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Renegotiation-proof contracting, disclosure, and incentives for efficient investment

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Abstract

Disclosure by firms would seem to reduce investment inefficiency by reducing informational asymmetry. However, the impact of disclosure is endogenous and depends on incentives within the firm. Given optimal renegotiation-proof contracts, disclosing only accepted contracts does not solve the Myers–Majluf problem. What solves the problem is having either full transparency of all compensation negotiations or, more reasonably, additional forward-looking announcements. The model is robust to renegotiation in equilibrium, the order of moves, and moral hazard. The analysis illuminates disclosure regulation: forward-looking disclosure is beneficial when the manager's contract is optimal and induces truth-telling.

JEL classification: G38; M41; M52

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1. Introduction

Informational asymmetry spawns investment inefficiency, which is why many disclosure regulations attempt to reduce informational asymmetry by making private information public. In the

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hope of informing the ongoing debate on disclosure regulation, this paper analyzes the impact on investment efficiency of (i) forward-looking announcements made by the firm's manager about future payoffs of the firm's assets and investment projects and (ii) disclosures about the manager's compensation contract. It is natural to think that disclosure improves efficiency by reducing the informational asymmetry. However, the impact of disclosure is subtle because forward-looking announcements and disclosure about compensation are endogenous and their information content depends on equilibrium incentives. A failure of the contracting mechanism that determines the incentives could imply a failure of disclosure. Using the framework of Myers and Majluf [16], a popular model that links investment inefficiency to informational asymmetry, we show that with optimal renegotiation-proof contracting, disclosing the manager's accepted contracts does not solve the Myers–Majluf investment inefficiency problem. Disclosure to the market of all compensation-related communications would solve the Myers–Majluf problem, but does not seem practical. More reasonably, allowing forward-looking announcements and disclosing the accepted contracts can solve the Myers–Majluf problem: the optimal contract assures the market that the manager has an incentive to announce truthfully.

The notion that disclosure may reduce informational asymmetry and improve efficiency has motivated regulatory changes over the past 30 years, encouraging managers to announce forward-looking information in SEC filings such as the 10-Q, 10-K, and prospectus.[1] Our results are broadly supportive of this trend, but with a cautionary note that announcements could be damaging if investors do not understand the manager's incentives.

Our model considers a firm with assets in place and a new investment opportunity. The manager has private information about the firm's future cash flows and decides whether to invest in a new project. The existing shareholders hold their shares until liquidation and, if undertaken, the new project is financed entirely by an equity issue. Myers and Majluf show that the manager who acts faithfully on behalf of existing shareholders invests inefficiently by forgoing a modestly positive NPV project when existing assets are worth more than investors expect (avoiding dilution of share value). In this model, the manager also has an incentive to invest in a negative NPV project when the existing assets are worth less than investors expect (inflating the share value). We assume renegotiation-proof contracting, and judge a disclosure regime to be effective if it solves the Myers–Majluf problem. Feasibility of the first-best investment in some variant of our model should not be taken literally; in reality the first-best is likely to be infeasible due to numerous agency problems not modeled here. For parsimony, we will speak of efficiency or the first-best, understanding that this is only regarding the Myers–Majluf inefficiency. In Section 6 we add moral hazard to the model and show that forward-looking announcements still eliminate the Myers–Majluf problem and achieve the second-best.

To determine the manager's incentives, we solve for the optimal contract between the manager and existing shareholders (or more realistically, their representatives on the board), requiring the

[1] In addition, the safe-harbor provisions protect firms from law suits – if forward-looking announcements are not fraudulent. For details, see "*Securities Regulation: Cases and Materials*" by Coffee and Seligman [4]. Regulators, however, have been less willing to relax the restrictions imposed on disclosure prior to public offerings in Section 5 of the Security Act of 1933. Current regulation still discourages managers of IPO firms from making certain types of forward-looking announcements during the "quiet period" (the period between "filing" and "effective" dates). The main concern is that issuers may use rosy forward-looking announcements as a vehicle to oversell (to "hype") stock. Because the law is somewhat ambiguous, most issuers are cautious and prefer not to "talk" at all to investors during the "quiet period". This reduces the timely disclosure of information useful for pricing. The new SEC rule (*Securities Offering Reform*, passed in July 2005) permits more communication between issuers and investors prior to public offerings. Under this new rule, certain forward-looking announcements are still discouraged.

investment policy to be incentive-compatible. We also require the contract to be renegotiation-proof, which is to say that the existing shareholders do not prefer to propose a new contract to the manager. There are several reasons for imposing renegotiation-proofness, all having to do with why it might be infeasible or undesirable to commit to a contract. The simplest justification follows from the observation that courts acting in the name of efficiency[2] will typically approve any changes agreed upon by all parties to a contract.[3]

Our requirement of renegotiation-proofness for contracts is similar to the requirement on the investment policy imposed by Myers and Majluf. Myers and Majluf argued that a firm cannot credibly pursue an efficient investment policy if investors' belief in the efficient investment gives the firm an incentive to switch and manipulate investors into paying too much. In our model, the shareholders' choice variable is the manager's compensation contract, not the investment policy, but renegotiation-proofness imposes the same discipline on the shareholders' choice. In particular, existing shareholders (or their representatives on the board) cannot commit to a contract if the new investors' belief in the contract gives existing shareholders an incentive to switch (and manipulate new investors into paying too much). When offered a contract that is not renegotiation-proof, investors refuse to participate in the new issue, knowing that investing in the company would be a no-win situation. In particular, when new investors do not have much information, they realize that they are especially vulnerable to manipulation, and therefore renegotiation-proofness tends to rule out all relatively efficient contracts.

Disclosing more information to investors makes price manipulation using renegotiation less feasible, implying that more contracts (including those that improve investment efficiency) are renegotiation-proof. Disclosing accepted compensation contracts (the *limited-disclosure* regime) is typically not sufficient because shareholders could use renegotiation to "cherry pick" the most valuable states. Additional disclosure of either all negotiations (the *full-transparency* regime) or more realistically, forward-looking announcements (the *forward-looking-announcement* regime) does eliminate investment inefficiency in our model. Throughout the paper, we assume disclosure of the entire compensation rule and not just realized compensation. This is a reasonable assumption given the new SEC rules, though it is not literally true. Interestingly, limited disclosure of only the accepted compensation contract is probably worse than no disclosure at all, as illustrated by Example 1 in Appendix A.

The full-transparency regime assumes that all proposed contracts, whether they are subsequently accepted or rejected, are disclosed to the market. In this regime, investors know enough to eliminate the manipulation, even if they do not know everything the manager knows. Also, the optimal contract in the full transparency regime induces efficient investment. Perhaps the optimal contract is not unique; one contract that works is the Dybvig–Zender [6] contract that is linear in the intrinsic value of the firm. The proof of renegotiation-proofness is a Modigliani–Miller [15]

[2] Although the law emphasizes *ex post* efficiency, it is well known that imposing *ex post* efficiency can reduce overall efficiency. For example, in the Diamond [5] version of the Townsend [24] model of optimality of debt, the lender destroys the firm if the debt payment is not made, but this is not *ex post* efficient. *Ex post* efficiency may sound like a good thing, but in Diamond's analysis, *ex post* efficiency would imply that the borrower never has any incentive to repay the lender anything and therefore the efficient investment could not occur.

[3] It can be argued that the legal system does include devices for commitment that could preclude renegotiation. For example, reneging on commitments in public statements or the offering prospectus can be punished under rule 10b5. A more robust justification is that renegotiation-proofness serves as an imperfect proxy for a complex reality, and there are reasons outside the model why it is undesirable to commit to a contract. For example, absolute commitment to a managerial contract would make it impossible for the firm to respond to an outside offer to hire the manager, and the manager cannot commit to turn down such an offer because indentured servitude is illegal.

argument. Renegotiation cannot improve efficiency (because investment is already efficient), harm new investors (because prices are fair), or harm the manager (because the manager can reject the change in contract). Therefore, renegotiation cannot make the existing shareholders better off. While we do not think the full-transparency case is realistic because it is hard to imagine how to enforce disclosure of private talks between the managers and members of the board's compensation committee, this case shows what information investors would like to have to keep their evaluations from being manipulated. Absent knowledge of what proposals were offered to the manager and rejected, investors cannot assess accurately the value of the firm.

In the more realistic forward-looking-announcement regime, the market observes only accepted compensation contracts and the manager is allowed to reveal private information via forward-looking announcements. The optimal contract provides an incentive for efficient investment and for truth-telling. If shareholders offered renegotiation in some states, investors would see the renegotiation and would price the stock accordingly; in the remaining states, the investors would receive the truthful forward-looking announcement induced by the optimal contract and would not be fooled into paying too much. In other words, the forward-looking announcement gives investors the information they cannot infer reliably from the agreed contract alone. Without manipulation, the Modigliani–Miller argument implies there is no profitable renegotiation because the optimal contract induces efficient investment.

A number of theoretical papers show that renegotiation may help to achieve interesting solutions.[4] Can renegotiation in equilibrium solve the investment inefficiency problem? As an extension to the basic model, we show that the limited-disclosure regime is still not effective even if we allow renegotiation in equilibrium.[5] Specifically, we show that shareholders facing an efficient candidate equilibrium will in general still wish to use additional renegotiation to signal high profits, which is a violation of renegotiation-proofness. Another way to put this is that the investors' belief in no renegotiation would give shareholders an incentive to renegotiate, which is inconsistent with equilibrium. As a result, even with multiple rounds or renegotiation, the limited-disclosure regime implies inefficient investment.

Solutions in information models often depend on the fine structure of the problem. In another extension of the basic model, we ask whether the results would still hold if any renegotiation is initiated by the manager, rather than the shareholders. Interestingly, the results are robust: both the full-transparency and forward-looking-announcement regimes are still effective with the reversal of move order. The reason is that the Modigliani–Miller argument still works the same. We also show that our results extend to a more complex setting with moral hazard.

Given that our model is posed as an optimal contracting problem, one might expect that the revelation principle[6] would be useful for our analysis. After all, the revelation principle is the most common tool for analyzing optimal contracts. The revelation principle can be useful for finding the optimal contract because it says the search can restrict attention, without loss of generality, to direct mechanisms (in which agents truthfully report their types). However, it is not clear how to adapt the revelation principle to the presence of the renegotiation-proofness

[4] See, for example, Aghion and Bolton [1], Green and Laffont [8], and Nosal [18].

[5] Like all other results in the paper, this still assumes renegotiation-proofness, which means that there is no desire to renegotiate beyond any equilibrium renegotiations.

[6] The revelation principle, which applies to many two-agent models of hidden information, says that for every mechanism there is an equivalent direct mechanism with a truthful report of the agent's hidden information. "Equivalent" means that both mechanisms create the same incentives and are consistent with the same equilibrium actions and payoffs.

constraint. Fortunately, it is not necessary to adapt the revelation principle for our model because we can offer direct proofs that do have the flavor of the proof of the revelation principle.

Our model is similar to several papers that extend Myers and Majluf [16]: Dybvig and Zender [6] examine the role of optimal contracting and Persons [20] raises the question of renegotiation-proofness. The paper most related to ours is Kumar and Langberg [12]. Similar to our paper, they analyze investment efficiency with renegotiation-proof optimal contracts. Assuming that forward-looking announcements are allowed and contracts are observed (as in our forward-looking-announcement regime), they find that there are fraud and overinvestment caused by a managerial desire for empire-building. Their paper differs from ours in many assumptions including their assumption that the manager has private benefits of control and the benefits are not included in the assessment of investment efficiency. In another related paper, Östberg [19] argues that disclosure may have both positive and negative effects on investment efficiency and concludes that mandating complete disclosure may be suboptimal. Östberg derives the results in the model that abstracts from the issues of renegotiation-proofness and optimal contracting central to our paper.

Our paper is also closely related to the stream of literature that analyzes whether contracts with agents can allow principals to precommit to certain actions. A number of papers show that when contracts are fully observable (similar to our full disclosure case), precommitment is feasible; see Bolton and Scharfstein [2], and Dybvig and Zender [6]. Katz [10], however, shows that when contracts are unobservable and the agent and the principal have the same preferences, the agent acts on behalf of the principal in equilibrium and precommitment is not feasible. We contribute to this literature by analyzing consequences of various alternative disclosure regimes when contracts are required to be renegotiation-proof.

There is a vast related theoretical literature that investigates the costs and benefits of disclosure in a wide variety of situations; see Dye [7], Healy and Palepu [9], and Verrecchia [25] for comprehensive reviews, and Stamland [22] for an example of a recent work on the topic. We contribute to this literature by studying on the role of disclosure in mitigating Myers–Majluf inefficiency. While there is also a large empirical literature analyzing disclosure, we are not aware of any direct tests of our model predictions (see Section 7 for further discussion). One example of an indirect support for our model predictions is Lo [14] who finds that increased compensation disclosure in 1992 improved shareholders' wealth.

The paper proceeds as follows. The next section describes the model. In Section 3, we show that in the limited-disclosure regime, investment is inefficient, while in full-transparency and forward-looking-announcement regimes, the investment in our model is first-best. This section also shows that the contract implicitly assumed in Myers and Majluf [16] is not effective even if it includes a penalty for errors in forward-looking announcements. Section 4 shows that disclosing the accepted contract alone (limited disclosure) does not eliminate investment inefficiency even if renegotiation is allowed in equilibrium. Sections 5 and 6 analyze the robustness of the positive results in full-transparency and forward-looking-announcement regimes when the manager initiates any renegotiation, and when the manager is subject to a moral hazard problem. Section 7 discusses empirical implications of our model and describes the relevant empirical literature, and Section 8 concludes. Appendix A includes proofs and the limited-disclosure regime.

