The Governance Role of Accounting Information in External Financing*

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Abstract

Accounting information can affect economic performance through its governance role (Bushman and Smith (2001)). We study the governance role of accounting information by embedding a moral hazard problem into the framework of a multi-firm economy. Moral hazard distorts the sharing of idiosyncratic risk but does not affect the sharing of systematic risk. An improvement in the quality of idiosyncratic information facilitates a firm's financing, but this effect is not captured by the risk premium implied in traded shares. Moreover, an economy-wide improvement in idiosyncratic information quality reduces the risk premium for idiosyncratic risk but increases the risk premium for systematic risk. Thus, its overall effect on firms' ability to finance their projects is ambiguous and depends on firms' risk profiles.

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1 Introduction

Bushman and Smith (2001) suggest that accounting information can affect economic performance through its governance role (channel 2 in Figure 1). Corporate insiders possess private information that enables them to pursue their own interests at the expense of investors who provide funds to the firm. To protect themselves against this possibility, investors make it more expensive to finance the firm's activities ex ante. One way to ameliorate this problem is to design corporate control mechanisms that discipline the corporate insiders to take firm-value maximizing actions. Accounting information is a direct, major input to such corporate governance mechanisms.

In this paper we examine how the governance role of accounting information interacts with firms' financing in a multi-firm economy. Firms are subject to moral hazard. The solution to the moral hazard problem distorts the sharing of idiosyncratic risk, but has no effect on the sharing of the systematic risk (Baiman and Demski (1980)). In the absence of moral hazard, a firm issues traded shares to share risk. In the presence of moral hazard, the firm issues both traded shares to generic investors to share appropriately the risk of the firm, and a restricted equity interest in the firm to the manager to provide incentives. These incentives endogenously preclude the manager from trading his restricted equity interest in the firm, resulting in the distortion of risk sharing. However, because the realization of systematic risk is revealed ex post (by the performance of the market portfolio, for example) while the realization of idiosyncratic risk is commingled with the manager's action, the incentive contract saddles the manager with exclusively idiosyncratic risk. As a result, moral hazard in a multi-firm setting leads to distortion in the sharing of idiosyncratic risk, but not systematic risk. The endogenously concentrated idiosyncratic risk commands a risk premium, which makes financing more expensive for a firm.

We report two main results based on this insight. First, an improvement in the quality of idiosyncratic information facilitates a firm's financing, but this effect is not captured by the risk premium for traded shares. The first part is intuitive. Because idiosyncratic accounting information is informative about the manager's action, it enables the firm to substitute an accounting-based bonus for a restricted equity interest. The substitution reduces the restricted equity interest, improves the sharing of idiosyncratic risk, and reduces the cost to the firm to finance its project. The implication that the risk premium for traded shares does not reflect the benefit of idiosyncratic information arises from the fact that moral hazard has no effect on the sharing of systematic risk in the first place. Investors in traded shares are not restricted from hedging the idiosyncratic risk of their positions, and thus in equilibrium traded shares command a risk premium for exclusively systematic risk.

The governance role of accounting information thus contrasts two notions of "cost of capital." One is the total risk premium cost a firm pays to finance its project, and the other is the risk premium implied in traded shares. The former is often adopted in corporate finance, including in most text books and in the classic paper by Modigliani and Miller (1958) titled as "The cost of capital, corporation finance and the theory of investment." The latter has been the focus of most studies in accounting literature that examine the capital market role of information. Bertomeu and Cheynel (2015) provide an excellent discussion about this distinction as well as a comprehensive review of these studies.

This distinction has important empirical implications. An econometrician who focuses on the risk premium for traded shares may perceive no improvement in the quality of idiosyncratic information. The wedge between the risk premium of traded shares and the total risk premium the firm has to pay for financing may account for the difficulty in establishing the empirical link between accounting information quality and the total risk premium. Further, the above mechanism suggests that an appropriate empirical measure for the economic consequences of idiosyncratic accounting information is the size of the traded shares, not their risk premium. To illustrate, consider two firms with an identical risk profile, Firm A and Firm B, in an identical circumstance except that Firm A's accounting system provides better idiosyncratic information. In equilibrium, the risk premiums of the traded shares of the two firms are the same; these risk premiums only compensate for systematic risk. The total risk premium Firm A pays to finance its project, however, is lower than that of Firm B. Idiosyncratic information does not manifest in the risk premium for traded shares, but rather in the composition of the firms' equity interest. Firm A has a larger fraction of shares issued as traded shares and a smaller fraction issued as restricted equity interest.

The second main result of the paper concerns the economic consequences of economy-wide improvements in the quality of idiosyncratic accounting information. Economy-wide factors such as accounting standards and legal and regulatory environment affect the quality of accounting information. For example, the rapid pace of the global convergence of accounting standards and harmonization of disclosure regulations could change simultaneously the quality of all firms' accounting information. While idiosyncratic information does not affect the risk premium of systematic risk directly, an economy-wide change in the quality of idiosyncratic accounting information does have an indirect effect, and one whose direction is somewhat surprising. When the quality of economy-wide idiosyncratic information improves, firms' costs to finance their projects drop due to the reduction of the risk premium for idiosyncratic risk. As a result, more projects are financed simultaneously and the market portfolio becomes larger. This implies that each firm's risk premium for systematic risk *increases* because information quality does not affect the economy's risk-bearing capacity. To the extent that a firm's exposure to systematic and idiosyncratic risks is not symmetric, the firm's benefit from the reduction in the risk premium for idiosyncratic risk is not linked directly to the cost associated with the increase in the risk premium for systematic risk. As a result, an economy-wide improvement in the quality of idiosyncratic information could either increase or decrease the overall cost to a firm to finance its project. In other words, accounting standards have both efficiency and redistributive effects. These results may aid cross-sectional studies that attempt to capture the economic consequences of an economy-wide change in accounting quality, such as the adoption of IFRS and Sarbanes-Oxley Act.

Our paper builds upon the literature of the differential role of information for incentive versus valuation purposes (e.g., Gjesdal (1981), Bushman and Indjejikian (1993), Bushman, Engel, and Smith (2006)), and of the differential value of the incentive compensation to the manager and to the firm (e.g., Lambert and Larcker (1987), Lambert, Larcker, and Verrecchia (1991) and Hall and Murphy (2002)). We embed the governance role of accounting information into a multi-firm setting with endogenous project selection and link the quality of a firm's *idiosyncratic* accounting information to the risk premium the firm pays to finance its project. In this respect, our analysis is related to three papers that investigate moral hazard within the context of asset pricing. Fischer (2000) studies the optimal compensation contract when the agent can trade in the capital market. Among other results, he shows that the combination of contracting only on output and allowing the agent to trade doesn't replicate the optimal contract unless the wealth effect from the realization of the controllable event is either absent or manageable from trading. Ou-Yang (2005) derives an equilibrium asset pricing model with moral hazard using a similar framework of ours, namely, the constant absolute risk aversion (CARA) preference. He observes that idiosyncratic cash flow risk affects the stock price but not the dollar returns (risk premium). He doesn't model project selection, a key focus of our study.

The other closely related paper is Bertomeu (2015). He studies a general agency model within a multi-firm setting and proves a powerful irrelevance result: the pricing kernel is independent of the agency friction under two conditions. First, agents share homogeneous utility that exhibits linear risk tolerance. Second, the optimal effort in the agency is constant. Our model introduces endogenous project selection and breaks the irrelevance result in two ways. First, an economy-wide improvement in firms' idiosyncratic information affects the risk premium for traded shares. Second, an improvement in the quality of idiosyncratic information for an individual firm doesn't affect the risk premium implied in traded shares, but it does reduce the risk premium cost a firm pays to finance its project. The irrelevance result in Bertomeu (2015), like other irrelevant results, provides a powerful benchmark to understand studies on the relation between agency friction and the cost of capital. In other words, if agency frictions affect risk premium, like in our model, it must be the case that at least one of the two conditions is violated. The endogenous project selection in our model essentially relaxes the second condition, the constant optimal effort. Since moral hazard reduces the NPV of projects, it affects investors' selection of projects and thus the supply of risky assets. As a result, the governance role of accounting information, through mitigating the moral hazard problem, can affect the pricing of risk. Bertomeu (2015) provides more discussion about the significance of the irrelevance result.

