^1\right) - c^1\right) - \widehat{\gamma}\left(V\left(R^1, c^1\right) + U_D(R^1, c^1) - x_l - c^1\right) \\
= \; & \widetilde{\gamma}\Delta S + (\widetilde{\gamma} - \widehat{\gamma})\left(V\left(R^1, c^1\right) + U_D(R^1, c^1) - x_l - c^1\right) \\
= \; & \widetilde{\gamma}\Delta S + (\widetilde{\gamma} - \widehat{\gamma})\frac{K_1 - x_l + \tau K_2}{\widehat{\gamma}}
\end{aligned} \tag{35}$$

where the last equality obtains by plugging in from the investor's ex ante break even condition (4), using that $P = K_1 + K_2$ and that $c^1 = K_2$. Expression (35) gives is negative and gives a contradiction (i.e., there is no profitable deviation for which the investor breaks even when offering $P_\gamma < K_1 + K_2$ even for beliefs placing probability one on the highest type) if ΔS is negative—i.e., there is more underinvestment if $P < K_1 + K_2$—and/or $\widehat{\gamma}$ is high, and/or K_2 is small. **Q.E.D.**

Proof of Proposition 8. Suppose first that the investor just breaks even ex-ante, so that

$$\begin{aligned}\Delta R^1 &= \frac{K_1 - R_l^1}{p_N(\widehat{q})},\\ \Delta R^2 &= \Delta x - \frac{R_l^2 - R_l^1 + p_N(q^*)\left(\Delta x - \Delta R^1\right)}{p_Y(q^*)}.\end{aligned} \tag{36}$$

(Recall that $\widehat{q}$ is the unconditional expectation of q.) Note that $R_l^2 = x_l$, so that we can represent the equilibrium security R^2 as a function of R^1 and q^* only. By plugging (36) into the investor's binding ex ante participation constraint, one can express this constraint entirely as a function of R_l^1 and q^*

$$\begin{aligned}K_1 &= \int_0^{q^*}\left(R_l^1 + p_N(q)\frac{K_1 - R_l^1}{p_N(\widehat{q})}\right)dF(q) \\ &+ \int_{q^*}^1\left(R_l^2 + p_Y(q)\left(\Delta x - \frac{x_l - R_l^1 + p_N(q^*)\left(\Delta x - \frac{K_1 - R_l^1}{p_N(\widehat{q})}\right)}{p_Y(q^*)}\right) - K_2\right)dF(q).\end{aligned} \tag{37}$$

Taking the total derivative of (37) allows us, therefore, to examine how a change in R_l^1 affects the equilibrium cutoff q^* at the interim stage, given that R^1 and R^2 adjust so that the investor has the same ex ante expected payoff under the old and the new equilibrium. From total differentiation we obtain

$$\begin{aligned}0 &= \left[\begin{array}{c}\left(R_l^1 + p_N(q^*)\Delta R^1 - x_l - p_Y(q^*)\Delta R^2\right)f(q^*) \\ +\int_{q^*}^1 p_Y(q)\frac{d\Delta R^2}{dq^*}dF(q)\end{array}\right]dq^* \\ &+ \left[\int_0^{q^*}\left(1 - \frac{p_N(q)}{p_N(\widehat{q})}\right)dF(q) + \int_{q^*}^1 \frac{p_Y(q)}{p_Y(q^*)}\left(1 - \frac{p_N(q^*)}{p_N(\widehat{q})}\right)dF(q)\right]dR_l^1,\end{aligned} \tag{38}$$

where for ease of exposition only we have plugged back in for ΔR^t in the first line. With overinvestment, $q^* < q_{FB}$, the first term in the first line is positive. Also the second term is positive, as $d\Delta R^2/dq^* > 0$.[24] Finally, the second line is also positive. To see this, note that differentiating the terms in front of dR_l^1 with respect to q^* we have

$$\int_{q^*}^1\left[\frac{p_Y(q)}{p_N(\widehat{q})}\left(\frac{(p_{YG}p_{NB} - p_{NG}p_{YB}) - (p_{YG} - p_{YB})\,p_N(\widehat{q})}{p_Y(q^*)^2}\right)\right]dF(q) < 0.$$

Further, these terms are zero at $q^* = 1$, while $q^* \leq q_{FB} < 1$. Taken together, from the preceding observations on (38) we obtain $dq^*/dR_l^1 < 0$. As the owner-manager is the

[24] See (36) and (20) and recall that $R_l^2 = x_l$.

residual claimant and as $q^* < q_{FB}$, we thus have that R_l^1 is optimally chosen as small as possible: $R_l^1 = 0$.

It remains to show that it is optimal for the owner-manager to offer the investor a contract for which he *just* breaks even at $t = 1$. For this it is sufficient to show that q^* decreases (i.e. becomes more inefficient) as the investor's ex-ante payoff increases. To avoid new notation, note that we can likewise analyze a change in K_1, while still assuming that the investor just breaks even. Total differentiation yields then

$$\begin{aligned} 0 &= \left[\left(p_N(q^*)\Delta R^1 - x_l - p_Y(q^*)\Delta R^2\right) f\left(q^*\right) + \int_{q^*}^1 p_Y(q)\frac{d\Delta R^2}{dq^*}dF\left(q\right)\right] dq^* \\ &\quad + \left[\int_0^{q^*} \frac{p_N(q)}{p_N(\widehat{q})}dF\left(q\right) + \int_{q^*}^1 \frac{p_Y(q)}{p_Y(q^*)}\frac{p_N(q^*)}{p_N(\widehat{q})}dF\left(q\right) - 1\right] dK_1. \end{aligned}$$

Since the terms in the second line are positive, it must be that $dq^*/dK_1 < 0$.[25] **Q.E.D.**

[25]Similarly to above, to verify this note that differentiating the second line with respect to q^* yields $-\int_{q^*}^1 \left[\frac{p_Y(q)}{p_N(\widehat{q})}\frac{(p_{YG}p_{NB} - p_{NG}p_{YB})}{p_Y(q^*)^2}\right] dF\left(q\right) < 0$.