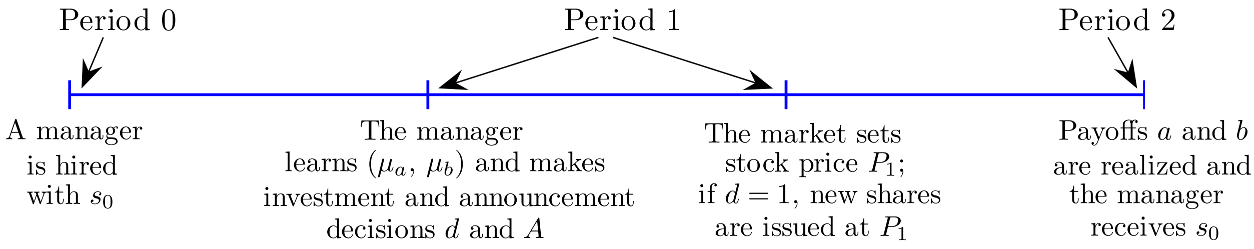

Fig. 1. Time line of the model without renegotiation.

2. Model setup

Consider a firm existing for three periods: 0, 1 and 2. In period 0, the existing shareholders invest in an initial project (assets in place), hire a manager with a reservation utility u_0, and design a managerial compensation contract s_0, which is made public, subject to satisfying the manager's reservation utility constraint. All agents are assumed to be risk neutral over nonnegative terminal wealth and there is no time discounting. The compensation s_0 is constrained to be nonnegative (limited liability) and bounded from above by the total final payoff in all states.

In period 1, a new project arrives. If undertaken, it requires an investment of I, which is raised by issuing equity. The investment scale I is exogenously given. The manager then learns two pieces of private information: the conditional mean value μ_a of assets in place and the conditional mean net value μ_b of the new investment.[7] After learning μ_a and μ_b, the manager makes a forward-looking announcement $A = A(\mu_a, \mu_b)$ of total project payoff; we impose $A \equiv 0$ if forward-looking announcement is prohibited. Next, the manager decides whether to undertake the new project. The investment decision is $d(\mu_a, \mu_b) = 1$ if the new project is undertaken and $d(\mu_a, \mu_b) = 0$ otherwise. The market forms a stock price $P_1(d, A)$, the total value of existing shares, rationally based on the manager's investment decision d and forward-looking announcement A. The market value of the firm in period 1 is $P_1(d, A) + Id$.

In period 2, project payoffs are realized. The market observes the total payoff $a + (b + I)d$: a from assets in place and $b + I$ from the new project, if undertaken. The manager gets paid according to the contract signed at the outset $s_0(d, A, a + bd, P_1, P_2)$, where P_2 is the value of the existing shares in period 2. The contract depends only on public information: the investment choice d, the forward-looking announcement A, the realized total payoff $a + (b + I)d$, and the stock prices in periods 1 and 2: P_1 and P_2.[8] In our model, s_0 is the all-inclusive compensation: salary payment, performance-contingent bonuses, value of stock and stock options, as well as implicit compensation due to career concerns. The firm is valued at the total payoff net of managerial compensation $a + (b + I)d - s_0$, of which a fraction $P_1/(P_1 + Id)$ goes to the existing shareholders and the rest goes to the new investors. The time line is summarized in Fig. 1.

Because we wish to require renegotiation-proofness of managerial contract, we next describe what we mean by renegotiation-proofness. Specifically, we require that there does not exist a *blocking* compensation contract that would benefit the existing shareholders if offered in period 1 to replace the initial contract s_0. We have the following time line in mind for such potential

[7] We assume the manager learns the conditional mean values of the project payoffs, μ_a and μ_b, but not a and b, to preclude trivial solutions (such as forcing contracts). In Myers and Majluf, a and b were learned exactly.

[8] The set of publicly observed information may include other variables. Adding additional variables, however, would unnecessarily complicate the exposition without affecting the results. In fact, stock prices are also redundant; they are included, nonetheless, to explicitly allow for the type of contract implicit in Myers and Majluf.

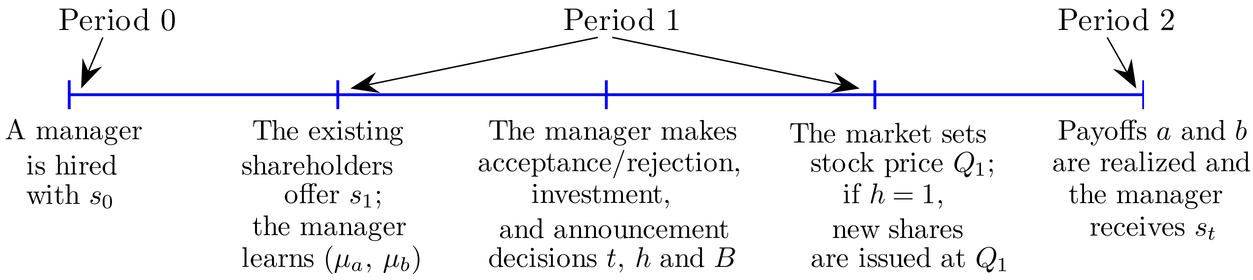

Fig. 2. The existing shareholders initiate renegotiation.

renegotiation (summarized in Fig. 2): in period 1, the existing shareholders offer the manager a new contract s_1; after learning the conditional means of the project payoffs, the manager either accepts or rejects the proposal (we let indicator $t = 1$ if the manager accepts s_1, and $t = 0$ if the manager rejects s_1) and then makes a forward-looking announcement and an investment decision. Because renegotiation may affect the subsequent actions of both the manager and the market, we introduce the following notation for the out of equilibrium strategies of the manager and the market after renegotiation. Indicator h denotes the out of equilibrium investment policy: $h = 1$ if the manager undertakes the new project and $h = 0$ otherwise; B denotes the out of equilibrium announcement policy; and Q_1 and Q_2 denote the out of equilibrium market values of the existing shares in periods 1 and 2 respectively. The new contract s_1 is always disclosed to the market in the full transparency regime, and is only disclosed if accepted in the limited-disclosure and forward-looking-announcement regimes. Announcement B is constrained to $B \equiv 0$ if forward-looking announcement is prohibited.

The existing shareholders' choice problem, Problem 1 below, includes parameters that indicate the degree of transparency of negotiations and the feasibility of forward-looking announcement. Let λ be an indicator for whether there is full transparency ($\lambda = 1$: yes, $\lambda = 0$: no), and let κ be an indicator for whether forward-looking announcement is allowed ($\kappa = 1$: yes, $\kappa = 0$: no). The forward-looking-announcement regime has $\lambda = 0$ and $\kappa = 1$, the limited-disclosure regime has $\lambda = 0$ and $\kappa = 0$, and the full-transparency regime has $\lambda = 1$ and $\kappa = 0$. (There is no point having a fourth regime with $\lambda = 1$ and $\kappa = 1$ because it is redundant to have both announcement and full transparency: either regime is sufficient for efficiency and the joint case is efficient too with the same proof.)

Following the approach common in the agency literature (originally from Ross [23]), we next formally state the existing shareholders' problem as a maximization problem where the existing shareholders choose a managerial compensation contract, the manager's investment and announcement policies, and the market's pricing rules subject to incentive compatibility, participation, and rationality constraints of the agents. Although having the shareholders choose market prices and investment may seem peculiar, it helps to circumvent technical problems with existence and uniqueness of equilibrium.

Problem 1 *(Existing Shareholders' Problem).* The existing shareholders choose a compensation contract s_0 (for any d, A, $a + bd$, P_1 and P_2, $s_0(d, A, a + bd, P_1, P_2) \in [0, a + (b + I)d]$), an investment plan d^*, a forward-looking-announcement policy A^*, and rational pricing rules $P_1(d, A)$ and $P_2(d, A, a + bd)$ to maximize the expected terminal stock price:

$$\text{O1:} \quad E\big[P_2\big(d^*(\mu_a, \mu_b), A^*(\mu_a, \mu_b), a + bd^*(\mu_a, \mu_b)\big)\big],$$

subject to:

(P1a) (Incentive Compatibility) For each μ_a and μ_b, setting $d = d^*(\mu_a, \mu_b)$, $A = A^*(\mu_a, \mu_b)$ solves:
Choose an investment indicator $d \in \{0, 1\}$ and a forward-looking announcement A to maximize the manager's expected compensation:

$$E\big[s_0\big(d, A, a + bd, P_1(d, A), P_2(d, A, a + bd)\big) \mid \mu_a, \mu_b\big],$$

subject to $A = 0$ if forward-looking announcement is prohibited ($\kappa = 0$).

(P1b) (Participation Constraint) Let $s_0^*(\mu_a, \mu_b)$ be the maximum in (P1a), then

$$E\big[s_0^*(\mu_a, \mu_b)\big] \geqslant u_0.$$

(P1c) (Rational Pricing of Existing Shares in Period 1) The rational pricing rule in period 1 is

$$P_1(d, A) = E\big[a + bd - s_0^*(\mu_a, \mu_b) \mid d^*(\mu_a, \mu_b) = d,\ A^*(\mu_a, \mu_b) = A\big].$$

(P1d) (Rational Pricing of Existing Shares in Period 2) The rational pricing rule in period 2 is

$$P_2(d, A, a + bd) = \frac{P_1(d, A)}{P_1(d, A) + Id}\big(a + (b + I)d - s_0(d, A, a + bd, P_1, P_2)\big).$$

(P1e) (Renegotiation-Proofness) The contract s_0, investment plan d^*, forward-looking-announcement policy A^*, and rational pricing rules P_1 and P_2 are not blocked in the sense of Definition 1.

Definition 1 *(Blocking Contract).* (*Note*: *this is what* cannot *exist by definition in a renegotiation-proof equilibrium.*)

A compensation contract s_0, an investment plan d^*, a forward-looking-announcement strategy A^*, and rational pricing rules P_1 and P_2 that satisfy (P1a) to (P1d) are said to be **blocked** if there exist a new contract s_1 (for any $h, B, a + bh, Q_1$, and Q_2, $s_1(h, B, a + bh, Q_1, Q_2) \in [0, a + (b + I)d]$), an acceptance strategy t^*, an investment plan h^*, an announcement strategy B^*, and rational pricing rules Q_1 and Q_2 such that:

(D1a) (Initiator's Higher Expected Payoff) The existing shareholders strictly prefer the deviation:

$$E\big[Q_2\big(t^*(\mu_a, \mu_b), h^*(\mu_a, \mu_b), B^*(\mu_a, \mu_b), a + bh^*(\mu_a, \mu_b)\big)\big] > E\big[P_2\big(d^*(\mu_a, \mu_b), A^*(\mu_a, \mu_b), a + bd^*(\mu_a, \mu_b)\big)\big].$$

(D1b) (Incentive Compatibility) For each μ_a and μ_b, setting $t = t^*(\mu_a, \mu_b)$, $h = h^*(\mu_a, \mu_b)$, and $B = B^*(\mu_a, \mu_b)$ solves:
Choose an acceptance indicator $t \in \{0, 1\}$, an investment indicator $h \in \{0, 1\}$, and a forward-looking announcement B to maximize the manager's expected compensation:

$$E\big[s_t\big(h, B, a + bh, Q_1(t, h, B), Q_2(t, h, B, a + bh)\big) \mid \mu_a, \mu_b\big],$$

subject to $B = 0$ if forward-looking announcement is prohibited ($\kappa = 0$).

(D1c) (Rational Pricing of Existing Shares in Period 1) The pricing rule in period 1 is

$$Q_1(t, h, B) = \begin{cases} P_1(h, B), & \text{if } t = 0 \text{ and } \lambda = 0, \\ E[a + bh - s_t^*(\mu_a, \mu_b) \mid t^*(\mu_a, \mu_b) = t,\ h^*(\mu_a, \mu_b) = h, \\ \quad B^*(\mu_a, \mu_b) = B], & \text{otherwise,} \end{cases}$$

where $s_1^*(\mu_a, \mu_b)$ is the maximum in (D1b) when the manager accepts the new offer and $P_1(h, B)$ is defined in (P1c).

(D1d) (Rational Pricing of Existing Shares in Period 2) The pricing rule in period 2 is

$$Q_2(t, h, B, a+bh) = \frac{Q_1(t, h, B)}{Q_1(t, h, B) + Ih}\big(a + (b+I)h - s_t(h, B, a+bh, Q_1, Q_2)\big).$$

According to Problem 1, the existing shareholders choose a compensation contract s_0, an investment plan d^*, a forward-looking-announcement strategy A^* and anticipated rational pricing rules P_1 and P_2 to maximize their expected payoff (O1) subject to the incentive compatibility and participation constraints of the manager. The incentive compatibility constraint (P1a) requires the chosen investment and forward-looking-announcement strategies d^* and A^* to maximize the manager's expected compensation for any given μ_a and μ_b. If forward-looking announcement is not permitted ($\kappa = 0$), then the announcement A cannot reveal any information: the manager announces a constant (zero) in each state. The participation constraint (P1b) requires the expected compensation to be bigger than the manager's reservation utility u_0.

Rationality of the pricing rules requires the market to incorporate all public information into the stock prices. Knowing the contract s_0, the market may learn additional information about the conditional mean payoffs μ_a and μ_b through observing the manager's investment choice d and forward-looking announcement A. Thus, (P1c) requires the market price in period 1 to be $P_1 = E[a + bd - s_0 \mid d, A]$. In period 2, the total value is realized and publicly observed. The final market value of the firm is $a + (b+I)d - s_0$, which is the realized total value $a + (b+I)d$ less the manager's compensation s_0. The existing shareholders obtain a fraction $P_1/(P_1 + Id)$ of the market value, as specified in (P1d).

The last condition (P1e) requires renegotiation-proofness, meaning that there does not exist a (*blocking*) compensation contract that would benefit the existing shareholders if offered in period 1 to replace the initial contract s_0. Whether a candidate blocking contract could benefit the existing shareholders depends on the beliefs about whether the manager would accept the new contract, as well as the subsequent investment, forward-looking announcement, and prices. Therefore, our definition of a blocking contract, Definition 1, includes a specification of all these (rational) beliefs alongside the specification of the contract itself.