The paper proceeds as follows. In Section 2 we describe our model of moral hazard in a diversified market setting, and then in Section 3 derive an equilibrium to our model. In Sections 4 and 5 we examine the economic consequences of a change in accounting quality at the firm level and economy-wide, respectively. In Section 6 we conclude. We provide proofs to lemmas and propositions stated in the paper in the Appendix.

2 Model

To study the governance role of accounting information in external financing, we embed a parsimonious, moral hazard problem into a multi-firm setting with endogenous project selection. Specifically, we assume that a representative investor j is endowed with project j, and incorporates this project into firm j (we use the terms “project” and “firm” interchangeably). With the necessary human capital from manager j (whom investor j hires), project j generates an uncertain cash flow $\tilde{F}_j$:

$$\tilde{F}_j \equiv F \cdot \imath + \phi_j \tilde{\xi}_j + \gamma_j \tilde{\eta},$$

where F is the mean of the firm's cash flow and $\imath$ is an indicator function of the manager's action. The project is subject to moral hazard. The manager can "behave" ($\iota = 1$) or "misbehave" ($\iota = 1$). If he behaves, $\imath = 1$ and the mean cash flow of the project is F. If he misbehaves, the manager receives a private benefit B but the project has a lower expected cash flow ($i.e., \imath = 0$). We interpret the manager's behavior ι broadly. It refers to actions the manager can take that benefit himself at the expense of the firm value. Some actions maximize the project's cash flow, but the manager may prefer others that are easier, more fun, more glamorous, allow more perk consumption, improve his human capital more or benefit his friends. We assume that F is sufficiently large in relation to B such that it is always socially optimal to motivate the manager to behave when the project is financed. Both $\tilde{\xi}_j$ and $\tilde{\eta}$ are random variables with a standard normal distribution: $\tilde{\xi}_j$ is the idiosyncratic risk of the project's cash flow, and $\tilde{\eta}$ is the project's systematic risk. By definition, $\tilde{\xi}_j$ is independent of $\tilde{\eta}$ and $\tilde{\xi}_i$, for $i \neq j$. The non-negative constants ϕ_j and γ_j represent the project's exposure to these sources of risk.

The accounting system provides information $\tilde{Y}_j$ about the manager's behavior:

$$\tilde{Y}_j \equiv F \cdot \imath + \alpha_j \tilde{\varepsilon}_j,$$

where $\imath$ is the same indicator function defined above. The random variable $\tilde{\varepsilon}_j$ also has a standard normal distribution that is independent of all other random variables; $\tilde{\varepsilon}_j$

represents idiosyncratic measurement risk. The non-negative constant α_j is an inverse measure of the quality of the idiosyncratic accounting information. Since $\tilde{Y}_j$ is partially informative about the manager's action, it could play the governance role of dealing with the manager's moral hazard.

While in reality an accounting system provides information that is both systematic and idiosyncratic in nature, the purpose of our model is to focus on the idiosyncratic component. Thus, we assume away the systematic component of the accounting signal $\tilde{Y}_j$. We use the expression "idiosyncratic risk" to describe both the idiosyncratic cash flow risk, $\phi_j\tilde{\xi}_j$, and the idiosyncratic accounting measurement error, $\alpha_j\tilde{\varepsilon}_j$, because both are sources of uncertainty in the manager's compensation, as we shall soon see.

There are two dates. All actions take place at date 1 except cash flow realization and consumption, which occur at date 2. Where appropriate, we use I and A to represent the investor and agent (manager), respectively. Investors and managers have negative exponential utility functions (CARA) with (constant) tolerance for risk of r_I and r_A, respectively.[1] We exploit the well-known result that when wealth at date 2, $\tilde{W}_i$, has a normal distribution, the certainty equivalent of an expected CARA utility has the simple form of $CE\left(W_i\right) = E[\tilde{W}_i] - \frac{1}{2r_i}Var[\tilde{W}_i]$, $i \in \{I, A\}$. In other words, maximizing expected utility is equivalent to maximizing the mean of wealth minus a discount for its risk.

We embed our moral hazard problem into a multi-firm setting to differentiate between idiosyncratic and systematic risks. We assume that there exists a continuum of investors and managers in the economy, where each group has a mass of 1. The multi-firm setting introduces two features into the model. First, it enlarges the space

[1] There are three reasons why CARA utility facilitates our analysis. First, with CARA utility there is no wealth effect; this enables us to focus exclusively on the effect of information quality on the risk premium. Second, CARA utility in conjunction with normally-distributed payoffs yields closed-form solutions for prices and risk premia. Third, CARA utility, normally-distributed payoffs, and linear contracts yield closed-form solutions for equilibrium compensation contracts. Because our model incorporates both firms' share prices in a multi-firm setting and firms' intra-firm contracts, closed-form solutions to both phenomena make our analysis considerably more tractable.

of compensation contracts to deal with moral hazard. The compensation contract investor j offers to manager j is contingent not only on firm j's performance, but also the performance of every other firm in the economy. From the relative performance literature (Holmstrom (1982), Bushman, Indjejikian, and Smith (1996)), one can simplify the contract design without loss of generality by writing the contract solely on the market index. The market index is the best-diversified portfolio and thus yields the least amount of noise for relative performance evaluation. Second, both investors and managers are able to optimize their portfolios across the public shares of all firms. Because risk sharing between the investor and the manager could be arranged through either the compensation contract or their respective portfolio decisions, there are many equivalent ways to model contracting and portfolio decisions.[2] We adopt the following one: we assume that manager j does not directly invest in firms and that his exposure to risk comes only from the compensation contract with investor j.[3] In particular, investor j offers a linear contract to manager j:

$$\tilde{w}_j \equiv v_j + b_j \tilde{Y}_j + m_j \tilde{M} + s_j \tilde{G}_j, \tag{1}$$

where v_j is the base salary, b_j is the accounting-based bonus coefficient, m_j is the coefficient on a market index, $\tilde{M}$, and s_j is the percentage of the equity of firm j awarded to the manager under the contract. The market portfolio $\tilde{M}$ has a mean of $E[\widetilde{M}]$ and standard deviation of σ_M.[4] The inclusion of the market-based pay m_j is a form of relative performance evaluation. It also allows an investor to invest in the stock

[2]The proof of this feature can be derived from the results in Fischer (2000). The wealth effect is absent in the CARA framework. Thus, based on Observation 1 in Fischer (2000), it doesn't matter in our setting whether the principal or the agent manages the market risk.

[3]To facilitate the analysis, we also assume that the manager continues to invest through his matching investor even in the event that the project is not financed.

[4]Because it is a representative-agent model with a continuum of agents, unscaled aggregate variables all go to infinity. Thus, all the aggregate variables, including $\tilde{M}$, are expressed in per-share (per capita) terms: for example, $\tilde{M}$ is the representative, per capita market portfolio. In Section 5 we determine $E[\widetilde{M}]$ and σ_M endogenously.

market on behalf of a manager, which frees us from modeling the manager's portfolio decision. The expression $\tilde{G}_j \equiv \tilde{F}_j - (v_j + b_j\tilde{Y}_j + m_j\tilde{M})$ is the cash flow that is available for equity holders. We refer to s_j as "restricted equity interest." The restriction that the equity interest cannot be traded or otherwise redeemed before the project pays out at date 2 arises endogenously as part of the optimal contract. To facilitate the analysis, we also assume that the firm pays the base salary v_j, the accounting-based bonus $b_j\tilde{Y}_j$, and the market-based pay $m_j\tilde{M}$ before distributing the (residual) cash flow to shareholders.