In Definition 1, constraint (D1b) ensures that the manager's strategies t^*, h^*, and B^* are indeed incentive compatible. Rational pricing in period 1 requires the market to incorporate the observed forward-looking announcement B, investment h and the new contract s_1 into the stock price Q_1. If only the accepted contracts are disclosed ($\lambda = 0$), absent a switch ($t = 0$), the new investors' expectation does not change since they think they are in the original equilibrium: $Q_1(0, h, B) = P_1(h, B)$.[9] If, however, the manager accepts the new contract or the market observes the rejected proposal, then $Q_1(t, h, B) = E[a + bh - s_t \mid t, h, B]$, where $s_t = s_1$ if the manager accepts the new contract and $s_t = s_0$ otherwise. In period 2, the realized firm value (gross of salary) $a + (b+I)h$ becomes publicly known. Taking dilution into account,

[9] Because the market observes only the outcome but not the process of negotiations, the market has the same information when no renegotiation takes place and when the new proposal is rejected: the market only knows that the initial contract is intact. Because no renegotiation occurs in equilibrium, the market rationally believes that no renegotiation has taken place when no new contract is observed. These beliefs are consistent with the equilibrium path, similar to beliefs in a weak perfect Bayesian equilibrium.

the existing shareholders obtain the fraction $Q_1/(Q_1 + Ih)$ of realized firm value net of salary $a + (b + I)h - s_t$.[10] As in Problem 1, a forward-looking announcement does not convey any information ($B \equiv 0$) if it is not permitted.

According to Definition 1, the market price may not correctly reflect the expected value of the firm when the existing shareholders deviate from the equilibrium path and renegotiate the contract with the manager ($Q_1(0, h, B)$ coincides with $P_1(h, B)$). The market price in our model behaves in essentially the same manner as the market price in the original Myers and Majluf model. In Myers and Majluf [16], the market price does not correctly reflect the expected value of the firm when the manager deviates from the equilibrium investment policy anticipated by the market. The gap between the expected value of the firm and the market price provides incentives to the manager to invest inefficiently, leading to the Myers and Majluf problem.

We finish the section with some technical observations and assumptions. First, we make assumptions about productivity and reservation utility to ensure that the firm is viable. Assume the loss from a project does not exceed the initial investment: $\nu \leqslant a \leqslant \bar{a}$ and $-I \leqslant b \leqslant \bar{b}$ almost surely, where ν is a small positive constant because the investment in assets in place is sunk. Assume also that reservation utility satisfies $u_0 \leqslant \nu$ so that the firm has enough resources to pay the manager. Finally, we make assumptions about a and b that will simplify the proofs without affecting the economics. Define forecast errors $\varepsilon_a \equiv a - \mu_a$ and $\varepsilon_b \equiv b - \mu_b$. We assume $\mathrm{var}(\varepsilon_a \mid \mu_a, \mu_b) > 0$, $\mathrm{var}(\varepsilon_b \mid \mu_a, \mu_b) > 0$, and $\mathrm{cov}(\varepsilon_a, \varepsilon_b \mid \mu_a, \mu_b) = 0$.

3. Main results

This section shows that the forward-looking-announcement and full-transparency regimes are effective. Specifically, it shows that these regimes result in the following investment policy:

Definition 2.

$$d_{fb}(\mu_a, \mu_b) \equiv \begin{cases} 1, & \mu_b \geqslant 0; \\ 0, & \mu_b < 0. \end{cases}$$

Up to indifference when $\mu_b = 0$, d_{fb} is the unique efficient (first-best) investment policy that maximizes the firm value (gross of salary) $E[a + bd \mid \mu_b]$. We show in Appendix A (Claim 1) that disclosing the compensation contract alone (the limited-disclosure regime) is not effective. Formally, we show that all solutions to the existing shareholder's problem in the limited-disclosure regime are degenerate in the sense that they require the manager's compensation to vary one-to-one with the firm value when the new investment is undertaken.[11] In general, this implies that the existing shareholders induce the manager to engage in an inefficient investment. Moreover, investment under limited disclosure may be even less efficient than the investment under no disclosure (see Example 1 in Appendix A).

[10] Assuming that the manager learns about μ_a and μ_b before the new contract is offered does not change the result. In either specification, the existing shareholders originate renegotiation without any additional information, while the manager learns about μ_a and μ_b before making decisions.

[11] We prove the result by constructing a blocking contract for any non-degenerate initial contract. Specifically, if shareholders initially offer a non-degenerate contract, they can benefit from offering a new contract which the manager accepts only if the manager expects high profits. Thus, the manager's acceptance conveys favorable information about the firm value. The renegotiation strategy we consider does not affect the manager's investment policy. Thus, it benefits the existing shareholders by improving the stock price in some states.

3.1. Forward-looking announcement

This subsection shows how a voluntary forward-looking announcement, combined with disclosure of accepted managerial contract, eliminates the Myers–Majluf problem. The optimal contract is not unique; the contract we choose has a linear term offering incentives for efficient investment (d_{fb}), and a penalty term inducing truthful reporting of the managerial expectation on the total profit. Specifically, we define truthful reporting as

Definition 3.

$$A_{fb}(\mu_a, \mu_b) \equiv \mu_a + \mu_b d_{fb}(\mu_a, \mu_b),$$

and let

$$s_{fla}(d, A, a+bd, P_1, P_2) \equiv \alpha + \beta\left((a+bd) - \eta\frac{(a+bd-A)^2}{\operatorname{var}(\varepsilon_a + \varepsilon_b d)}\right), \tag{1}$$

where α, β, and η are positive constants, $\varepsilon_a \equiv a - \mu_a$ and $\varepsilon_b \equiv b - \mu_b$, and subscript "fla" stands for "forward-looking announcement". By definition, A_{fb} is a truthful forward-looking announcement of the expected net value of the firm (gross of salary) given the first-best investment policy d_{fb}.

Theorem 1. *The forward-looking-announcement regime is effective, i.e., permitting the manager to announce a forecast of firm value results in the first-best investment policy. Formally, there exist constants α, β and η such that the contract s_{fla}, the first-best investment plan d_{fb}, the truthful forward-looking announcement A_{fb}, and rational pricing rules P_1 and P_2 solve the existing shareholders' problem with forward-looking announcement* (*Problem* 1 *with* $\kappa = 1$ *and* $\lambda = 0$).

Proof. See Appendix A. □

The proof is based on the following intuition. It is straightforward to show that, under the contract s_{fla}, the efficient investment policy and truthful reporting are incentive compatible. Additionally, for some α, β, and η, this contract is feasible and satisfies the manager's participation constraint. It remains to show that s_{fla} is not blocked. The proof uses a Modigliani–Miller argument. Any blocking contract can only reduce investment efficiency (since s_{fla} is efficient) and also, by definition, cannot make the manager worse off. It also cannot make outside investors worse off because pricing is fair and so the outside investors earn zero rents whether or not renegotiation takes place. Modigliani–Miller argument then implies that no blocking contract can make the existing shareholders better off. Therefore, s_{fla} is renegotiation-proof. The crucial step of the proof, which utilizes disclosure requirements, is to show that pricing is fair even if the existing shareholders privately renegotiate the contract with the manager. Specifically, we show that if the new contract is accepted, pricing is fair because the disclosure of the new contract allows investors to infer the set of states in which the manager chooses to accept. More importantly, if the new contract is rejected, pricing is fair because the manager has an incentive to make a truthful forward-looking announcement.

In the proof, managers make truthful earnings forecasts. It would also work if managers are given incentives to report an invertible transformation of their earnings forecasts. (For example, maybe the norm is to inflate earnings by 30% and managers get penalized for deviating from this norm.) In these cases, new investors can still infer manager's earnings forecasts and price the stock correctly, consistent with incentives for efficient investment. Therefore:

Corollary 1. *The efficient investment in Theorem* 1 *is consistent with truthful reporting of* $\mu_a + \mu_b d$*, as stated in the proof. It is also consistent with reporting any invertible function of* $\mu_a + \mu_b d$*.*

In the forward-looking-announcement regime, it may seem that efficient investment could be achieved by adding a quadratic penalty for errors in the forward-looking announcement to the contract linear in existing shareholders' payoff P_2 (this contract aligns the interests of the manager and the existing shareholders and is implicitly assumed in Myers and Majluf [16]). This intuition is misleading. When there is no new equity issue, the existing shareholders' payoff P_2 is independent of the intermediate price P_1 and the manager optimally makes a truthful forward-looking announcement. When there is a new issue, however, the manager makes a distorted forward-looking announcement because P_2 is increasing in P_1. The optimal distortion is positive (the forward-looking announcement is higher than $\mu_a + \mu_b d$) and it trades off the marginal benefit of an increased intermediate price P_1 against the marginal cost imposed by the quadratic penalty for distortions. In equilibrium, the market rationally expects the distortion and is always able to infer the correct value of $\mu_a + \mu_b d$. Although the price fully reflects the manager's information, the distortion of the forward-looking announcement influences the manager's investment decision: when b is marginally positive, the manager foregoes the profitable new project to avoid the penalty for the distorted forward-looking announcement.[12] To summarize, even if the investors can infer $\mu_a + \mu_b d$, it is also necessary to avert investment distortion by neutralizing the manager to changes in the intermediate stock price.

3.2. Full transparency

This subsection shows that absent forward-looking announcement, full transparency of negotiations ($\kappa = 0$, $\lambda = 1$) also leads to the first-best investment in our model. This regime differs from the forward-looking-announcement regime in that the price formation of the blocking contract reflects the knowledge of the proposal even if it is rejected: $Q_1(t, h, 0) = E[a + bh - s_t \mid t, h, 0]$ for both $t = 1$ (acceptance) and $t = 0$ (rejection). The disclosure of the rejected contract eliminates the informational advantage of the existing shareholders over new investors.

Specifically, let

$$s_{tn}(d, 0, a + bd, P_1, P_2) \equiv \alpha + \beta(a + bd), \tag{2}$$

where α and β are positive constants and "tn" stands for "transparency" (this contract is suggested by Dybvig and Zender [6]). We will prove that if negotiations are fully transparent, this linear contract induces efficient investment and survives renegotiation: it solves Problem 1.

Theorem 2. *The full-transparency regime is effective, i.e., requiring full disclosure of all managerial contract negotiations results in the first-best investment policy. In particular, there exist constants* α *and* β *such that the contract* (s_{tn})*, the first-best investment plan* d_{fb}*, and rational pricing rules* P_1 *and* P_2 *solve the existing shareholders' problem with full transparency* (*Problem* 1 *with* $\lambda = 1$ *and* $\kappa = 0$).

[12] This penalty does not go to zero as b goes to zero. Even when b is very small, the incentive to distort the forward-looking announcement in order to reduce dilution is non-trivial: the forward-looking announcement affects the share of the *total* profit $a + b$ received by the existing shareholders, which may be large even if b is small.

Proof. See Appendix A. □

The proof is based on the following intuition. It is straightforward to show that the contract s_{tn} with efficient investment is incentive compatible for some α and β. The proof of renegotiation-proofness follows a Modigliani–Miller argument as in the proof of Theorem 1. In fact, the proof is almost identical (substituting s_{tn} for s_{fla}) until the crucial step showing that pricing is fair when the new contract is declined. In this case, pricing is fair because full transparency implies that investors can infer the set of states in which the new contract is declined. (In Theorem 1, fair pricing in this step came from a truthful forward-looking announcement.)

4. Renegotiation in equilibrium

Can we achieve renegotiation-proof investment efficiency by allowing renegotiation in equilibrium? We show that without sufficient disclosure, allowing the existing shareholders to renegotiate once does not prevent them from wishing to renegotiate further. Specifically, we show that with limited disclosure (with accepted contract disclosure alone), the existing shareholders still wish to use additional renegotiation to signal high profits. In this context, the manager's acceptance strategy on the equilibrium path is formally similar to the forward-looking announcement in Problem 1 (both serve to convey the manager's private information to the market). Thus, we denote this acceptance strategy as A (the notation previously used for forward-looking announcement).

With renegotiation on the equilibrium path, the existing shareholders' problem is

Problem 2 *(Existing Shareholders' Problem (Renegotiation in Equilibrium)).* The existing shareholders choose a compensation contract s_0 (for any $d, A, a+bd, P_1$ and P_2, $s_0(d, A, a+bd, P_1, P_2) \in [0, a+(b+I)d]$), an investment plan d^*, an acceptance strategy A^*, and rational pricing rules $P_1(d, A)$ and $P_2(d, A, a+bd)$ to maximize the expected terminal stock price

$$\text{O2:} \quad E\big[P_2\big(d^*(\mu_a,\mu_b), A^*(\mu_a,\mu_b), a+bd^*(\mu_a,\mu_b)\big)\big],$$

subject to:

(P2a) (The Existing Shareholders' IC in Period 1) Choosing functions $s_0^\dagger = s_0, d^\dagger = d^*, A^\dagger = A^*, P_1^\dagger = P_1$, and $P_2^\dagger = P_2$ maximizes

$$E\big[P_2^\dagger\big(d^\dagger(\mu_a,\mu_b), A^\dagger(\mu_a,\mu_b), a+bd^\dagger(\mu_a,\mu_b)\big)\big],$$

subject to:

(a) (The Manager's IC) For each μ_a and μ_b, setting $d = d^\dagger(\mu_a,\mu_b)$ and $A = A^\dagger(\mu_a,\mu_b)$ solves:
Choose an investment indicator $d \in \{0,1\}$ and an acceptance indicator $A \in \{0,1\}$ to maximize the manager's expected compensation:

$$E\big[s_0^\dagger\big(d, A, a+bd, P_1^\dagger(d,A), P_2^\dagger(d,A,a+bd)\big) \,\big|\, \mu_a,\mu_b\big].$$

(b) (Rational Pricing of Existing Shares in Period 1) The rational pricing rule in period 1 is

$$P_1^\dagger(d,A) = \begin{cases} E[a+bd-s_0^*(\mu_a,\mu_b) \mid d^*(\mu_a,\mu_b)=d,\ A^*(\mu_a,\mu_b)=A], \\ \quad \text{if } A=0, \\ E[a+bd-s_0^{\dagger*}(\mu_a,\mu_b) \mid d^\dagger(\mu_a,\mu_b)=d,\ A^\dagger(\mu_a,\mu_b)=A], \\ \quad \text{if } A=1, \end{cases}$$

where

$$s_0^*(\mu_a,\mu_b) \equiv \max_{d,A} E\big[s_0\big(d,A,a+bd,P_1(d,A),P_2(d,A,a+bd)\big) \bigm| \mu_a,\mu_b\big],$$

$$s_0^{\dagger*}(\mu_a,\mu_b) \equiv \max_{d,A} E\big[s_0^\dagger\big(d,A,a+bd,P_1^\dagger(d,A),P_2^\dagger(d,A,a+bd)\big) \bigm| \mu_a,\mu_b\big].$$

(c) (Rational Pricing of Existing Shares in Period 2) The rational pricing rule in period 2 is

$$P_2^\dagger(d,A,a+bd) = \frac{P_1^\dagger(d,A)}{P_1^\dagger(d,A)+Id}\big(a+(b+I)d-s_0^\dagger\big(d,A,a+bd,P_1^\dagger,P_2^\dagger\big)\big).$$

(d) (Commitment to the Initial Contract) For all d, A, $a+bd$, P_1, and P_2, shareholders commit to the initial contract $s_0(d,A,a+bd,P_1,P_2)$ in period 0, which is before the equilibrium renegotiation in period 1, and therefore

$$s_0^\dagger(d,0,a+bd,P_1,P_2) \equiv s_0(d,0,a+bd,P_1,P_2).$$

(P2b) (The Manager's Participation Constraint) The manager's expected utility satisfies

$$E\big[s_0^*(\mu_a,\mu_b)\big] \geqslant u_0,$$

where $s_0^*(\mu_a,\mu_b)$ was defined in (P2a)(b).

(P2c) (Renegotiation-Proofness) The contract s_0, investment plan d^*, acceptance strategy A^*, and rational pricing rules P_1 and P_2 are not blocked in the sense of Definition 4.

Definition 4 *(Blocking Contract (Renegotiation in Equilibrium)).* Same as Definition 1 with $\kappa = 1$, except imposing in (D1b) an additional constraint that $B = A$: A, the acceptance strategy on the equilibrium path, is chosen before a blocking contract is offered, so it cannot be changed upon renegotiation.

The new problem statement (Problem 2) includes one renegotiation in the equilibrium strategy of the existing shareholders and the manager. Note that the new notation s_0 now includes the original contract $s_0(\cdot,0,\cdot,\cdot)$ and the renegotiated contract $s_0(\cdot,1,\cdot,\cdot)$. Importantly, we still require an equilibrium to be renegotiation-proof by imposing condition (P2c), which is analogous to condition (P1e) in Problem 1.[13] The following theorem states that all the solutions to Problem 2 are degenerate in the sense that they require the manager's compensation to vary one-to-one with the firm value when the new investment is undertaken.

[13] Without this requirement, we know that efficient investment can be achieved even without renegotiation on the equilibrium path (Dybvig and Zender).

Theorem 3. *Consider the limited-disclosure regime, i.e., suppose that only accepted contracts are disclosed to the market and forward-looking announcement is prohibited. Call a solution degenerate if, for both* $A \in \{0, 1\}$*, either* $\Pr(d^* = 1 \text{ and } A^* = A) = 0$ *or the conditional expectation of the market value of the firm,* $E[a + (b + I)d^* - s_0^*(\mu_a, \mu_b) \mid \mu_a, \mu_b, d^* = 1,\ A^* = A]$*, is a constant and does not depend on* μ_a *and* μ_b*. Then, every solution to the existing shareholders' problem* (*Problem* 2) *is degenerate.*

Proof. See Appendix A. □

Here is the central idea of the proof. If after any equilibrium renegotiation the manager ends up with a non-degenerate contract and investors believe there would be no further renegotiation, shareholders would have an incentive to renegotiate. When a candidate blocking contract is offered and accepted, investors see what is happening and purchase shares at a fair price. However, when the candidate blocking contract is not accepted, investors expecting no renegotiation could be fooled into paying too much, which is clearly not an equilibrium outcome. Non-degenerate contracts are always blocked in this way and therefore can never be renegotiation-proof.

We have shown that one round of renegotiation in equilibrium is not effective. This result can be extended to any finite number of rounds, although the sense of non-degeneracy becomes more stringent as we add rounds. It is an open question to what extent a finite number of rounds may improve investment efficiency and whether, in the limit, the first-best investment can be achieved.

5. Informed manager initiates renegotiation

Information models are often very sensitive to the fine structure of the problem, such as when information arrives, who moves first, or who makes a proposal. In this section, we show that our main results are robust to having renegotiation initiated by the manager rather than by the shareholders.

The literature on asymmetric information indicates that it is typically difficult to define beliefs when the informed party proposes the contract; see Myerson [17]. As a result, it is difficult to define equilibrium, and we have the same difficulties when we try to define a blocking contract if the informed manager initiates any renegotiation. In particular, it is difficult to define the intermediate pricing rule and conditions for incentive-compatibility of a blocking contract. However, the exact equilibrium is not so important to us if we are willing to assume that all agents form expectations consistently. In this case, the Modigliani–Miller argument can be used to prove renegotiation-proofness, and we still obtain efficient investment under the conditions of either Theorem 1 or Theorem 2.

When the manager initiates any renegotiation, the sequence of events is as follows. After observing μ_a and μ_b, the manager may propose a new contract s_1. The existing shareholders accept the proposal if it increases their expected payoff. The manager then chooses whether to undertake the new project and makes a forward-looking announcement (if allowed). If the new project is undertaken, shares are issued to raise capital. The market then sets stock prices rationally based on all the available information. The time line is summarized in Fig. 3.

It is optimal for the existing shareholders to induce the manager to invest efficiently if either (i) the accepted contracts are disclosed and the manager is allowed to make a forward-looking

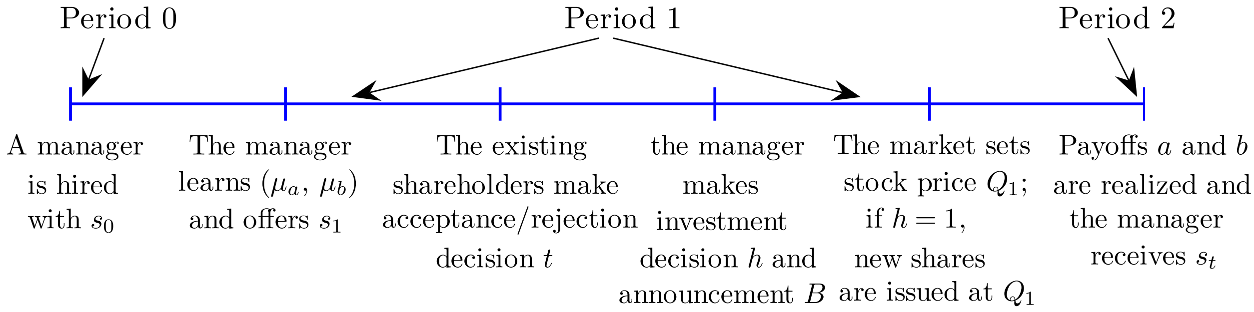

Fig. 3. The manager initiates renegotiation.

announcement, or (ii) the renegotiation process is fully transparent to the market. The proof applies the Modigliani–Miller argument and the revealed preferences argument under the efficient market hypothesis as follows. Let the initial contract s_0 be given by (1) in case (i) and given by (2) in case (ii). Both contracts induce efficient investment and satisfy the manager's participation constraints with equality. Suppose the manager initiates a renegotiation and offers a new contract s_1. Because the investment is already efficient under s_0, accepting s_1 cannot further increase the total value of the firm. Additionally, it is rational to infer (by revealed preferences) that accepting s_1 will only increase the expected managerial compensation. Moreover, if either (i) or (ii) holds, new investors have sufficient information (although perhaps, less information than the manager) to correctly value the firm for the same reasons as in Theorems 1 and 2. Therefore, pricing is fair and they recoup their investment. The net value of the firm (total value less investment) to be shared can only decrease, while the manager gets more and outside investors still have zero net present value. Therefore, shareholders are worse off accepting any new proposal and an efficient contract is not blocked.

6. Embedded moral hazard and the second-best

In most of this paper, solving the Myers–Majluf problem gets us to the first-best. Of course, we do not really expect to obtain the first-best in practice because there are many sources of inefficiency. For example, in the presence of moral hazard, the first-best is often infeasible and optimal contracts induce inefficient investment. However, we still expect that forward-looking announcement can eliminate the Myers–Majluf problem, i.e. the financial contracting problem does not interfere with achieving the second-best.

To formalize these ideas, we prove a result similar to the Dybvig and Zender's result on the separation of financing and incentives. We first modify the model to incorporate hidden effort. Suppose the manager can impact the projects' outcomes by exerting costly effort, described by a vector $e = (e_1, \dots, e_n)$. In this setting, we care about more than expectations, and would like to have a general setting for the effect of information and effort on project outcomes. So, we want to allow for more than learning of μ_a and μ_b we had in the base model. Let $a = f^a(e, \zeta, \varepsilon_a)$ and $b = f^b(e, \zeta, \varepsilon_b)$, where the vector $\zeta = (\zeta_1, \dots, \zeta_m)$ is the signal obtained by the manager (the counterpart of learning (μ_a, μ_b) in the main model). Let $u(w, e)$ be the utility of the manager from wealth w and effort e. If the manager exerts any effort before renegotiation, the optimal contracts that arise in the absence of renegotiation-proofness are generally not robust to renegotiation. That is because, once effort is exerted, existing shareholders would wish to renegotiate the contract to remove costly incentives for the already-exerted effort. However, because this problem is not related to the Myers–Majluf inefficiency, in the remainder of this section we assume it away by letting the effort policy be chosen by the manager simultaneously with investment and announcement policies, after all contract negotiations are over.

Because we view the forward-looking-announcement regime as more interesting and empirically relevant, we next restate the existing shareholders' problem with this regime in mind. The same result with essentially the same proof also holds in the full transparency regime.

Problem 3 *(Existing Shareholders' Problem with Agency and Forward-looking Announcement).* The existing shareholders choose a compensation contract s_0 (for any $d, A, a+bd, P_1$ and P_2, $s_0(d, A, a+bd, P_1, P_2) \in [0, a+(b+I)d]$), an effort policy e^*, an investment plan d^*, a forward-looking-announcement policy A^*, and rational pricing rules $P_1(d, A)$ and $P_2(d, A, a+bd)$ to maximize:

$$\text{O3:} \quad E\big[P_2\big(d^*(\zeta), A^*(\zeta), a\big(e^*(\zeta), \zeta, \varepsilon_a\big) + b\big(e^*(\zeta), \zeta, \varepsilon_b\big)d^*(\zeta)\big)\big],$$

subject to:

(P3a) (Incentive Compatibility) For each ζ, setting $e = e^*(\zeta)$, $d = d^*(\zeta)$, $A = A^*(\zeta)$ solves: Choose an effort e, an investment indicator $d \in \{0, 1\}$ and a forward-looking announcement A to maximize the manager's expected utility:

$$E\big[u\big(s_0\big(d, A, a(e, \zeta, \varepsilon_a) + b(e, \zeta, \varepsilon_b)d, P_1(d, A), P_2\big(d, A, a(e, \zeta, \varepsilon_a) + b(e, \zeta, \varepsilon_b)d\big)\big), e\big) \,\big|\, \zeta\big].$$

(P3b) (Participation Constraint) Let $s_0^*(\zeta)$ be the manager's compensation at the maximum in (P3a), then

$$E\big[u\big(s_0^*(\zeta), e^*(\zeta)\big)\big] \geqslant u_0.$$

(P3c) (Rational Pricing of Existing Shares in Period 1) The rational pricing rule in period 1 is

$$P_1(d, A) = E\big[a\big(e^*(\zeta), \zeta, \varepsilon_a\big) + b\big(e^*(\zeta), \zeta, \varepsilon_b\big)d - s_0^*(\zeta) \,\big|\, d^*(\zeta) = d,\ A^*(\zeta) = A\big].$$

(P3d) (Rational Pricing of Existing Shares in Period 2) The rational pricing rule in period 2 is

$$P_2(d, A, a+bd) = \frac{P_1(d, A)}{P_1(d, A) + Id}\big(a + (b+I)d - s_0(d, A, a+bd, P_1, P_2)\big).$$

(P3e) (Renegotiation-Proofness) The contract s_0, effort policy e^*, investment plan d^*, announcement policy A^*, and rational pricing rules P_1 and P_2 are not blocked in the sense of Definition 5.

Definition 5 *(Blocking Contract).* A compensation contract s_0, an effort policy e^*, an investment plan d^*, a forward-looking-announcement strategy A^*, and rational pricing rules P_1 and P_2 that satisfy (P3a) to (P3d) are said to be **blocked** if there exist a new contract s_1 (for any $h, B, a+bh$, Q_1, and Q_2, $s_1(h, B, a+bh, Q_1, Q_2) \in [0, a+(b+I)d]$), an acceptance strategy t^*, and effort policy g^*, an investment plan h^*, a forward-looking-announcement strategy B^*, and rational pricing rules Q_1 and Q_2 such that:

(D5a) (Initiator's Higher Expected Payoff) The existing shareholders strictly prefer the deviation:

$$E\big[Q_2\big(t^*(\zeta), h^*(\zeta), B^*(\zeta), a\big(g^*(\zeta), \zeta, \varepsilon_a\big) + b\big(g^*(\zeta), \zeta, \varepsilon_b\big)h^*(\zeta)\big)\big]$$
$$> E\big[P_2\big(d^*(\zeta), A^*(\zeta), a\big(e^*(\zeta), \zeta, \varepsilon_a\big) + b\big(e^*(\zeta), \zeta, \varepsilon_b\big)d^*(\zeta)\big)\big].$$

(D5b) (Incentive Compatibility) For each ζ, setting $t = t^*(\zeta)$, $g = g^*(\zeta)$, $h = h^*(\zeta)$, and $B = B^*(\zeta)$ solves:
Choose an acceptance indicator $t \in \{0, 1\}$, an effort g, an investment indicator $h \in \{0, 1\}$, and a forward-looking announcement B to maximize the manager's expected compensation:

$$E\big[u\big(s_t\big(h, B, a(g, \zeta, \varepsilon_a) + b(g, \zeta, \varepsilon_b)h, Q_1(t, h, B), Q_2\big(t, h, B, a(g, \zeta, \varepsilon_a)$$
$$+ b(g, \zeta, \varepsilon_b)h\big)\big), e\big) \,\big|\, \zeta\big],$$

subject to if $t^*(\zeta) = 0$, then $g^*(\zeta) = e^*(\zeta)$, $B^*(\zeta) = A^*(\zeta)$, and $h^*(\zeta) = d^*(\zeta)$.