In addition to designing the compensation contract, investor j also optimizes his portfolio across the equity of all firms and a risk-free asset whose return is normalized to be 1. We assume that compensation contracts are observable to all investors. By standard portfolio theory, after awarding manager j with s_j shares of equity interest, investor j sells the remaining $1-s_j$ shares of equity interest in his own firm and invests the total proceeds between the market portfolio and the risk-free asset. Denote investor j's weight on the representative market portfolio as x_j, the per-share price of firm j's equity share as p_j, and the per-share price of the representative market portfolio as p_M.[5] Investor j's budget at date 1 is $(1-s_j)p_j$. He pays $x_j p_M$ for a fraction x_j of the representative market portfolio and invests the remaining wealth in the risk-free asset (which generates a rate of return of 1). Thus, investor j's wealth at date 2 is $\tilde{W}_j = ((1-s_j)p_j - x_j p_M) + x_j\widetilde{M} = (1-s_j)p_j + x_j(\widetilde{M} - p_M)$.[6] In addition, the CE of

[5] Recall that $\tilde{M}$ is the representative market portfolio (Footnote 4). Consequently, p_M is the price of the representative market portfolio and x_j is the fraction of the representative market portfolio, not the entire aggregate market portfolio. In other words, each atomless investor owns an infinitesimally small fraction of the aggregate market portfolio. When $x_j = 1$, a representative investor holds the representative (average) market portfolio, $\tilde{M}$. In aggregate, investors collectively hold the aggregate market portfolio (i.e., $\int_j x_j d_j = 1$) and the aggregate market clears.

[6] Formally, let a_j denote investor j's investment in the risk-free asset. Then investor j solves the following allocation problem:

$$\max_{a_j, x_j} a_j + x_j E[\tilde{M}] - \frac{x_j^2}{2r_I}\sigma_M^2 \text{ subject to } a_j = (1-s_j)p_j - x_j p_M.$$

investor j is

$$CE(W_j) = (1 - s_j)p_j + x_j(E[\widetilde{M}] - p_M) - \frac{x_j^2}{2r_I}\sigma_M^2. \tag{2}$$

Note that $CE(W_j)$ has two components. First, investor j receives the NPV of his project j, $(1 - s_j)p_j$. This value depends on both the compensation contract and the portfolio decisions of all investors. The compensation contract determines not only the fraction of equity shares available for public issuance, but also the residual cash flow $\tilde{G}_j$ whose valuation is determined by the portfolio decisions of all investors. In addition, if this NPV is negative, then investor j could choose not to finance the project. Denote I_j as firm j's financing decision. Until Section 5, we assume that $I_j = 1$ for any j for ease of exposition. Second, investor j also receives a surplus from trading in the market portfolio, $x_j(E[\widetilde{M}] - p_M) - \frac{x_j^2}{2r_I}\sigma_M^2$. This surplus originates from the risk-bearing capacity that investor j contributes to the market.[7]

We summarize the problem as follows. Investor j chooses $\{x_j, v_j, b_j, s_j, m_j\}$ to maximize $CE(W_j)$ in eqn. (2), subject to the capital market equilibrium that determines price p_j and the manager's IR (Individual Rationality) condition and IC (Incentive Compatibility) condition.

3 Equilibrium

In this section, we sketch the process that yields a solution to the problem we posit above. The solution requires determining simultaneously the optimal compensation contract and the capital market equilibrium. To be more specific, p_j in investor j's objective function, i.e., $CE(W_j)$, is an endogenous variable that is determined by

[7] Because there is a surplus for bearing risk, manager j's reservation utility in our setting is complicated. In a stand-alone moral hazard problem, manager j's reservation utility is the opportunity cost of his effort-free labor. In our setting, the manager's compensation contract incorporates his portfolio decision. Thus, the manager's reservation utility has an additional component equivalent to the surplus he receives for the risk he bears through direct participation in the stock market.

the capital market equilibrium. At the same time, the capital market equilibrium is also determined by the compensation contract that affects both the generation and distribution of the cash flow. The solution process consists of two steps. First we fix the compensation contract to hold constant the distribution of the firm's cash flow $\tilde{G}_j$ and the fraction of shares available for public issuance $1 - s_j$. This allows us to solve the capital market equilibrium, which expresses p_j as a function of the compensation contract $\{v_j, b_j, s_j, m_j\}$. Then we substitute p_j into $CE(W_j)$ and solve for the optimal compensation contract. The solution to the problem is complicated but the techniques are relatively standard. Thus, we relegate most details to the Appendix.

Lemma 1 *Given the compensation contract $\{v_j, b_j, s_j, m_j\}$, the per-share price of the traded shares of firm j is*

$$p_j = E[\tilde{G}_j] - \frac{1}{r_I} Cov\left[\tilde{G}_j, \tilde{M}\right]. \tag{3}$$

Lemma 1 is a standard asset-pricing result. The price of traded shares equals the expected value of the residual cash flow available to equity holders minus a discount for risk whose size is determined by the covariance of the firm's cash flow and the market portfolio. The unusual feature here is that p_j is conditional on the compensation contract. In other words, the capital market is willing to pay p_j per share for the traded shares only if the firm sells a fraction $1 - s_j$ of shares as traded shares and retains the remaining s_j as restricted equity interest awarded to the manager. This is important for understanding the governance role of accounting information with the endogenous supply of projects.

Plugging p_j into investor j's $CE(W_j)$, we obtain a standard moral hazard problem. Let $CE(w_j(\iota))$ denote the certainty equivalent of manager j's wealth.[8] By comparing

[8] $CE(w_j)$ is straightforward to calculate but complicated in detail, and so we reserve the expression for the Appendix: see eqn. (11).

the manager's CE between behaving and misbehaving, we obtain the manager's IC condition:

$$(b_j(1-s_j)+s_j)F - B \geq 0. \quad (4)$$

Let CE^0 represent the manager's reservation CE in the absence of working for the firm. The manager's IR condition is

$$CE(w_j(\iota = 1)) - B \geq CE^0. \quad (5)$$

Lemma 2 *1. When the manager actions are contractible,* $b_j^{FB} = s_j^{FB} = 0$, *where "FB" denotes "first best."*

2. When the manager actions are not contractible, $s_j = \frac{B}{F(1+(\frac{\phi_j}{\alpha_j})^2)} > 0$ *and* $b_j = \frac{\frac{B}{F}-s_j}{1-s_j} > 0$.

3. The agency cost (i.e., the reduction in firm value in the presence of moral hazard) is $\Pi_j \equiv \frac{1}{2r_A}\frac{B^2}{F^2}\frac{\alpha_j^2\phi_j^2}{(\alpha_j^2+\phi_j^2)}$.

Part 1 of Lemma 2 is straightforward. In absence of moral hazard, the compensation contract imposes no idiosyncratic risk on the manager and thus the coefficients on the accounting-based bonus and restricted equity interest are both 0. In other words, the capital market is willing to purchase all shares of the firm at p_j per share and all shares are publicly traded.

Part 2 of Lemma 2 is a direct application of the insight in Holmstrom (1979) that any information about the manager's non-contractible action is useful as an incentive provision. Both the firm's terminal cash flow and accounting signal are informative about the manager's actions and thus both are utilized in the compensation contract. Recall that the IC condition for the manager is $(b_j(1-s_j)+s_j)F-B \geq 0$. Thus, $s_j > 0$ and/or $b_j > 0$ imply that the manager's expected compensation increases if he behaves.

The exact magnitudes of s_j and b_j are determined by their relative informativeness $\frac{\phi_j}{\alpha_j}$ and the scaled parameter of the manager's private benefit $\frac{B}{F}$.

Part 3 of Lemma 2 follows from the comparison of firm value with and without moral hazard. The agency cost of moral hazard is the reduction in firm value in the presence of moral hazard. An inspection of the expression reveals that the agency cost results exclusively from the project's idiosyncratic risk, not its systematic risk. This result is the starting point of our main results. The intuition for this important result is as follows. Recall that the manager's exposure to risk, rearranged from his wealth using eqn. (1), is $b_j(1-s_j)\alpha_j\tilde{\varepsilon}_j + s_j(\phi_j\tilde{\xi}_j + \gamma_j\tilde{\eta}) + (1-s_j)m_j\sigma_M\tilde{\eta}$. The manager is exposed to idiosyncratic risk through the accounting-based bonus and the restricted equity interest, and to systematic risk through the restricted equity interest and the market-based pay. Because only the idiosyncratic component of the firm's performance is indicative of the manager's actions, the compensation contract allows the manager to hedge away the systematic risk of the restricted equity interest by adjusting the coefficient for the market-based pay. In contrast, for incentive provision purposes, the compensation contract does not permit the manager to hedge his exposure to the idiosyncratic risk associated with the accounting-based bonus and the restricted equity interest. As a result, the sharing of the idiosyncratic risk *per se* is suboptimal in equilibrium, whereas the sharing of systematic risk is. In other words, the cost of moral hazard manifests in the distortion in the sharing of idiosyncratic risk. This explains part 3 of Lemma 2: the agency cost of moral hazard is captured solely by the risk premium for the idiosyncratic risk the manager endogenously bears.