(D5c) (Rational Pricing of Existing Shares in Period 1) The pricing rule in period 1 is

$$Q_1(t, h, B) = \begin{cases} P_1(h, B), & \text{if } t = 0, \\ E[a(e^*(\zeta), \zeta, \varepsilon_a) + b(e^*(\zeta), \zeta, \varepsilon_b)h \\ \quad - s_t^*(\zeta) \mid t^*(\zeta) = t,\ h^*(\zeta) = h,\ B^*(\zeta) = B], & \text{otherwise}, \end{cases}$$

where $s_1^*(\zeta)$ is the manager's compensation at the maximum in (D5b) when the manager accepts the new offer, and $P_1(h, B)$ is defined in (P3c).

(D5d) (Rational Pricing of Existing Shares in Period 2) The pricing rule in period 2 is

$$Q_2(t, h, B, a + bh)$$
$$= \frac{Q_1(t, h, B)}{Q_1(t, h, B) + Ih}\big(a + (b + I)h - s_t(h, B, a + bh, Q_1, Q_2)\big).$$

Note that the above definition of blocking contract has a new assumption within (D5b), which requires the manager, if indifferent, to act according to the original plan when $t^* = 0$. This assumption is in the spirit of assuming truth-telling when the agent is indifferent, but a bit stronger. Below, we will discuss relaxing this assumption.

The Myers–Majluf problem in our setting is modeled as a failure of renegotiation proofness. Thus, if we remove the renegotiation-proofness condition (P3e) from Problem 3, we will obtain a second-best solution that is not subject to the Myers–Majluf problem. The following theorem shows that in the forward-looking-announcement regime, we can do just as well with the renegotiation-proofness constraint.

Theorem 4. *Suppose there is a solution to Problem* 3 *with the renegotiation-proofness constraint* (P3e) *removed. Then, there is also a solution to the full Problem* 3 *giving the same value to the existing shareholders' objective* (O3) *and with the same effort and investment policies. In this sense, allowing forward-looking announcements solves the Myers–Majluf problem.*

Proof. See Appendix A. □

Intuitively, the existence of direct mechanisms equivalent to both the original contract s_0^* and the blocking contract s_1 allows us to obtain a truthful announcement policy regardless of renegotiations. Combined with the disclosure of the new contract when there is a change, truthful announcement ensures that market prices are unbiased and new investors earn zero returns. Because the manager will not accept a proposal that reduces the manager's utility, and a new contract cannot improve the expected total value of the firm, the existing shareholders cannot gain from initiating renegotiation.

A weakness of this result is the new assumption within (D5b), requiring the manager to adhere to the original reporting strategy, investment, and effort plans, if indifferent, when $t^* = 0$. We could use a penalty for false reporting like the penalty in (2) to solve this problem but to do so we need some additional assumptions and a more complex model. First, we need the manager's incentives for choosing $e^*(\zeta)$ and $d^*(\zeta)$ to be strict in a strong enough sense so that a sufficiently small penalty does not change the choice by much. Otherwise, for example, if the agent is always indifferent about the investment choice d, any penalty for misreporting could make the manager's choice completely different. Second, we need to address a closure problem that arises due to the manager's risk aversion. With a risk averse manager, any penalty to enforce truth-telling reduces welfare. Thus, the maximum value is achieved only in the limit when the penalty gets small. Moreover, any contract with a penalty can be blocked by cutting the penalty in half, which reduces the welfare loss but retains the incentive for truthful reporting. We can solve the closure problem by using a notion of ϵ-renegotiation-proofness (renegotiation is successful only if it improves the existing shareholders' wealth by at least ϵ) and by restating Theorem 4 to saying the there exists a solution to the full problem, Problem 3, that achieves the objective value that is arbitrarily close to the original value.

7. Empirical implications and the existing empirical evidence

There are some empirical hypotheses motivated by our main model discussed in Section 3.

Hypothesis 1. Allowing forward-looking announcements improves efficiency.

Hypothesis 2. If forward-looking announcements are permitted, managers will reveal their best forecasts.

Hypothesis 3. At the time of a forward-looking announcement, prices are efficient with respect to public information and manager's information.

Hypothesis 4. If manager's information is incorporated into prices, investment efficiency is improved.

Hypothesis 5. Improvements in compensation disclosure may decrease firm value when managers are unable or do not have incentives to reveal their best forecasts.

Hypothesis 1, motivated by the result in Theorem 1, is the main hypothesis. It asserts that investment is efficient if the manager is allowed to make forward-looking announcements. Hypotheses 2 through 4 are useful for diagnostic purpose when Hypothesis 1 fails. By Theorem 1 and its corollary, a contract that induces a truthful announcement or a monotone transformation can yield efficient pricing, as reflected in Hypotheses 2 and 3.[14,15] Hypothesis 4 asserts that such a contract improves investment efficiency. Hypothesis 5 follows from the argument, discussed at the end of Section 3, that Example 1 in Appendix A is typical. In this example, offering compensation which varies one-to-one with firm value when investment occurs is prohibitively expensive. With limited disclosure, every renegotiation-proof contract varies one-to-one with firm value in states in which investment occurs and therefore, the firm foregoes some profitable investment projects. This results in an investment policy that is even less efficient than the investment policy under no disclosure.

The most relevant empirical evidence in the existing literature is offered in Lo [14]. Lo finds that the increased requirements on compensation disclosure implemented in 1992 have improved shareholders' wealth. While it appears to be consistent with our model, it is not a direct test of any of the above hypotheses. In general, the existing empirical literature analyzing disclosure largely focuses on the relationship between disclosure and the cost of capital. A number of papers find that sustained and reliable disclosure appears to mitigate informational asymmetry and improve efficiency. For example, Lang and Lundholm [13] find that long-term abnormal returns from sustained forward-looking disclosure prior to SEOs are greater than those from temporary increases in disclosure, which in turn are greater than those from consistently low disclosure.[16] Additionally, Korajczyk, Lucas, and McDonald [11] document that equity issues tend to follow credible information releases when the market is most informed about the quality of the firm. A negative relationship between accounting disclosure and the cost of capital is shown in Botosan [3] and Piotroski [21]. While this literature supports our model implication that disclosure generally improves efficiency, more empirical investigation is necessary to test our model directly.

8. Conclusion

Corporate disclosures have endogenous information content that depends on incentives within the firm. Although this is true to some extent for almost all disclosures (for example, accounting disclosures are subject to manipulation), it is especially true for disclosure of compensation and disclosure of forward-looking announcements because the meaning of these disclosures is very sensitive to the context. We look at the effectiveness of various disclosure regimes in eliminating the Myers–Majluf problem in a model with optimal negotiation-proof contracts. We find that permitting a firm to make a forward-looking announcement solves the Myers–Majluf problem if the compensation contract is disclosed to investors and the contract is optimally designed (to induce truth-telling and to neutralize the manager to intermediate price). In the absence of a forward-looking announcement, compensation disclosure of only accepted contracts is not very helpful unless all contract negotiations between the existing shareholders and the manager are made fully

[14] Note that, in practice, the announcement policy is affected not only by explicit penalties and rewards for forecast quality but also by stock ownership, reputation, and career concerns.

[15] Hypothesis 3 can be implemented by testing (e.g. using GMM) the moment condition. In particular, if there is an earnings announcement at time t, then

$$E\left[\left(P_t - \frac{\xi_{t+1} P_{t+1}}{\xi_t}\right) f(I_t)\right] = 0,$$

where P_t is the all-inclusive stock price (adjusting for dividends and splits, etc.), ξ_t is the state price density (stochastic discount factor or pricing kernel) and $f(I_t)$ is a function of public information and the manager's information.

[16] Arguably, this result may have a problem with causality if good firms disclose more.

transparent to the market. These results hold whether shareholders or informed managers initiate any renegotiation.

Our results also show that allowing a finite number of rounds of renegotiation in equilibrium (with renegotiation-proofness at the end) is not sufficient to solve the Myers–Majluf problem. It is an interesting open question whether the Myers–Majluf problem disappears in the limit as the number of rounds of renegotiation in equilibrium increases.

An interesting alternative to our formulation would allow shareholders to offer a menu of contracts that the manager could choose from after becoming informed. Given a menu, the manager's choice of contract might or might not convey a lot of information. Unfortunately, menus pose subtle modeling difficulties: for example, we do not even know how to define renegotiation-proofness in this case.[17]

Arguably, our results also point out that avoiding the Myers–Majluf problem requires more stringent disclosure standards than one might expect; in particular, disclosing realized compensation instead of compensation schemes is not sufficient. The new SEC requirement on disclosing bonus formulas made a useful step in this direction. Our results also give support to allowing forward-looking announcements. However, this support comes with a warning: if the determination of compensation in practice is not consistent with the optimal contracting assumed in the model, there is no reason to expect any benefit from allowing forward-looking announcements and traditional concerns about misleading investors could be valid.

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Appendix A

The proof of Theorem 1 focuses on the renegotiation-proofness of the proposed contract. Lemma 2 ensures that contract s_{fla} induces the manager to invest efficiently and to announce truthfully and thereby maximizes the existing shareholders' expected terminal wealth. Lemmas 1 and 3 state that the existing shareholders' expected terminal wealth equals the expected intrinsic value of the firm less the manager's compensation given corresponding pricing rules.

Proof of Theorem 1. Let $s_{fla}(d, A, a+bd, P_1, P_2)$ be defined by (1) with parameters α, β, and η such that[18]

[17] Investor expectations conditional on acceptance of a blocking contract depend on the menu that is offered and not just the contract observed by the investors.

[18] Given the assumption that $u_0 \leqslant v$, one can choose, for example, $\alpha = u_0$, $\eta = E[a + bd_{fb}]$, and β smaller than both $\frac{v-u_0}{v}$ and $\frac{u_0}{(I-v)+\eta(\bar{a}+\bar{b}+I-v)^2/\mathrm{var}(\varepsilon_a)}$ (the former ensures that compensation is below the firm value and the latter ensures that compensation is always nonnegative).

(i) for all admissible values of d, A, P_1, P_2, a and b, the compensation is admissible:

$$0 \leqslant s_{fla}(d, A, a + bd, P_1, P_2) \leqslant a + (b + I)d;$$

(ii) given efficient investment d_{fb} and truthful forward-looking announcement A_{fb}, the unconditional expected compensation satisfies the manager's participation constraint:

$$E\big[s_{fla}(d_{fb}, A_{fb}, a + bd_{fb}, P_1, P_2)\big] = u_0.$$

The market prices P_1 and P_2 defined by (P1c) and (P1d) are uniquely determined because s_{fla} does not depend on P_1 and P_2. Lemma 2 shows that s_{fla}, d_{fb}, A_{fb}, P_1, and P_2 maximize the existing shareholders' expected payoff subject to constraints (P1a)–(P1d). We next show that these functions also satisfy the constraint (P1e). This last step allows us to conclude that s_{fla}, d_{fb}, A_{fb}, P_1, and P_2 maximize the existing shareholders' expected payoff subject to constraints (P1a)–(P1e) and thus solve Problem 1.

Constraint (P1e) requires us to prove that there does not exist a deviation contract that blocks s_{fla} in the sense of Definition 1. Suppose, to the contrary, that the deviation s_1 blocks s_{fla}. Applying Lemmas 1 and 3 to (D1a), we have

$$E\big[a + bh^*(\mu_a, \mu_b)\big] - E\big[s_t^*(\mu_a, \mu_b)\big] > E\big[a + bd_{fb}(\mu_a, \mu_b)\big] - E\big[s_{fla}^*(\mu_a, \mu_b)\big]. \tag{3}$$

Since $E[a + bh(\mu_a, \mu_b)]$ is maximized by $d_{fb}(\mu_a, \mu_b)$, we have

$$E\big[a + bh^*(\mu_a, \mu_b)\big] \leqslant E\big[a + bd_{fb}(\mu_a, \mu_b)\big]. \tag{4}$$

Moreover, the manager always has the option to stay with the original contract s_{fla}, which is independent of prices. Thus, we have

$$E\big[s_t^*(\mu_a, \mu_b)\big] \geqslant E\big[s_{fla}^*(\mu_a, \mu_b)\big]. \tag{5}$$

Combining (4) and (5), we conclude that (3) does not hold. Therefore, contract s_{fla} is not blocked. □

Lemma 1. *If P_1 and P_2 satisfy* (P1c) *and* (P1d)*, then*

$$E\big[P_2\big(d^*(\mu_a, \mu_b), A^*(\mu_a, \mu_b), a + bd^*(\mu_a, \mu_b)\big)\big] = E\big[a + bd^*(\mu_a, \mu_b)\big] - E\big[s_0^*(\mu_a, \mu_b)\big].$$

Proof. Substituting for P_2 from (P1d), we have

$$\begin{aligned} &E\big[P_2\big(d^*(\mu_a, \mu_b), A^*(\mu_a, \mu_b), a + bd^*(\mu_a, \mu_b)\big)\big] \\ &\quad = E\bigg[\frac{P_1(d^*(\mu_a, \mu_b), A^*(\mu_a, \mu_b))}{P_1(d^*(\mu_a, \mu_b), A^*(\mu_a, \mu_b)) + Id^*(\mu_a, \mu_b)} \\ &\qquad \times \big(a + (b + I)d^*(\mu_a, \mu_b) - s_0^*(\mu_a, \mu_b)\big)\bigg] \\ &\quad = E\bigg[E\bigg[\frac{P_1(d^*(\mu_a, \mu_b), A^*(\mu_a, \mu_b))}{P_1(d^*(\mu_a, \mu_b), A^*(\mu_a, \mu_b)) + Id^*(\mu_a, \mu_b)} \\ &\qquad \times \big(a + (b + I)d^*(\mu_a, \mu_b) - s_0^*(\mu_a, \mu_b)\big) \,\Big|\, d^*(\mu_a, \mu_b) = d,\ A^*(\mu_a, \mu_b) = A\bigg]\bigg] \end{aligned}$$

$$= E\left[\frac{P_1(d^*(\mu_a,\mu_b), A^*(\mu_a,\mu_b))}{P_1(d^*(\mu_a,\mu_b), A^*(\mu_a,\mu_b)) + Id^*(\mu_a,\mu_b)} \times E\left[a + (b+I)d^*(\mu_a,\mu_b) - s_0^*(\mu_a,\mu_b) \,\middle|\, d^*(\mu_a,\mu_b) = d,\ A^*(\mu_a,\mu_b) = A\right]\right]$$
$$= E\left[E\left[a + bd^*(\mu_a,\mu_b) - s_0^*(\mu_a,\mu_b) \,\middle|\, d^*(\mu_a,\mu_b) = d,\ A^*(\mu_a,\mu_b) = A\right]\right]$$
$$= E\left[a + bd^*(\mu_a,\mu_b)\right] - E\left[s_0^*(\mu_a,\mu_b)\right],$$

where the third equality is derived by taking $\frac{P_1(d,A)}{P_1(d,A)+Id}$ out of the inner expectation. This is possible because $P_1(d,A)$ depends only on d and A, which are included in the conditioning set of the inner expectation. The fourth equality is derived by substituting for P_1 from (P1c). □

Lemma 2. *The compensation contract s_{fla} (as defined in the proof of Theorem 1), the investment strategy $d_{fb}(\mu_a,\mu_b)$, the forward-looking-announcement policy $A_{fb}(\mu_a,\mu_b)$ and prices P_1 and P_2 defined by (P1c) and (P1d) maximize the existing shareholders' expected payoff subject to constraints (P1a)–(P1d).*

Proof. Constraints (P1c) and (P1d) obtain immediately from the definition of P_1 and P_2. The manager's participation constraint (P1b) is satisfied by the definition of α, β and η. It remains to verify constraint (P1a). For each μ_a and μ_b, the manager chooses d and A to maximize

$$E\left[s_{fla}\big(d, A, a+bd, P_1(d,A), P_2(d,A,a+bd)\big) \,\middle|\, \mu_a,\mu_b\right]$$
$$= \alpha + \beta E\left[a + bd - \eta\frac{(a+bd-A)^2}{\operatorname{var}(\varepsilon_a+\varepsilon_b d)} \,\middle|\, \mu_a,\mu_b\right]$$
$$= \alpha + \beta(\mu_a+\mu_b d) - \beta\eta\frac{\operatorname{var}(\varepsilon_a+\varepsilon_b d) + (\mu_a+\mu_b d - A)^2}{\operatorname{var}(\varepsilon_a+\varepsilon_b d)},$$

where the second equality is derived by adding $(\mu_a+\mu_b d)$ to and subtracting $(\mu_a+\mu_b d)$ from the numerator $(a+bd-A)$. Hence, for any d, forward-looking announcement $A = \mu_a+\mu_b d$ minimizes the penalty and thereby maximizes $E[s_{fla} \mid \mu_a,\mu_b]$. Substituting for A, we obtain

$$E[s_{fla} \mid \mu_a,\mu_b] = \alpha + \beta(\mu_a+\mu_b d) - \beta\eta.$$

Therefore, d_{fb} and A_{fb} maximize $E[s_{fla} \mid \mu_a,\mu_b]$. From Lemma 1, the existing shareholders' expected payoff is

$$E\left[P_2\big(d_{fb}(\mu_a,\mu_b), a + bd_{fb}(\mu_a,\mu_b)\big)\right] = E\left[a + bd_{fb}(\mu_a,\mu_b)\right] - E\left[s_{fla}^*(\mu_a,\mu_b)\right].$$

Because $d_{fb}(\mu_a,\mu_b)$ maximizes $E[a + bd(\mu_a,\mu_b)]$ and $E[s_{fla}^*(\mu_a,\mu_b)] = u_0$, functions s_{fla}, d_{fb}, A_{fb}, P_1, and P_2 maximize $E[P_2]$. □

Lemma 3. *If Q_1 and Q_2 satisfy (D1c) and (D1d) and the manager's initial compensation is described by s_{fla}, then*

$$E\left[Q_2\big(t^*(\mu_a,\mu_b), h^*(\mu_a,\mu_b), B^*(\mu_a,\mu_b), a + bh^*(\mu_a,\mu_b)\big)\right]$$
$$= E\left[a + bh^*(\mu_a,\mu_b)\right] - E\left[s_t^*(\mu_a,\mu_b)\right]. \tag{6}$$

Proof. Substituting for Q_2 from (D1d), the left-hand side of (6) can be rewritten as

$$\begin{aligned}
&E\big[Q_2\big(t^*(\mu_a,\mu_b),h^*(\mu_a,\mu_b),B^*(\mu_a,\mu_b),a+bh^*(\mu_a,\mu_b)\big)\big]\\
&\quad= E\bigg[\frac{Q_1(t^*(\mu_a,\mu_b),h^*(\mu_a,\mu_b),B^*(\mu_a,\mu_b))}{Q_1(t^*(\mu_a,\mu_b),h^*(\mu_a,\mu_b),B^*(\mu_a,\mu_b))+Ih^*(\mu_a,\mu_b)}\\
&\qquad\times\big(a+(b+I)h^*(\mu_a,\mu_b)-s_t^*(\mu_a,\mu_b)\big)\bigg]\\
&\quad= E\bigg[E\bigg[\frac{Q_1(t^*(\mu_a,\mu_b),h^*(\mu_a,\mu_b),B^*(\mu_a,\mu_b))}{Q_1(t^*(\mu_a,\mu_b),h^*(\mu_a,\mu_b),B^*(\mu_a,\mu_b))+Ih^*(\mu_a,\mu_b)}\\
&\qquad\times\big(a+(b+I)h^*(\mu_a,\mu_b)\\
&\qquad-s_t^*(\mu_a,\mu_b)\big)\,\Big|\,t^*(\mu_a,\mu_b)=t,\ h^*(\mu_a,\mu_b)=h,\ B^*(\mu_a,\mu_b)=B\bigg]\bigg]\\
&\quad= E\bigg[\frac{Q_1(t^*(\mu_a,\mu_b),h^*(\mu_a,\mu_b),B^*(\mu_a,\mu_b))}{Q_1(t^*(\mu_a,\mu_b),h^*(\mu_a,\mu_b),B^*(\mu_a,\mu_b))+Ih^*(\mu_a,\mu_b)}\\
&\qquad\times E\big[a+(b+I)h^*(\mu_a,\mu_b)\\
&\qquad-s_t^*(\mu_a,\mu_b)\,\big|\,t^*(\mu_a,\mu_b)=t,\ h^*(\mu_a,\mu_b)=h,\ B^*(\mu_a,\mu_b)=B\big]\bigg],
\end{aligned}\tag{7}$$

where the third equality is derived by taking $\frac{Q_1(t,h,B)}{Q_1(t,h,B)+Ih}$ out of the inner expectation. This is possible because $Q_1(t,h,B)$ depends only on t, h, and B, which are included in the conditioning set of the inner expectation.

To complete the proof, we need to show that

$$\begin{aligned}
Q_1(t,h,B) = E\big[&a+bh^*(\mu_a,\mu_b)\\
&-s_t^*(\mu_a,\mu_b)\,\big|\,t^*(\mu_a,\mu_b)=t,\ h^*(\mu_a,\mu_b)=h,\ B^*(\mu_a,\mu_b)=B\big].
\end{aligned}\tag{8}$$

It directly follows from (D1c) that (8) holds when $t^*(\mu_a,\mu_b)=1$. We will show that (8) also holds when $t^*(\mu_a,\mu_b)=0$. According to Lemma 2, the manager chooses $h^*(\mu_a,\mu_b)=d_{fb}(\mu_a,\mu_b)$ and announces truthfully given contract s_{fla}: $B^*(\mu_a,\mu_b)=A_{fb}(\mu_a,\mu_b)=\mu_a+\mu_b d_{fb}(\mu_a,\mu_b)$. Therefore, we have

$$\begin{aligned}
&Q_1(0,h,B)\\
&\quad= E\big[a+bd_{fb}(\mu_a,\mu_b)\,\big|\,d_{fb}(\mu_a,\mu_b)=h,\ \mu_a+\mu_b d_{fb}(\mu_a,\mu_b)=B\big]\\
&\qquad- E\big[s_{fla}^*(\mu_a,\mu_b)\,\big|\,d_{fb}(\mu_a,\mu_b)=h,\ \mu_a+\mu_b d_{fb}(\mu_a,\mu_b)=B\big]\\
&\quad= B-\alpha-\beta E\bigg[\mu_a+\varepsilon_a+(\mu_b+\varepsilon_b)h\\
&\qquad-\eta\frac{(\mu_a+\varepsilon_a+(\mu_b+\varepsilon_b)h-B)^2}{\operatorname{var}(\varepsilon_a+\varepsilon_b h)}\,\bigg|\,d_{fb}(\mu_a,\mu_b)=h,\ \mu_a+\mu_b d_{fb}(\mu_a,\mu_b)=B\bigg]\\
&\quad= (1-\beta)B-\alpha+\beta\eta E\bigg[\frac{(\varepsilon_a+\varepsilon_b h)^2}{\operatorname{var}(\varepsilon_a+\varepsilon_b h)}\bigg]\\
&\quad= (1-\beta)B-\alpha+\beta\eta,
\end{aligned}$$

where the second equality is derived by using the definition of s_{fla} given by (1).

The right-hand side of (8) can also be reduced to the same expression:

$$E\big[a+bh-s_t^*(\mu_a,\mu_b)\,\big|\,t^*(\mu_a,\mu_b)=0,\ h^*(\mu_a,\mu_b)=h,\ B^*(\mu_a,\mu_b)=B\big]$$
$$=E\big[\mu_a+\varepsilon_a+(\mu_b+\varepsilon_b)h$$
$$-s_{fla}^*(\mu_a,\mu_b)\,\big|\,t^*(\mu_a,\mu_b)=0,\ h^*(\mu_a,\mu_b)=h,\ \mu_a+\mu_b h^*(\mu_a,\mu_b)=B\big]$$
$$=(1-\beta)B-\alpha+\beta\eta.$$

Therefore, we obtain

$$Q_1(0,h,B)$$
$$=E\big[a+bh-s_t^*(\mu_a,\mu_b)\,\big|\,t^*(\mu_a,\mu_b)=0,\ h^*(\mu_a,\mu_b)=h,\ B^*(\mu_a,\mu_b)=B\big].$$

This proves that (8) holds. Substituting (8) into (7), we obtain (6).

Lemma 3 crucially depends on the assumptions on contract disclosure and forward-looking announcement: truthful forward-looking announcement complements the weaker contract disclosure requirement that allows the rejected proposal to be unobserved by the market. □

The proof of Theorem 2 uses the results in Lemmas 4 and 5 (below), which ensure that the expected terminal wealth of the existing shareholders equals the expected intrinsic value of the firm less the manager's compensation given corresponding pricing rules. Because forward-looking announcement is prohibited ($A\equiv 0$), we omit forward-looking announcement A in the proof of Theorem 2, and Lemmas 4 and 5.

Proof of Theorem 2. Let $s_{tn}(d,a+bd,P_1,P_2)=\alpha+\beta(a+bd)$, where $\beta=\frac{u_0}{E[a+bd_{fb}]+(I-\nu)}$ ($\leqslant\frac{\nu}{I}$) and $\alpha=\beta(I-\nu)$.[19] For these choices, compensation is admissible, i.e., (i) for all $d\in\{0,1\}$, P_1, P_2, $a\geqslant\nu$ and $b\geqslant -I$, $0\leqslant s_{tn}(d,a+bd,P_1,P_2)\leqslant a+(b+I)d$; and (ii) given efficient investment d_{fb}, the manager's participation constraint is satisfied: $E[\alpha+\beta(a+bd_{fb})]=u_0$. The market prices P_1 and P_2 defined by (P1c) and (P1d) are unique because s_{tn} does not depend on P_1 and P_2. We will prove that s_{tn}, d_{fb}, P_1 and P_2 maximize the existing shareholders's expected payoff (O1) subject to (P1a)–(P1e) by showing that these functions maximize (O1) subject to (P1a)–(P1d) and also satisfy (P1e).

Conditional on μ_a and μ_b, the expected compensation of the manager equals $\alpha+\beta(\mu_a+\mu_b d)$ which is maximized by the efficient investment policy d_{fb}. Hence, the incentive compatibility constraint (P1a) is satisfied. From the choice of α and β, the manager's participation constraint (P1b) is also satisfied. Constraints (P1c) and (P1d) are satisfied by the definition of P_1 and P_2. Using Lemma 4, we can express the existing shareholder's payoff as

$$E\big[P_2\big(d_{fb}(\mu_a,\mu_b),a+bd_{fb}(\mu_a,\mu_b)\big)\big]=E\big[a+bd_{fb}(\mu_a,\mu_b)\big]-E\big[s_{tn}^*(\mu_a,\mu_b)\big].$$

Because $d_{fb}(\mu_a,\mu_b)$ maximizes $E[a+bd(\mu_a,\mu_b)]$ and $E[s_{tn}^*(\mu_a,\mu_b)]=u_0$, functions s_{tn}, d_{fb}, P_1, and P_2 maximize the expected payoff of the existing shareholders. Thus, it remains only to

[19] Without loss of generality, we assume $\nu<I$. Values of α and β are chosen by solving the reservation utility equation $u_0=\alpha+\beta E[a+bd_{fb}]$ and making the worst-case compensation $\alpha+\beta(\nu-I)=0$. The assumption $u_0\leqslant\nu$ implies that the firm has sufficient resources to retain the manager. In particular, when $d=0$, we have $\alpha+\beta a=\beta(I-\nu+a)\leqslant a$ for all a because $\beta\leqslant\nu/I$ by construction. When $d=1$, we have $\alpha+\beta(a+b)=\beta(I-\nu+a+b)<\beta(a+(b+I))<a+(b+I)$.

show that these functions satisfy (P1e), i.e., that s_{tn} is renegotiation-proof as defined in Definition 1.