One can expand on the intuition for part 3 of Lemma 2 by making reference to the manager's risk exposure in equilibrium. Using eqn. (1) and eqn. (12), the manager's equilibrium exposure to systematic risk $\widetilde{\eta}$ is $s_j\gamma_j\tilde{\eta}+(1-s_j)m_j\sigma_M\tilde{\eta} = \frac{r_A}{r_I}\sigma_M\widetilde{\eta}$. Note that it does not depend on the incentive coefficients $\{b_j, s_j\}$ or any other characteristics of the firm. Because the manager can always trade publicly-traded equity, the sharing of systematic risk between managers and investors is determined solely by their relative risk tolerances $\frac{r_A}{r_I}$. When s_j changes to provide incentives, m_j adjusts to ensure that s_j does not affect the manager's total exposure to systematic risk. As a result, one can obtain the risk premium for systematic risk (i.e., the risk premium charged for publicly-traded equity) from Lemma 1 and eqn. (12):

$$\Gamma_j \equiv (1 - s_j)(p_j - E[\tilde{G}_j]) = \frac{\bar{\gamma}}{r_A + r_I}\gamma_j. \tag{6}$$

The classic asset-pricing result that systematic risk alone commands a risk premium is valid for the firm's publicly-traded equity. In contrast, the manager's equilibrium exposure to idiosyncratic risk is $b_j(1 - s_j)\alpha_j\widetilde{\varepsilon}_j + s_j\phi_j\widetilde{\xi}_j$; $b_j > 0$ and $s_j > 0$ mean that the manager bears idiosyncratic risk in equilibrium. This endogenous concentration of idiosyncratic risk is costly and the manager requires a risk premium for it. The risk premium for concentrated idiosyncratic risk is

$$\Pi_j \equiv \frac{1}{2r_A}\frac{B^2}{F^2}\frac{\alpha_j^2\phi_j^2}{(\alpha_j^2 + \phi_j^2)}. \tag{7}$$

In presence of moral hazard, idiosyncratic risk exacerbates the incentive problem and thus makes the financing of the project more costly by Π_j. Thus, Π_j has a dual identity. On the one hand, it represents the reduction in firm value in the presence of moral hazard. On the other hand, Π_j also represents the risk premium for the endogenously concentrated, idiosyncratic risk imposed on the manager. This dual identity underlies the intuition for part 3 of Lemma 2.

Finally, from the firm's perspective, the total risk premium the firm *pays* to finance the project consists of the risk premium for systematic risk and the idiosyncratic risk borne by the manager:

$$\Delta_j = \Gamma_j + \Pi_j = \frac{\bar{\gamma}}{r_A + r_I}\gamma_j + \frac{1}{2r_A}\frac{B^2}{F^2}\frac{\alpha_j^2\phi_j^2}{\alpha_j^2 + \phi_j^2}. \tag{8}$$

While part 3 of Lemma 2 is intuitive, it yields an important insight about the economic consequences of idiosyncratic accounting information. Specifically, moral hazard creates a wedge between the risk premium investors charge for publicly-traded equity (Γ_j) and the total risk premium the firm actually pays to finance the project (Δ_j). The wedge, i.e., Π_j, manifests as a risk premium for idiosyncratic risk and reflects the shadow price for restrictions on the restricted-equity interest. The existence of this wedge was noted as early as in Diamond and Verrecchia (1982), Holmstrom (1982) and Ramakrishnan and Thakor (1982). It has been used subsequently to address issues related to executive compensation (e.g., Hall and Murphy (2002) and Ou-Yang (2005)). In the next section, we develop this basic observation to study the economic consequences of idiosyncratic information.

Finally, the intuition that underlies part 3 of Lemma 2 could be likened to "capital rationing," a circumstance where a firm cannot borrow additional funds even though it is willing to pay the current interest rate. The reason is that more borrowing destroys the incentive for the firm to behave appropriately. As with credit rationing, firms in our model are rationed for risk sharing. A firm cannot issue more traded shares even though it is willing to pay the prevailing risk premium, or an even higher premium than the one the market is asking for the existing traded shares. More traded shares (a smaller restricted equity interest) destroy the incentive for the manager to behave. In other words, moral hazard leads to the firm being rationed by quantity (i.e., the number of traded shares it could issue), not by price (i.e., the risk premium of the traded shares).

4 Firm-Level Information Quality

We attempt to capture the fact that both firm-level and economy-wide factors influence accounting information quality by positing the following structure for accounting measurement error α_j:

$$\alpha_j \equiv \lambda_j \alpha + \delta_j. \tag{9}$$

Here there are two sources of accounting measurement error: a common factor α, and a firm-specific factor δ_j. We interpret δ_j as a determinant of accounting quality that differs across firms within the same regime or industry. Alternatively, δ_j could be interpreted as factors that are under the control of firm j. Firms could choose more informative accounting methods, use more precise accounting estimates, commit to more forthcoming disclosure or guidance, and bond themselves to regimes with more stringent requirements or stronger enforcement. On the other hand, we interpret α as factors that affect a firm's accounting quality outside the firm's direct control. These factors could include economy-wide determinants of accounting quality such as accounting standards, legal and regulatory enforcement, social norms, and economic environment of an economy. The parameter λ_j measures a firm's exposure to the economy-wide factor α. Cross-sectional differences in λ_j capture the notion that an economy-wide factor could have differential effects on the quality of firms' idiosyncratic accounting information.

Note that a firm's accounting information, $\tilde{Y}_j \equiv F \cdot \iota + \alpha_j \tilde{\varepsilon}_j$, remains idiosyncratic through $\alpha_j \tilde{\varepsilon}_j = (\lambda_j \alpha + \delta_j)\, \tilde{\varepsilon}_j$, but shares a common source with other firms through α. For example, when a new accounting standard becomes effective, this affects the quality of the idiosyncratic accounting information of all firms in the economy, albeit differentially.

In this section we consider the effect of cross-sectional differences through δ_j. A decrease in δ_j improves the quality of idiosyncratic information at the firm level; this, in turn, reduces the risk premium the firm pays to finance its project, as stated in the following proposition.

Proposition 1 *As the quality of accounting information at the firm-level improves (δ_j becomes smaller), the risk premium for the systematic risk, Γ_j, remains the same, the risk premium for the idiosyncratic risk, Π_j, becomes smaller, and the total risk premium the firm pays to finance the project, Δ_j, falls.*

The proof is straightforward from the expression for Δ_j, i.e., eqn. (8). To better understand the intuition, we consider the effect of idiosyncratic accounting information on the compensation contract. The key is to observe that as accounting information becomes more precise, the optimal compensation contract tilts more towards an accounting-based bonus and less towards restricted equity interest. Recall from Lemma 2, the restricted equity interest s_j is increasing in α_j and the accounting-based bonus b_j is decreasing in s_j. Thus, the accounting-based bonus and restricted equity interest are substitute incentive mechanisms. The restricted equity interest and bonus are both costly to the firm because of the inefficient sharing of idiosyncratic risk. However, as idiosyncratic accounting information quality improves, it becomes relatively cheaper to use the bonus as an incentive mechanism; this tilts the firm toward more bonus and less restricted equity interest until the exposures to $\tilde{\varepsilon}_j$ and $\tilde{\xi}_j$ are equalized, i.e., $b_j(1 - s_j)\alpha_j = s_j\phi_j$. As a result, this improves idiosyncratic risk sharing and the risk premium for idiosyncratic risk falls. In contrast, because the compensation contract does not affect the sharing of systematic risk in the first place, it should be clear that the change in the compensation contract induced by an improvement in idiosyncratic information does not affect the risk premium for systematic risk.