Suppose that, on the contrary, a deviation s_1 blocks s_{tn}. Applying Lemmas 4 and 5 to constraint (D1a), we have that the blocking contract must satisfy

$$E\left[a+bh^*(\mu_a,\mu_b)\right]-E\left[s_t^*(\mu_a,\mu_b)\right]>E\left[a+bd_{fb}(\mu_a,\mu_b)\right]-E\left[s_{tn}^*(\mu_a,\mu_b)\right]. \tag{9}$$

Since $E[a+bd(\mu_a,\mu_b)]$ is maximized by $d_{fb}(\mu_a,\mu_b)$, we have

$$E\left[a+bh^*(\mu_a,\mu_b)\right]\leqslant E\left[a+bd_{fb}(\mu_a,\mu_b)\right]. \tag{10}$$

Moreover, because s_{tn} is independent of prices, the manager's expected compensation when deviation is possible is at least as large as when deviation is not an option:

$$E\left[s_t^*(\mu_a,\mu_b)\right]\geqslant E\left[s_{tn}^*(\mu_a,\mu_b)\right]. \tag{11}$$

Combining (10) and (11), we conclude that (9) does not hold. Therefore, the contract s_{tn} is not blocked. □

Lemma 4. *If P_1 and P_2 satisfy* (P1c) *and* (P1d), *then*

$$E\left[P_2\left(d^*(\mu_a,\mu_b),a+bd^*(\mu_a,\mu_b)\right)\right]=E\left[a+bd^*(\mu_a,\mu_b)\right]-E\left[s_0^*(\mu_a,\mu_b)\right].$$

Proof. Substituting for P_2 from (P1d), we have

$$\begin{aligned}
&E\left[P_2\left(d^*(\mu_a,\mu_b),a+bd^*(\mu_a,\mu_b)\right)\right]\\
&\quad=E\left[\frac{P_1(d^*(\mu_a,\mu_b))}{P_1(d^*(\mu_a,\mu_b))+Id^*(\mu_a,\mu_b)}\left(a+(b+I)d^*(\mu_a,\mu_b)-s_0^*(\mu_a,\mu_b)\right)\right]\\
&\quad=E\left[E\left[\frac{P_1(d^*(\mu_a,\mu_b))}{P_1(d^*(\mu_a,\mu_b))+Id^*(\mu_a,\mu_b)}\right.\right.\\
&\qquad\left.\left.\times\left(a+(b+I)d^*(\mu_a,\mu_b)-s_0^*(\mu_a,\mu_b)\right)\,\Big|\,d^*(\mu_a,\mu_b)=d\right]\right]\\
&\quad=E\left[\frac{P_1(d^*(\mu_a,\mu_b))}{P_1(d^*(\mu_a,\mu_b))+Id^*(\mu_a,\mu_b)}\right.\\
&\qquad\left.\times E\left[\left(a+(b+I)d^*(\mu_a,\mu_b)-s_0^*(\mu_a,\mu_b)\right)\,\Big|\,d^*(\mu_a,\mu_b)=d\right]\right]\\
&\quad=E\left[E\left[a+bd^*(\mu_a,\mu_b)-s_0^*(\mu_a,\mu_b)\,\Big|\,d^*(\mu_a,\mu_b)=d\right]\right]\\
&\quad=E\left[a+bd^*(\mu_a,\mu_b)\right]-E\left[s_0^*(\mu_a,\mu_b)\right],
\end{aligned}$$

where the third equality is derived by taking $\frac{P_1(d)}{P_1(d)+Id}$ out of the inner expectation. This is possible because $P_1(d)$ depends only on d, which is included in the conditioning set of the inner expectation. The fourth equality is derived by substituting for P_1 from (P1c). □

Lemma 5. *If Q_1 and Q_2 satisfy* (D1c) *and* (D1d), *then*

$$\begin{aligned}
&E\left[Q_2\left(t^*(\mu_a,\mu_b),h^*(\mu_a,\mu_b),a+bh^*(\mu_a,\mu_b)\right)\right]\\
&\quad=E\left[a+bh^*(\mu_a,\mu_b)\right]-E\left[s_t^*(\mu_a,\mu_b)\right].
\end{aligned}$$

Proof. Substituting for Q_2 from (D1d), we have

$$\begin{aligned}
&E\big[Q_2\big(t^*(\mu_a,\mu_b), h^*(\mu_a,\mu_b), a+bh^*(\mu_a,\mu_b)\big)\big] \\
&\quad= E\bigg[\frac{Q_1(t^*(\mu_a,\mu_b), h^*(\mu_a,\mu_b))}{Q_1(t^*(\mu_a,\mu_b), h^*(\mu_a,\mu_b)) + Ih^*(\mu_a,\mu_b)} \\
&\qquad\times \big(a+(b+I)h^*(\mu_a,\mu_b) - s_t^*(\mu_a,\mu_b)\big)\bigg] \\
&\quad= E\bigg[E\bigg[\frac{Q_1(t^*(\mu_a,\mu_b), h^*(\mu_a,\mu_b))}{Q_1(t^*(\mu_a,\mu_b), h^*(\mu_a,\mu_b)) + Ih^*(\mu_a,\mu_b)} \\
&\qquad\times \big(a+(b+I)h^*(\mu_a,\mu_b) - s_t^*(\mu_a,\mu_b)\big) \,\Big|\, t^*(\mu_a,\mu_b)=t,\ h^*(\mu_a,\mu_b)=h\bigg]\bigg] \\
&\quad= E\bigg[\frac{Q_1(t^*(\mu_a,\mu_b), h^*(\mu_a,\mu_b))}{Q_1(t^*(\mu_a,\mu_b), h^*(\mu_a,\mu_b)) + Ih^*(\mu_a,\mu_b)} \\
&\qquad\times E\big[\big(a+(b+I)h^*(\mu_a,\mu_b) - s_t^*(\mu_a,\mu_b)\big) \,\big|\, t^*(\mu_a,\mu_b)=t,\ h^*(\mu_a,\mu_b)=h\big]\bigg] \\
&\quad= E\big[E\big[a+bh^*(\mu_a,\mu_b) - s_t^*(\mu_a,\mu_b) \,\big|\, t^*(\mu_a,\mu_b)=t,\ h^*(\mu_a,\mu_b)=h\big]\big] \\
&\quad= E\big[a+bh^*(\mu_a,\mu_b)\big] - E\big[s_t^*(\mu_a,\mu_b)\big],
\end{aligned}$$

where the third equality is derived by taking $\frac{Q_1(t,h)}{Q_1(t,h)+Ih}$ out of the inner expectation and the fourth equality is derived by substituting for $Q_1(t,h)$ from (D1c).

The second equality is the key step for proving Lemma 5. It relies on the requirement that the newly offered contract s_1 is revealed to the market, as defined in condition (D1c). Consequently, the existing shareholders know that new investors will price the shares correctly and therefore they expect the new investors to receive zero returns on their investment. The result does not hold (as shown by Persons) if the market is not aware of the renegotiation between the existing shareholders and the manager. □

Here is the result showing that the Myers–Majluf problem is not resolved by disclosure of the compensation contract alone. Proving this is surprisingly tricky because the inefficiency disappears sometimes. We prove that only degenerate contracts, efficient or inefficient, can be renegotiation-proof. The sense of degeneracy is that, given new investment is undertaken, the manager's contract is like a residual claim in that the manager's compensation varies one-to-one with firm value. In other words, a contract is degenerate if, given that new investment is undertaken, firm value net of the manager's claim is constant.

Claim 1. *Suppose only accepted contracts are disclosed to the market and forward-looking announcement is prohibited. Call a solution degenerate if* $\Pr(d^*=1)=0$ *or if the conditional expectation of the market value of the firm,* $E[a+(b+I)d^* - s_0^*(\mu_a,\mu_b) \mid \mu_a,\mu_b,d^*=1]$*, is a constant and does not depend on* μ_a *and* μ_b*. Then, every solution to the existing shareholders' problem* (*Problem* 1 *with* $\lambda=0$ *and* $\kappa=0$) *is degenerate.*

Proof. We will show that if a non-degenerate solution (a contract s_0, an investment d^* and rational pricing rules P_1 and P_2) satisfies (P1a)–(P1d) with $A(\mu_a,\mu_b)\equiv 0$, then there exists a new offer (s_1, t^*, h^*, Q_1 and Q_2) that blocks the solution (s_0, d^*, P_1 and P_2) in the sense of Definition 1 with $B^*(\mu_a, \mu_b) \equiv 0$. We drop A and B in the rest of the proof because these variables are identically 0 – no forward-looking announcement is allowed.

Specifically, we construct the following new offer. Let

$$s_1(h, a+bh, Q_1, Q_2) = s_0\big(h, a+bh, P_1(h), P_2(h, a+bh)\big).$$

Let investment policy $h^*(\mu_a, \mu_b)$ be equal to $d^*(\mu_a, \mu_b)$ for any μ_a and μ_b and let the acceptance strategy be

$$t^*(\mu_a, \mu_b) = \begin{cases} 1, & E[a + bd^*(\mu_a, \mu_b) - s_0^*(\mu_a, \mu_b) - P_1(1) \mid \mu_a, \mu_b] > 0; \\ 0, & \text{otherwise.} \end{cases} \tag{12}$$

Additionally, let $Q_1(t, h)$ and $Q_2(t, h, a+bh)$ be given by (D1c) and (D1d). Notice that t^* and h^* defined above satisfy (D1b) given that the investment policy h^*, same as d^*, is an optimal choice and the acceptance strategy t^* given by (12) maximizes the manager's expected payoff. The acceptance of a new contract indicates to new investors that the firm is more valuable than they originally thought.

To prove that the initial solution is blocked, it remains to verify (D1a), which states that the offer would make existing shareholders strictly better off. In the states where the manager chooses $t^* = 0$, we have exactly the same outcome. We need to consider what happens when $t^* = 1$. Let $p_i = \Pr(d^*(\mu_a, \mu_b) = i$ and $t^*(\mu_a, \mu_b) = 1)$ for $i \in \{0, 1\}$. The existing shareholders' expected benefit from renegotiation can be expressed as

$$\begin{aligned}
&\Pr\big(t^* = 1\big) E\big[Q_2\big(t^*, h^*, a+bh^*\big) - P_2\big(d^*, a+bd^*\big) \,\big|\, t^*(\mu_a, \mu_b) = 1\big] \\
&\quad = p_1 E\bigg[\big(a + bd^*(\mu_a, \mu_b) - s_1^*(\mu_a, \mu_b)\big) - \frac{P_1(1)}{P_1(1) + I} \\
&\qquad \times \big(a + bd^*(\mu_a, \mu_b) + I - s_0^*(\mu_a, \mu_b)\big) \,\Big|\, t^*(\mu_a, \mu_b) = 1,\ d^*(\mu_a, \mu_b) = 1\bigg] \\
&\qquad + p_0 E\big[\big(a - s_1^*(\mu_a, \mu_b)\big) - \big(a - s_0^*(\mu_a, \mu_b)\big) \,\big|\, t^*(\mu_a, \mu_b) = 1,\ d^*(\mu_a, \mu_b) = 0\big] \\
&\quad = p_1 E\bigg[\big(a + bd^*(\mu_a, \mu_b) - s_0^*(\mu_a, \mu_b)\big) \\
&\qquad \times \frac{I}{P_1(1) + I} - \frac{P_1(1) I}{P_1(1) + I} \,\Big|\, t^*(\mu_a, \mu_b) = 1,\ d^*(\mu_a, \mu_b) = 1\bigg] \\
&\quad > p_1 E\bigg[P_1(1) \frac{I}{P_1(1) + I} - \frac{P_1(1) I}{P_1(1) + I} \,\Big|\, t^*(\mu_a, \mu_b) = 1,\ d^*(\mu_a, \mu_b) = 1\bigg] \\
&\quad = 0,
\end{aligned}$$

where the first equality holds according to the definition of Q_2 given in (D1d) and P_2 given in (P1d); the second equality is derived by construction: $s_1^*(\mu_a, \mu_b) = s_0^*(\mu_a, \mu_b)$ for all μ_a, μ_b; the inequality holds because of (12) when $t^* = 1$. Additionally, the non-degeneracy condition given in the statement of Theorem 1 implies that $p_1 > 0$; that is, there exist states (with a positive measure) in which the firm is more profitable than investors originally expected, and thus the manager accepts the new proposal. Therefore, the existing shareholders are strictly better off by proposing this new offer. □

Example 1. Suppose that the following project payoff realizations are possible and equally likely: $(a = 12, b = 8)$, $(a = 120, b = -100)$, $(a = 25, b = 75)$, $(a = 95, b = 5)$, $(a = 200, b = -100)$, and the probability of each is 0.2. Suppose also that the manager's reservation utility is $u_0 = 5$, the manager learns a and b precisely in period 1, and the investment required by the new project is $I = 100$. In this example, the investment under limited disclosure is less efficient than that under no disclosure.

A manager who maximizes the initial shareholders' wealth (as in Myers and Majluf) invests only in the following two states: $(a = 12, b = 8)$ and $(a = 25, b = 75)$. As shown in Persons [20] or Katz [10], the contract that induces the manager to behave on behalf of the initial shareholders is renegotiation-proof when renegotiations are fully secret (even if the new contract is accepted, it is not disclosed) and announcements are not allowed.