Proposition 1 has important implications for the vast empirical literature that seeks to measure the economic consequences of accounting information. Proposition 1 implies that empirical proxies for a firm's risk premium - proxies based on the price of traded shares, Γ_j - may underestimate the *total* premium a firm pays to finance its project, Δ_j, by the risk premium for idiosyncratic risk, Π_j. For example, consider two, ostensibly identical projects that have the same systematic and idiosyncratic cash flow risks: we label the first project A and the second project B. While ostensibly identical, we assume that the accounting system of firm A provides better idiosyncratic information than the accounting system of firm B. If financed, both projects are expected to generate cash flow F. Thus, firm value is inversely related to the total risk premium the firm pays to finance the project. Lemma 2 and Proposition 1 establish that the total risk premium to finance project A (Δ_A) is lower than that to finance project B (Δ_B). In other words, project A is more likely to be financed than firm B. However, when an empiricist contemplates the risk premiums of the two projects, typically he or she only considers the prices p_A and p_B of the firms' traded shares. Because the risk premiums the empiricist infers from the traded shares are Γ_A and Γ_B, he or she will arrive at the conclusion that the two projects' risk premiums are identical (i.e., $\Gamma_A = \Gamma_B$).

Because idiosyncratic accounting information only reduces Π_j, failing to account for idiosyncratic risk in the risk premium a firm pays implies that improvements in the quality of idiosyncratic information may appear to yield no benefit. This underestimate may account for the difficulty in establishing an empirical link between accounting information quality and the risk premium.

Proposition 2 *The implied risk premium from traded shares, Γ_j, biases downward the risk premium the firm pays to finance a project, Δ_j. The magnitude of the bias, Π_j, increases in the size of the restricted equity interest s_j and the idiosyncratic cash flow risk ϕ_j, and decreases in the risk tolerance of the manager, r_A.*

In our previous example, we observed that even though the risk premiums of the traded shares of the two firms are identical, firm A has a larger fraction of shares traded publicly than firm B (i.e., $1 - s_A > 1 - s_B$). Firm A's better accounting information does reduce its cost of financing its project, but this is only reflected in a larger fraction of firm A's equity interest being publicly traded, not in the lower risk premium implied in A's traded shares.

Restricted equity interest is a sign of distorted risk sharing resulting from intra-firm frictions including moral hazard. A proxy for restricted equity interest may be the ownership in a firm by top executives. As such, risk-sharing distortion could be a significant cost of financing. For example, Holderness, Kroszner, and Sheehan (1999) reports that in 1995 the mean and median equity ownership of directors and officers (D&O) of a sample of exchange-listed firms are 21.1% and 12.4% (12.2% and 4.6% for NYSE sample), respectively. Similarly, Fahlenbrach and Stulz (2009) finds that the mean and median of D&O ownership for their sample are 22.3% and 14.8%, respectively, for the average sample period between 1988 and 2003. Failure to account for the distortion in risk sharing in measures of risk premiums may explain why it has been difficult for empirical studies to identify the seemingly evident relation between information quality and the risk premium the firm pays to finance its project.

Ownership concentration is even larger in other countries. One extreme form of ownership concentration is family ownership, which is common in West Europe (e.g., Faccio and Lang (2002), Franks, Mayer, and Renneboog (2001)) and East Asia (e.g., Claessens, Djankov, and Lang (2000)). La Porta, Lopez-de Silanes, and Shleifer (1999) and Shleifer and Wolfenzon (2002) interpret the concentration of ownership as an optimal response to the agency problem and the lack of investors' projection. We have chosen a specific form of moral hazard for tractability, but it is worth pointing out that the governance role of accounting information applies to the dealing of other agency frictions. Solutions to intra-firm agency frictions commonly involve the concentration of idiosyncratic risk. For example, the solution to adverse selection in Leland and Pyle (1977) involves the concentration of ownership. The solution to the free-rider problem in monitoring insiders also entails block holders holding undiversified portfolios.

In particular, Himmelberg, Hubbard, and Love (2004) shows that stronger legal protection reduces a firm's risk premium to finance its project because it results in less insider ownership that requires compensation for the concentration of idiosyncratic risk. Hence, an improvement in idiosyncratic accounting information could also reduce the risk premium the firm pays to finance a project by acting as a substitute for these imperfect solutions.

5 Economy-wide Information Quality

A salient feature of accounting is that accounting information quality is governed by both the choices of individual firms and economy-wide factors such as accounting standards and legal regimes. Given the rapid pace of the global convergence of accounting standards and the harmonization of disclosure regulations, it is increasingly more important to understand how economy-wide changes in accounting quality affect the allocation of resources and the distribution of surplus.

Recall that the change in economy-wide information quality through α, the common factor in the expression $\alpha_j \equiv \lambda_j \alpha + \delta_j$, affects all firms (recall that we describe accounting information as $\tilde{Y}_j \equiv a_j + \alpha_j \tilde{\varepsilon}_j$). Thus, our next goal is to consider the economic consequences of a change in α. To do so, we need to relax the assumption that all projects are financed in equilibrium. Instead, we now explicitly study a firm's decision to finance its project, I_j.[9] This decision makes both the supply of risky assets and, as a consequence, the market portfolio endogenous. Recall the definition $\bar{\gamma} \equiv \int_{I_j=1} \gamma_j dj$; here, $\bar{\gamma}$ is the systematic risk of all projects that are financed in equilibrium. Note that from the proof of Lemma 2 in Appendix, the systematic risk of the market portfolio is

[9] By matching manager j with project j, we also use I_j to denote the employment status of the manager j without loss of generality: that is, $I_j = 1$ means that manager j is employed. The employment decision of a representative manager j is redundant because his investor will always adjust his compensation contract in such a way that the manager is indifferent between taking the offer or not.

$\sigma_M = \frac{r_I}{r_I + r_A}\bar{\gamma}$, which is proportional to $\bar{\gamma}$. Because of the proportionality, we refer to $\bar{\gamma}$ as the systematic risk of the market portfolio $\tilde{M}$. The manager bears the other portion of systematic risk through the compensation contract, $s_j\gamma_j + (1 - s_j)m_j\sigma_M = \frac{r_A}{r_A + r_I}\bar{\gamma}$ (see the expression for the manager's wealth $\tilde{w}_j$ in eqn. (1)).

The firm's decision as to whether to finance its project reduces to the NPV rule: $I_j = 1$ if firm value $(1 - s_j)p_j > 0$. Information quality affects firm value and thus affects the financing decision as well. When economy-wide information changes, this may simultaneously affect firms' financing decisions; this, in turn, may lead to changes in the market portfolio. Because the risk premium for systematic risk is determined by the risk of the market portfolio (that is, $\Gamma_j = \frac{\bar{\gamma}}{r_A + r_I}\gamma_j$), the change in the market portfolio affects the risk premium for systematic risk. We summarize the effects of an economy-wide improvement in accounting quality in the following proposition.

Proposition 3 *As the quality of economy-wide accounting information improves (α becomes smaller), for an existing firm:*

1. *the risk premium for the firm's idiosyncratic risk decreases ($\frac{\partial \Pi_j}{\partial \alpha} > 0$);*
2. *the risk premium for the firm's systematic risk increases ($\frac{\partial \Gamma_j}{\partial \alpha} < 0$); and*
3. *the total risk premium the firm pays to finance its project could either increase or decrease, depending on its sensitivity to the economy-wide factor α and its relative exposure to systematic and idiosyncratic risk.*

Part 1 of Proposition 3 is straightforward from Proposition 1. As the quality of economy-wide accounting information improves, the improvement reduces the total idiosyncratic noise in the accounting measure (α_j) for all firms, which results in a lower risk premium for idiosyncratic risk.

Part 2 of Proposition 3 is somewhat surprising. As the quality of economy-wide *idiosyncratic* accounting information improves, the improvement *increases* the risk premium for an existing firm's *systematic* risk. The intuition for the result is as follows. Improvements in the quality of idiosyncratic accounting information reduce the risk premium for idiosyncratic risk (or agency cost), which leads to riskier projects becoming more profitable and thus more likely to be financed. As a result, the market portfolio becomes larger and the level of systematic risk in the economy grows. Because the improvement in the quality of idiosyncratic accounting information does not affect the total risk-bearing capacity of the economy, of necessity the risk premium for systematic risk has to increase.

This intuition is borne out by a simple proof. Consider the effect of a change in α on Δ_j:

$$\frac{\partial \Delta_j}{\partial \alpha} = \frac{\gamma_j}{r_I + r_A} \frac{\partial \bar{\gamma}}{\partial \alpha} + \lambda_j \frac{\partial \Pi_j}{\partial \alpha_j}. \tag{10}$$

With moral hazard, a firm's total risk premium compensates for both systematic and idiosyncratic risk. Holding the market portfolio $\bar{\gamma}$ constant, Proposition 1 (similarly, part 1 of Proposition 3) predicts that the improvement in the quality of a firm's idiosyncratic information reduces the risk premium for idiosyncratic risk, i.e., $\frac{\partial \Pi_j}{\partial \alpha_j} > 0$. We label this the direct effect. When an economy-wide change takes place, the direct effect works on all firms simultaneously, i.e., $\frac{\partial \bar{\gamma}}{\partial \alpha} \neq 0$. We label this the indirect effect. What is the sign of the indirect effect? Suppose $\frac{\partial \bar{\gamma}}{\partial \alpha} \geq 0$. Then $\frac{\partial \Delta_j}{\partial \alpha} > 0$ and all firms' NPVs increase as economy-wide information quality improves. As a result, as α decreases, the set of firms (i.e., $\int_{I_j=1} I_j dj$) that are financed is strictly larger, which implies that $\bar{\gamma} = \int_{I_j=1} \gamma_j dj$ increases (i.e., $\frac{\partial \bar{\gamma}}{\partial \alpha} < 0$); this leads to a contradiction. Therefore, $\frac{\partial \bar{\gamma}}{\partial \alpha} < 0$ and $\frac{\partial \Gamma_j}{\partial \alpha} < 0$. This proves part 2 of Proposition 3.

The economic force behind part 2 of Proposition 3 manifests in other settings. For example, in Cheynel (2009), when the disclosure friction is high and thus the economy features overinvestment, an increase in disclosure increases the cost of capital because more risky projects are financed. This is true even though she uses constant relative risk aversion (CRRA) preference.

The indirect effect is an externality on existing firms arising from the influx of new firms. Firms (projects) that would otherwise have had negative NPVs become positive NPV projects as a result of the improvement in the quality of idiosyncratic information. These new firms enter the capital market and compete with existing firms for the market's limited risk-bearing capacity and hence push up the price for risk-bearing capacity (i.e., the risk premium for systematic risk).

Part 3 of Proposition 3 states that the overall effect of a change in economy-wide information quality on the total risk premium an existing firm pays to finance its project is the sum of the direct and indirect effects. An improvement in economy-wide idiosyncratic information quality reduces the risk premium for idiosyncratic risk (the direct effect, or part 1 of Proposition 3) but increases the risk premium for systematic risk (the indirect effect, or part 2 of Proposition 3). Intuitively, a firm with a higher exposure to idiosyncratic risk benefits more from the beneficial direct effect, and a firm with a higher exposure to systematic risk is hurt more by the detrimental indirect effect. Furthermore, existing firms could be worse off overall if they have high exposure to systematic risk and/or low exposure to idiosyncratic risk. To the extent that firms' risk profiles, i.e., $\{\gamma_j, \lambda_j, \phi_j, \alpha_j\}$, differ cross-sectionally, the effects of a change in economy-wide information quality will have differential effects on the cost to a firm to finance its projects. The proof of part 3 of Proposition 3 in the Appendix provides examples in which an increase in α *increases* the overall risk premium a firm pays to finance its project.

Note that the direct effect typically dominates the indirect effect in a general equilibrium. This is not the case, however, in our model. The following proposition summarizes the interesting difference between our model and a standard agency model with regard to welfare implications.

Proposition 4 *As economy-wide information quality improves, the sets of projects that are financed in equilibrium before and after the improvement may not subsume each other. Taking the improvement to the extreme, the sets of projects that are financed in equilibrium in the first- and second-best cases may not subsume each other.*

Proposition 4 differs from the intuition in a standard principal-agent setting. In a standard principal-agent setting, the set of projects that are financed in equilibrium grows as moral hazard decreases; this reflects the strict gain in efficiency through the reduction in moral hazard. In contrast, the set of projects that are financed in equilibrium does not necessarily grow as moral hazard becomes less severe in our model. In other words, the indirect effect in our model could be strong enough to dominate the direct effect. As a result, an equilibrium with higher quality information does not Pareto dominate an equilibrium with lower quality information. The proof of Proposition 4 in Appendix provides such examples.

The presence of a strong indirect effect complicates empirical studies of the economic consequences of the adoption of new accounting standards, and in particular the convergence of global accounting standards. In addition to the issue of choosing an appropriate proxy for the risk premium discussed in the previous section, such tests need to capture the change in the risk premium for both idiosyncratic and systematic risks.

The presence of a strong indirect effect suggests that accounting standards have both resource allocation *and* distributional consequences because firms share the same pool of risk-bearing capacity. This yields the prediction that some firms (or countries) with predictable characteristics could be worse off and opposed to accounting standards and disclosure regulations even if the standards improve the accounting quality of all firms. Those firms most likely to be opposed are ones with high systematic risk and low idiosyncratic risk. They do not benefit as much from improvement in idiosyncratic information quality, but share more of the negative externality in the form of an increased market risk premium.

6 Discussion and Conclusion

The purpose of this paper was to attempt to understand the governance role of accounting information in external financing. We integrate a moral hazard problem into the framework of a multi-firm economy with endogenous project selection, so as to better understand how an improvement in a firm's accounting information affects the cost to a firm to finance its projects/investments.

In a context of our analysis, first we establish that moral hazard distorts the sharing of idiosyncratic risk, but has no effect on systematic risk sharing. Armed with this insight, we attempt to make two points. First, because a firm's traded shares command a risk premium for exclusively systematic risk while idiosyncratic accounting information reduces the risk premium for idiosyncratic risk, an improvement in the quality of idiosyncratic information is unlikely to manifest in the risk premium of the firm's traded shares. Second, when the quality of economy-wide idiosyncratic information improves, the costs for firms to finance their projects drop and more projects are financed simultaneously; as a result, the market portfolio becomes larger and each firm's risk premium for systematic risk increases. Therefore, improvements in the quality of economy-wide idiosyncratic information could either increase or decrease the overall cost to a firm to finance its project. In other words, accounting standards may have both efficiency and redistributive effects.

Our analysis offers two chief empirical implications. First, an improvement in idiosyncratic information is unlikely to manifest in the risk premium of the firm's traded shares, a popular proxy for cost of capital in both empirical and theoretical studies. We also predict that the risk premium of traded shares is lower than a firm's cost of financing a project and that the discrepancy increases in the size of the restricted equity share. Second, an economy-wide improvement in the quality of idiosyncratic information decreases the risk premium for idiosyncratic risk but increases the risk premium for systematic risk. The overall cost for an existing firm to finance its project could either increase or decrease, depending on its risk profile. This insight could aid cross-sectional studies that attempt to capture the economic consequences of an economy-wide change in accounting quality, such as the adoption of IFRS.

While we make no attempt to test empirically our results, our claim that improvements in idiosyncratic information are unlikely to manifest in the risk premium of a firm's traded shares comports well with the survey results in Graham and Harvey (2001). This paper finds that private firms and small public firms with higher managerial ownership are less likely to use systematic risk to estimate their cost of equity capital than their large, public counterparts. The paper attributes the difference to implementation problems for private and small firms. An alternative explanation from our analysis is that systematic risk is less representative of the cost of equity capital for firms whose fraction of traded shares is smaller.

Finally, even though we introduce moral hazard, we don't model misreporting and earnings management. Thus, our model has nothing to say about whether information risk is a factor or not (e.g., Francis, LaFond, Olsson, and Schipper (2005), Core, Guay, and Verdi (2007)). We leave this to feature research.

Appendix

Proof of Lemma 1 and 2.

We assumed in the text that $I_j = 1$ for any j until Section 5. In this Appendix, however, we prove a more general version of the model with endogenous financing decision I_j. The results up to Section 5 are obtained by simply setting $I_j = 1$.

We characterize our economy by the exogenous parameters $\{\{\phi_j, \gamma_j, \alpha_j\}_{j\in[0,1]}, B, CE^0, r_A, r_I\}$, and an equilibrium to our economy by the endogenous variables $\{I_j, v_j, b_j, s_j, m_j, x_j, p_j\}_{j\in[0,1]}$. We solve for the endogenous variables in three steps. First, we solve the capital market equilibrium $\{x_j, p_j\}$, holding constant the financing and compensation decisions (i.e., holding $\{I_j, v_j, b_j, s_j, m_j\}$ constant). Second, we then take the financing decision I_j and the capital market equilibrium as constant and solve the compensation contract within firm $\{v_j, b_j, s_j, m_j\}$. Finally, we solve the financing decision I_j.