When accepted contracts are disclosed but forward-looking announcements are not allowed (the limited-disclosure case), Claim 1 implies that all renegotiation-proof contracts are degenerate, i.e. managerial compensation varies one-to-one with the firm value when investment is undertaken. Suppose a contract induces the efficient investment, that is, $d^* = 1$ for $(a = 25, b = 75)$, $(a = 95, b = 5)$ and $(a = 12, b = 8)$. Due to limited liability, the manager receives at least 0 in the state $(a = 12, b = 8)$. According to Claim 1, the contract is renegotiation-proof only if the manager receives at least 80 in the states $(a = 25, b = 75)$ and $(a = 95, b = 5)$ because the manager receives all change in cash flows, in this case $100 - 20 = 80$. As a result, the expected compensation exceeds the reservation level by $0.2 * 160 - 5 = 27$. Similar analysis shows that any contract which induces investment in the state $(a = 12, b = 8)$ as well as in the state $(a = 25, b = 75)$ (Myers–Majluf investment strategy) or the state $(a = 95, b = 5)$, results in the expected compensation that exceeds the reservation level by $0.2 * 80 - 5 = 11$. At the same time, the expected cash flow even under the efficient investment is only 1.6 units larger than the cash flow under the renegotiation-proof contract described below, which leaves the manager with the reservation utility level. Therefore, a contract that induces such investment is not a solution to Problem 1.

In the following, we construct a solution to Problem 1 in the limited-disclosure regime and show that under this contract, investment is less efficient than that under the Myers–Majluf contract. Consider a compensation contract specified as follows: $s(0, 12, P_1, P_2) = 10$; $s(0, 25, P_1, P_2) = 0$; $s(0, 95, P_1, P_2) = 0$; $s(0, 120, P_1, P_2) = 1$; $s(0, 200, P_1, P_2) = 12$; $s(1, 20, P_1, P_2) = 0$; $s(1, 100, P_1, P_2) = 1$. Under this contract, investment occurs ($d^* = 1$) only in the states of $(a = 25, b = 75)$ and $(a = 95, b = 5)$. The expected compensation is equal to the reservation utility of 5, satisfying the manager's participation constraint. In addition, the contract is feasible because in each state the payment to the manager is nonnegative and less than the total profit. It remains to show that such a contract is renegotiation-proof. Note that the existing shareholders can benefit from renegotiation only if it achieves the efficient investment by the Modigliani–Miller argument: the manager will accept the new contract only if he receives at least 10 in the state of $(a = 12, b = 8)$, that is, $s(1, 20, P_1, P_2) \geqslant 10$. Then, to avoid inefficient investment in the state of $(a = 120, b = -100)$, we need $s(0, 120, P_1, P_2) \geqslant s(1, 20, P_1, P_2) \geqslant 10$. As a result, under the new proposal, the expected compensation increases by at least $0.2 * 9 = 1.8$ while the expected cash flow only increases by $0.2 * 8 = 1.6$. Thus, the contract is renegotiation-proof. However, under this proposed solution to Problem 1, the expected value of existing shareholders and the manager is 1.6 units below the first-best, while the contract of Myers and Majluf results in an investment that yields only 1 unit below the first-best. Therefore, in Example 1, the limited-disclosure regime results in investment that is less efficient than that under no disclosure.

Proof of Theorem 3. The proof is very similar to that of Claim 1. We will show that if a non-degenerate solution (a contract s_0, an investment d^*, an acceptance strategy A^*, and rational pricing rules P_1 and P_2) satisfies (P2a)–(P2b), then there exists a new offer (s_1, t^*, $B^* = A^*$, h^*, Q_1 and Q_2) that blocks this solution (s_0, A^*, d^*, P_1 and P_2). Keeping in mind the constraint $B \equiv A$, let s_1 equal s_0:

$$s_1(h, A, a + bh, Q_1, Q_2) = s_0\big(h, A, a + bh, P_1(h, A), P_2(h, A, a + bh)\big).$$

Let investment policy $h^*(\mu_a, \mu_b)$ be equal to $d^*(\mu_a, \mu_b)$ for any μ_a and μ_b and let the acceptance strategy t^* be given as follows

$$t^*(\mu_a, \mu_b) = \begin{cases} 1, & E[a + bd^*(\mu_a, \mu_b) - s_0^*(\mu_a, \mu_b) - P_1(1, A^*) \mid \mu_a, \mu_b] > 0; \\ 0, & \text{otherwise.} \end{cases} \tag{13}$$

Notice that t^* and h^* defined above satisfy (D1b) given that the investment policy h^*, same as d^*, is an optimal choice and the acceptance strategy t^* given by (13) maximizes the manager's expected payoff. The acceptance of a new contract indicates to investors that the firm is more valuable than they originally thought.

To prove that the initial solution is blocked, it remains to verify (D1a), which states that the new offer makes existing shareholders strictly better off. In states in which the manager chooses $t^* = 0$, we have exactly the same outcome. We need to consider what happens when $t^* = 1$. Let $Q_1(t, h, A)$ and $Q_2(t, h, A, a + bh)$ be given by (D1c) and (D1d), respectively, and let $p_{iA} = \Pr(d^*(\mu_a, \mu_b) = i,\ t^*(\mu_a, \mu_b) = 1,\ A^* = A)$ for $i \in \{0, 1\}$ and $A \in \{0, 1\}$, the existing shareholders' expected benefit from renegotiation can be expressed as

$$\begin{aligned}
&\Pr\big(t^* = 1\big) E\big[Q_2\big(t^*, h^*, A^*, a + bh^*\big) - P_2\big(d^*, A^*, a + bd^*\big) \bigm| t^*(\mu_a, \mu_b) = 1\big] \\
&= p_{10} E\bigg[\big(a + bd^*(\mu_a, \mu_b) - s_0^*(\mu_a, \mu_b)\big)\frac{I}{P_1(1, 0) + I} \\
&\quad - \frac{P_1(1, 0)I}{P_1(1, 0) + I} \biggm| t^*(\mu_a, \mu_b) = 1,\ d^*(\mu_a, \mu_b) = 1,\ A^*(\mu_a, \mu_b) = 0\bigg] \\
&\quad + p_{11} E\bigg[\big(a + bd^*(\mu_a, \mu_b) - s_0^*(\mu_a, \mu_b)\big)\frac{I}{P_1(1, 1) + I} \\
&\quad - \frac{P_1(1, 1)I}{P_1(1, 1) + I} \biggm| t^*(\mu_a, \mu_b) = 1,\ d^*(\mu_a, \mu_b) = 1,\ A^*(\mu_a, \mu_b) = 1\bigg] \\
&> p_{10} E\bigg[P_1(1, 0)\frac{I}{P_1(1, 0) + I} \\
&\quad - \frac{P_1(1, 0)I}{P_1(1, 0) + I} \biggm| t^*(\mu_a, \mu_b) = 1,\ d^*(\mu_a, \mu_b) = 1,\ A^*(\mu_a, \mu_b) = 0\bigg] \\
&\quad + p_{11} E\bigg[P_1(1, 1)\frac{I}{P_1(1, 1) + I} \\
&\quad - \frac{P_1(1, 1)I}{P_1(1, 1) + I} \biggm| t^*(\mu_a, \mu_b) = 1,\ d^*(\mu_a, \mu_b) = 1,\ A^*(\mu_a, \mu_b) = 1\bigg] \\
&= 0,
\end{aligned}$$

where the inequality holds because $s_1^*(\mu_a,\mu_b)=s_0^*(\mu_a,\mu_b)$ for any μ_a and μ_b by construction, $E[a+bd^*(\mu_a,\mu_b)-s_0^*(\mu_a,\mu_b)-P_1(1,1)\mid t^*(\mu_a,\mu_b)=1,\ d^*(\mu_a,\mu_b)=1,\ A^*(\mu_a,\mu_b)=1]>0$ by (13), and $p_{10}+p_{11}>0$ implied by the non-degeneracy condition as stated in Claim 1. Therefore, the existing shareholders are strictly better off by proposing this new offer. □

Proof of Theorem 4. Let contract $s_0(d,A,a+bd,P_1,P_2)$, effort policy $e^*(\zeta)$, investment plan $d^*(\zeta)$, forward-looking-announcement policy $A^*(\zeta)$, and rational pricing rules $P_1(d,A)$ and $P_2(d,A,a+bd)$ maximize the existing shareholders' objective (O3) subject to (P3a)–(P3d). In the spirit of the Revelation Principle, we can define $\hat{s}_0(d,A,a+bd)\equiv s_0(d,A^*(A),a+bd,P_1(d,A^*(A)),P_2(d,A^*(A),a+bd))$, which, combined with the same effort policy $e^*(\zeta)$, the same investment policy $d^*(\zeta)$, truthful announcement policy $\hat{A}(\zeta)=\zeta$, and rational pricing rules $\hat{P}_1(d,A)$ and $\hat{P}_2(d,A,a+bd)$ specified in (P3c) and (P3d), achieves the same value of the objective (O3), and satisfies the same constraints (P3a)–(P3d). This contract $\hat{s}_0$ is a direct mechanism that leaves all agents with the same payoffs as the original contract and induces truth-telling by the manager. Next, we show that this mechanism also satisfies the renegotiation-proofness condition (P3e), which implies that the mechanism solves the full Problem 3.

Suppose that, on the contrary, there exists a blocking contract s_1 associated with the acceptance policy t^*, an effort policy g^*, an investment plan h^*, a forward-looking-announcement strategy B^*, and rational pricing rules Q_1 and Q_2. As before, we can restrict our attention to direct mechanisms that do not depend directly on prices: $s_1=s_1(h,B,a+bh)$ and $B^*(\zeta)=\zeta$. The definition of a blocking contract implies that (D5a) holds, that is, existing shareholders gain from renegotiations. Derivations closely following those for Lemma 1 show that, due to the truthful announcement policy $\hat{A}(\zeta)=\zeta$, the expected terminal wealth of the existing shareholders equals the expected value of the firm net of managerial compensation:

$$
\begin{aligned}
&E\big[\hat{P}_2\big(d^*(\zeta),\hat{A}(\zeta),a+bd^*(\zeta)\big)\big]\\
&\quad=E\big[a\big(e^*(\zeta),\zeta,\varepsilon_a\big)+b\big(e^*(\zeta),\zeta,\varepsilon_b\big)d^*(\zeta)\big]-E\big[\hat{s}_0^*(\zeta)\big],
\end{aligned}
$$

where $\hat{s}_0^*(\zeta)$ is the manager's compensation at the maximum in (D5b) when the manager is compensated according to the direct mechanism $\hat{s}_0(d,A,a+bd)$.

Replicating derivations in Lemma 3, we obtain that, if the manager accepts the blocking contract ($t^*=1$), then transparency of negotiations ensures that, again the expected terminal wealth of the existing shareholders equals the expected value of the firm net of managerial compensation:

$$
\begin{aligned}
&E\big[Q_2\big(t^*(\zeta),h^*(\zeta),B^*(\zeta),a\big(g^*(\zeta),\zeta,\varepsilon_a\big)+b\big(g^*(\zeta),\zeta,\varepsilon_b\big)h^*(\zeta)\big)\,\big|\,t^*(\zeta)=1\big]\\
&\quad=E\big[a\big(g^*(\zeta),\zeta,\varepsilon_a\big)+b\big(g^*(\zeta),\zeta,\varepsilon_b\big)h^*(\zeta)\,\big|\,t^*(\zeta)=1\big]-E\big[s_1^*(\zeta)\big].
\end{aligned}
\tag{14}
$$

When the manager rejects the blocking contract ($t^*=0$), the resulting truthful announcement policy, combined with the unchanged effort and incentive policies, again ensure that the expected terminal wealth of the existing shareholders equals the expected value of the firm net of managerial compensation:

$$
\begin{aligned}
&E\big[Q_2\big(t^*(\zeta),h^*(\zeta),B^*(\zeta),a\big(g^*(\zeta),\zeta,\varepsilon_a\big)+b\big(g^*(\zeta),\zeta,\varepsilon_b\big)h^*(\zeta)\big)\,\big|\,t^*(\zeta)=0\big]\\
&\quad=E\big[a\big(g^*(\zeta),\zeta,\varepsilon_a\big)+b\big(g^*(\zeta),\zeta,\varepsilon_b\big)h^*(\zeta)\,\big|\,t^*(\zeta)=0\big]-E\big[s_0^*(\zeta)\big].
\end{aligned}
\tag{15}
$$

Substituting (14) and (15) into (D5a), we obtain that offering the blocking contract leads to a higher expected shareholders' value:

$$E\big[a\big(g^*(\zeta),\zeta,\varepsilon_a\big)+b\big(g^*(\zeta),\zeta,\varepsilon_b\big)h^*(\zeta)\big]-E\big[\hat{s}_0^*(\zeta)\big(1-t^*(\zeta)\big)+s_1^*(\zeta)t^*(\zeta)\big]$$
$$> E\big[a\big(e^*(\zeta),\zeta,\varepsilon_a\big)+b\big(e^*(\zeta),\zeta,\varepsilon_b\big)d^*(\zeta)\big]-E\big[\hat{s}_0^*(\zeta)\big]. \tag{16}$$

Inequality (16), however, contradicts the assumption that $\hat{s}_0(d,A,a+bd)$ solves the existing shareholders' problem unconstrained by renegotiation-proofness. Specifically, if (16) were true, the existing shareholders could improve their wealth by using contract $\bar{s}_0(d,A,a+bd)=(1-t^*(A))\hat{s}_0(d,A,a+b)+t^*(A)s_1(d,A,a+b)$ with associated truthful announcement $A^*(\zeta)=\zeta$, investment policy $d^*(\zeta)$, and effort policy $e^*(\zeta)$. This contract mimics the manager's compensation obtained from the renegotiation considered above and thus leaves the existing shareholders with a higher value (defined by the left-hand side of (16)), which is a contradiction. Therefore, contract s_0^* is not blocked. □

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