Fixing the financing decision $I_j = 1$ and the compensation contract $\{v_j, b_j, s_j, m_j\}$, the market portfolio that is available to investor j is $\widetilde{M} \equiv \int_{I_j=1} (1-s_j)\tilde{G}_j dj$. Some algebra together with the definition of idiosyncratic risk (i.e., $\int_{I_j=1} \tilde{\xi}_j dj = \int_{I_j=1} \tilde{\varepsilon}_j dj = 0$) yields $\widetilde{M} = E[\widetilde{M}] + \sigma_M \tilde{\eta}$ where $E[\widetilde{M}] \equiv \frac{\int_{I_j=1} (1-s_j)((1-b_j)F - v_j)dj}{1+\int_{I_j=1} (1-s_j)m_j dj}$ and $\sigma_M \equiv \frac{\int_{I_j=1} (1-s_j)\gamma_j dj}{1+\int_{I_j=1} (1-s_j)m_j dj}$.

Plugging the definitions of $\tilde{Y}_j$, $\tilde{M}$, and $\tilde{F}_j$ into the manager j's wealth $\tilde{w}_j(\imath)$ in eqn. (1) yields the following certainty equivalent:

$$\begin{aligned} CE(w_j(\imath)) &= (1-s_j)v_j + (s_j + b_j(1-s_j))F\imath + m_j(1-s_j)E[\widetilde{M}] \\ &\quad - \frac{1}{2r_A}((b_j(1-s_j)\alpha_j)^2 + (s_j\phi_j)^2 + (s_j(\gamma_j - m_j\sigma_M) + m_j\sigma_M)^2). \quad (11) \end{aligned}$$

The IC condition reduces to $CE(w_j(\imath = 1)) - B \geq CE(w_j(\imath = 0))$, which we rearrange as $(s_j + b_j(1-s_j))F \geq B$. The IR condition reduces to $CE(w_j(\imath = 1)) - B \geq CE^0$. Note that the IR condition binds in equilibrium; we use this to determine v_j:

$$\begin{aligned} (1-s_j)v_j &= CE^0 + B - (s_j + b_j(1-s_j))F - m_j(1-s_j)E[\widetilde{M}] \\ &\quad + \frac{1}{2r_A}((b_j(1-s_j)\alpha_j)^2 + (s_j\phi_j)^2 + (s_j(\gamma_j - m_j\sigma_M) + m_j\sigma_M)^2). \end{aligned}$$

Finally, the certainty equivalent of investor j's wealth at date 2 is expressed in eqn. (2).

Denoting μ as the Lagrange multiplier, the Lagrange function of investor j's problem is

$$L(x_j, b_j, s_j, m_j, \mu) = (1-s_j)p_j + x_j(E[\tilde{M}] - p_M) - \frac{1}{2r_I}x_j^2\sigma_M^2 + \mu((s_j + b_j(1-s_j))F - B).$$

To solve the equilibrium, we first take the compensation contract as given and solve for p_j and p_M as functions of $\{v_j, b_j, s_j, m_j\}$. The first-order condition for L with respect to x_j yields $E[\tilde{M}] - p_M - \frac{x_j}{r_I}\sigma_M^2 = 0$. Because investors are symmetric in their tolerance for risk, they all hold the same portfolio. Market clearing implies that $x_j = 1$. Thus, $p_M = E[\tilde{M}] - \frac{1}{r_I}\sigma_M^2$.

An individual firm j's per-share price p_j is determined as follows. Allow for the fact that initially the market is in equilibrium. Next, suppose that an atomless firm, firm j, is offered to the market at per-share price p_j. Firm j generates cash flow $\tilde{G}_j$ for shareholders, but only $1 - s_j$ of this cash flow is offered to the public market. A representative investor i who demands z of firm j's share at p_j would have wealth of $z(\tilde{G}_j - p_j) + (1 - s_i)p_i + (\tilde{M} - p_M)$ and a certainty equivalent of $z(E[\tilde{G}_j] - p_j) + (1 - s_i)p_i + E[\tilde{M}] - p_M - \frac{1}{2r_I}(z^2 Var[\tilde{G}_j] + Var[\tilde{M}] + 2zCov[\tilde{G}_j, \tilde{M}])$. The first-order condition with respect to z generates $E[\tilde{G}_j] - p_j - \frac{1}{r_I}(zVar[\tilde{G}_j] + Cov\left[\tilde{G}_j, \tilde{M}\right])$. Because firm j is atomless, a representative investor only holds an infinitely small interest in firm j. Thus, p_j is determined by taking the limit of the above equation as z goes asymptotically to 0: $p_j = E[\tilde{G}_j] - \frac{1}{r_I}Cov\left[\tilde{G}_j, \tilde{M}\right]$. This proves Lemma 1.

Plugging p_j and v_j into $L(x_j, b_j, s_j, m_j, \mu)$ and substituting $x_j = 1$, we have

$$\begin{aligned} L(x_j, b_j, s_j, m_j, \mu) &= F - (CE^0 + B) + E[\tilde{M}] - p_M \\ &\quad - \frac{1}{2r_A}((b_j(1-s_j)\alpha_j)^2 + (s_j\phi_j)^2 + (s_j(\gamma_j - m_j\sigma_M) + m_j\sigma_M)^2) \\ &\quad - \frac{1}{2r_I}(2(1-s_j)(\gamma_j - m_j\sigma_M)\sigma_M + \sigma_M^2) + \mu(s_j + b_j(1-s_j))F - B). \end{aligned}$$

Taking the first-order conditions with respect to $\{b_j, s_j, m_j, \mu\}$ and solving for the equations yield the solutions:

$$s_j = \frac{B}{F(1+(\frac{\phi_j}{\alpha_j})^2)},\ b_j = \frac{B - Fs_j}{F - Fs_j},\ m_j = \frac{1}{1-s_j}(\frac{r_A}{r_I} - \frac{s_j\gamma_j}{\sigma_M}),\ \mu = \frac{c\alpha_j^2\phi_j^2}{F^2(\alpha_j^2+\phi_j^2)r_A}. \tag{12}$$

Substituting these variables into the expression of σ_M, we have $\sigma_M = \frac{r_I}{r_I+r_A}\bar{\gamma}$. Similarly, we obtain the two components of the value of investor j's objective function. First, investor j's surplus for bearing risk is

$$x_j(E[\tilde{M}] - p_M) - \frac{1}{2r_I}x_j^2\sigma_M^2 = \frac{r_I}{r_I+r_A}\frac{\bar{\gamma}^2}{2(r_I+r_A)}.$$

Second, the NPV of project j to investor j is

$$(1-s_j)p_j = F - (B + CE^0 - \frac{r_A}{r_I+r_A}\frac{\bar{\gamma}^2}{2(r_I+r_A)}) - \frac{1}{2r_A}\frac{B^2}{F^2}\frac{\alpha_j^2\phi_j^2}{(\alpha_j^2+\phi_j^2)} - \frac{\gamma_j\bar{\gamma}}{r_A+r_I}.$$

Investor j receives a surplus for bearing systematic risk, $\frac{r_I}{r_I+r_A}\frac{\bar{\gamma}^2}{2(r_I+r_A)}$. This surplus is proportional to the investor's risk tolerance relative to the manager's. Similarly, if manager j participates directly in the capital market, he could also obtain a surplus of $\frac{r_A}{r_I+r_A}\frac{\bar{\gamma}^2}{2(r_I+r_A)}$ for bearing risk. Therefore, $\frac{r_A}{r_I+r_A}\frac{\bar{\gamma}^2}{2(r_I+r_A)}$ is the additional component of the manager's reservation utility. See Footnote 7 for the discussion about this issue. Define $\overline{CE}^0 \equiv CE^0 - \frac{r_A}{r_I+r_A}\frac{\bar{\gamma}^2}{2(r_I+r_A)}$ as the opportunity cost of the manager. Thus, $\overline{CE}^0$ is not a function of $\bar{\gamma}$.

The NPV of project j is $(1-s_j)p_j$ and the net cash flow of project j is $F-(B+\overline{CE}^0)$: that is, gross cash flow F net of the manager's cost $(B+\overline{CE}^0)$. Define $\Gamma_j \equiv \frac{\gamma_j\bar{\gamma}}{r_A+r_I}$ and $\Pi_j \equiv \frac{1}{2r_A}\frac{B^2}{F^2}\frac{\alpha_j^2\phi_j^2}{(\alpha_j^2+\phi_j^2)}$. The risk premium the firm pays to finance the project is

$$\Delta_j = \frac{\gamma_j\bar{\gamma}}{r_A+r_I} + \frac{1}{2r_A}\frac{B^2}{F^2}\frac{\alpha_j^2\phi_j^2}{(\alpha_j^2+\phi_j^2)} = \Gamma_j + \Pi_j.$$

Moreover, if the manager's actions are contractible, then the IC condition is dropped from the optimization. Following the same procedure, the optimal contract in this first-best case is $b_j^{FB} = 0$, $s_j^{FB} = 0$, and $m_j^{FB} = \frac{r_A}{r_I}$. The firm value in this first-best case is $(1 - s_j^{FB})p_j^{FB} = E^{FB}[\tilde{G}] - \frac{\gamma_j \bar{\gamma}}{r_A + r_I} = F - (B + \overline{CE}^0) - \frac{\gamma_j \bar{\gamma}}{r_A + r_I}$. Therefore, the difference in firm value in the absence and presence of moral hazard is

$$(1 - s_j^{FB})p_j^{FB} - (1 - s_j)p_j = \frac{1}{2r_A} \frac{B^2}{F^2} \frac{\alpha_j^2 \phi_j^2}{(\alpha_j^2 + \phi_j^2)} = \Pi_j. \tag{13}$$

This proves Lemma 2.

Finally, the firm's financing decision I_j is simple: $I_j = 1$ if and only if the project has a positive NPV (i.e., $(1 - s_j)p_j > 0$).

Proof of part 3 of Proposition 3.

Part 3 is proved by showing that $\frac{\partial \Delta_j}{\partial \alpha}$ could be either positive or negative. From eqn. (8),

$$\frac{\partial \Delta_j}{\partial \alpha} > 0 \text{ if and only if } \frac{\gamma_j}{r_I + r_A} \frac{\partial \bar{\gamma}}{\partial \alpha} + \lambda_j \frac{\partial \Pi_j}{\partial \alpha_j} > 0. \tag{14}$$

We prove that the above condition is not an empty set by the construction of an example. Suppose the economy consists of two types of firms, with parameters $\{\lambda_j, \delta_j, \gamma_j, \phi_j\}$, $j \in \{1, 2\}$. The mass of type-1 firm is h and of type-2 firm $1 - h$. Set $\delta_1 = \delta_2 = 0$, $\phi_1 = \phi_2 = \phi_0 > 0$, $\gamma_1 < \gamma_2$, $\lambda_1 \leq \lambda_2$. Define $\hat{F} \equiv F - (B + \overline{CE}^0)$ as the net cash flow of a project. Assume that

$$\frac{h\gamma_1 + (1-h)\gamma_2}{r_A + r_I}\gamma_1 + \Pi(\alpha_1) \quad < \quad \hat{F}, \tag{Assumption 1}$$

$$\frac{h\gamma_1 + (1-h)\gamma_2}{r_A + r_I}\gamma_2 + \Pi(\alpha_2) \quad > \quad \hat{F} > \frac{h\gamma_1}{r_A + r_I}\gamma_2 + \Pi(\alpha_2) \tag{Assumption 2}$$

With these assumptions, we could prove that all type 1 firms and some interior fraction of type 2 firms are financed. Denote k as the fraction of type 2 firms that are financed.

Then $\bar{\gamma}(k) = h\gamma_1 + (1-h)\gamma_2 k$. By putting k explicitly as an argument, $\bar{\gamma}(k)$ highlights the general equilibrium effect that the aggregate risk in the economy depends on firms' financing decisions. Because $\bar{\gamma}(k)$ is increasing in k, there exists a k^* such that $\frac{\bar{\gamma}(k^*)}{r_A+r_I}\gamma_2 + \Pi(\alpha_2) = \hat{F}$ by Assumption 2. Differentiating it with respect to α, we have $\frac{\partial}{\partial\alpha}\bar{\gamma}(k^*) = -\frac{\partial\Pi(\alpha_2)}{\partial\alpha_2}\lambda_2\frac{r_A+r_I}{\gamma_2}$. Because $\frac{\partial\Pi(\alpha_2)}{\partial\alpha_2} > 0$, $\frac{\partial}{\partial\alpha}\bar{\gamma}(k^*) < 0$. That is, more type-2 firms are financed as α decreases. Further, for type-1 firms,

$$\frac{\partial\Delta_1}{\partial\alpha} = \frac{\gamma_1}{r_A+r_I}\frac{\partial}{\partial\alpha}\bar{\gamma}(k^*) + \frac{\partial\Pi(\alpha_1)}{\partial\alpha_1}\lambda_1 = \frac{\partial\Pi(\alpha_1)}{\partial\alpha_1}\lambda_1 - \frac{\gamma_1}{\gamma_2}\frac{\partial\Pi(\alpha_2)}{\partial\alpha_2}\lambda_2.$$

The second step applies $\frac{\partial}{\partial\alpha}\bar{\gamma}(k^*) = -\frac{\partial\Pi(\alpha_2)}{\partial\alpha_2}\lambda_2\frac{r_A+r_I}{\gamma_2}$. As $\lambda_1 \to 0$, $\frac{\partial\Delta_1}{\partial\alpha} < 0$. As $\lambda_1 \to \lambda_2, \alpha_1 \to \alpha_2$ and $\frac{\partial\Delta_1}{\partial\alpha} \to \frac{\partial\Pi(\alpha_2)}{\partial\alpha_2}\lambda_2(1-\frac{\gamma_1}{\gamma_2}) > 0$. Therefore, the condition in eqn. (14) is not an empty set.

Proof of Proposition 4.

The proof is also by construction. Following the two-type-firm economy in the previous proof, we now set $\delta_1 = \delta_2 = 0$, $\phi_1 = \phi_2 = \phi_0 > 0$, $\gamma_1 < \gamma_2$, and $\lambda_1 > \lambda_2 = 0$. Further, assume

$$\frac{\gamma_1 h + \gamma_2(1-h)}{r_A+r_I}\gamma_2 > \hat{F} > \frac{(1-h)\gamma_2^2}{r_A+r_I} \text{ and } \Pi(\alpha_1) > \hat{F} > \frac{h\gamma_1^2}{r_A+r_I}.$$

The proof is completed by two claims: a) all type-1, but not all type-2, firms are financed in the first-best equilibrium; b) all type-2, but no type-1, firms are financed in the second-best equilibrium. Therefore, the sets of firms that are financed in the first- and second-best cases do not subsume each other.

In the first-best equilibrium, only systematic risk matters for project selection. Because $\gamma_1 < \gamma_2$, a necessary condition for any type-2 firm to be financed is that all type-1 firms are financed. Suppose no firms are financed. But then the risk premium for the first firm is 0 because $\bar{\gamma}$ is 0. Therefore, at least some type-1 firms will be financed.

But this implies that all type-1 firms are financed because $\Delta_1 \leq \frac{h\gamma_1^2}{r_A+r_I} < \hat{F}$. Finally, suppose that all type-1 and type-2 firms are financed. Then $\bar{\gamma} = \gamma_1 h + \gamma_2(1-h)$. For a type-2 firm $\Delta_2 = \frac{\gamma_1 h+\gamma_2(1-h)}{r_A+r_I}\gamma_2 > \hat{F}$, leading to a contradiction. Thus, at least some type-2 firms are not financed. This proves claim a.

In a second-best equilibrium that satisfies $\Pi(\alpha_1) > \hat{F}$, no type-1 firm is financed because the risk premium for its idiosyncratic risk is too high. Thus, Δ_2 is 0 for the first type-2 firm to enter the market because $\bar{\gamma} = 0$. Further, all type-2 firms are financed because $\frac{(1-h)\gamma_2^2}{r_A+r_I} < \hat{F}$. This proves claim b.

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