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**“Essays on Corporate Disclosure and
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Essays on Corporate Disclosure and Organizational Structure

A DISSERTATION

SUBMITTED TO THE TEPPER SCHOOL OF BUSINESS

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Success is not final, failure is not fatal:
it is the courage to continue that counts.

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CHAPTER 1

Conceptual Framework: Corporate Disclosure and Organizational Structure

1.1 Introduction

Corporate disclosure refers to the communication of firm information to various stakeholders. A firm's organizational structure is a system that outlines how certain activities such as capital investment decisions are directed to achieve the goals of a firm. The concepts of disclosure and organizational structure are linked by the theory of the *firm*, and this insight is at the heart of Sunder's (1997) argument: "to understand accounting, firm itself must be understood." (p. 13). Research has shown that a multi-segment firm (i.e., conglomerate or diversified firm) and a group of single-segment firms exhibit different levels of performance in terms of capital investment efficiency (e.g., Rajan et al., 2000). In addition, a group of single-segment firms exhibits different disclosure behaviors relative to a comparable multi-segment firm (e.g., Bens et al., 2011).

This dissertation takes an analytical approach to understand firms' incentives for disclosing information from the perspective of the theory of the firm. Specifically, my dissertation intends to *jointly* investigate firms' disclosure behaviors and organizational structure in the context of investment efficiency, which is a key concern for any economy (Healy and Palepu, 2001).

The accounting and finance literatures have investigated factors that affect investment efficiency; one of the key factors is *information* problems. Information

problems arise because firms usually have more information about their projects than investors, and the firms have an incentive to overstate the values of their projects. Because of this tendency towards overstatement, firms cannot credibly communicate their private information to the investors. As a result, investors will undervalue good projects and overvalue bad projects. This can make it difficult for the firms to raise capital from the investors – an example of the “lemons problem” (Akerlof, 1970). The accounting literature has investigated firms’ incentives for disclosing information in the context of the lemons problem (See Beyer et al., 2010; Stocken, 2012 for a review).

To understand factors that affect investment efficiency, however, one must consider not only how capital is raised, but also how the raised capital is allocated to investment projects (i.e., internal capital allocation). Internal capital allocation is one of the most important tasks of firms that have multiple operations (Bolton and Scharfstein, 1998), and it can be complicated by *agency* problems. Agency problems arise because, once capital has been raised, firms may not have an incentive to use the raised capital in the interests of the investors, which can lead to inefficient internal capital allocation. The corporate finance literature has investigated multiple mechanisms through which inefficient capital allocation within organizations might occur, and research has shown that organizational structure plays an important role (See Stein, 2003; Gertner and Scharfstein, 2012 for a review). Specifically, whether a firm has multiple projects under the same roof (i.e., diversified firm) or a single project (i.e., stand-alone firm) directly affects the process of internal capital allocation and the related agency problems.

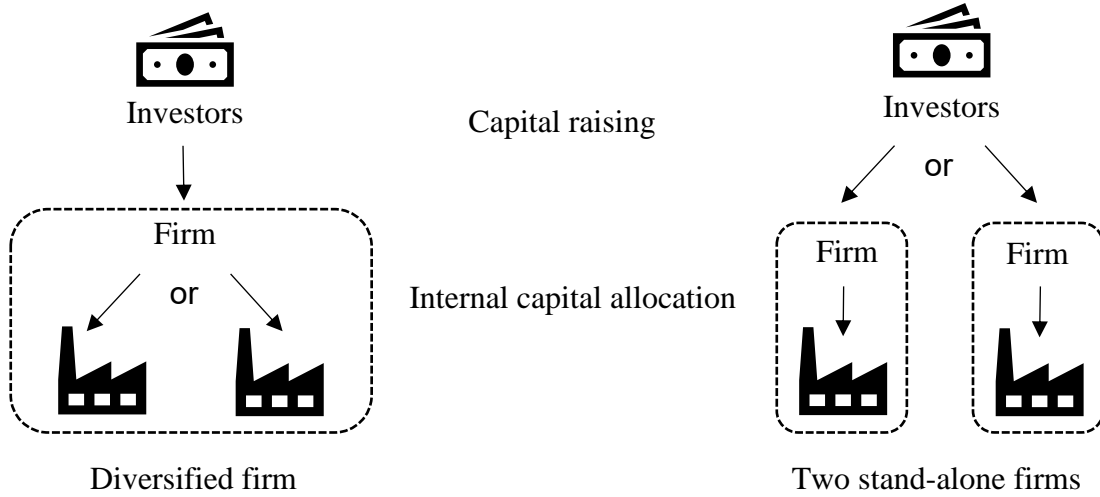


Figure 1.1: Capital investment process and organizational structures

The multi-layered process of capital investment implies that, in order to better understand the issues related to investment efficiency, one must *jointly* consider the two processes (i.e., capital raising and internal capital allocation) and the related information and agency problems. This perspective can help us better understand the disclosure behavior of firms that have multiple operations under the same roof.

Section 1.2 discusses the academic literatures that consider information and agency problems in the context of disclosure and internal capital allocation. Section 1.3 proposes an analytical framework that enables us to jointly consider firms' disclosure behavior and internal capital allocation.

1.2. Theoretical Backgrounds

1.2.1 Voluntary Disclosure

A vast literature in accounting investigates firms' incentive for disclosing information in the context of the lemons problem. A key feature of the literature is that a firm strategically manages the communication of information in the presence of a rational investor who anticipates the firm's self-interested behavior (See Stocken, 2012 for a review). An important result in this literature is that firms voluntarily disclose much of their private information, if external disclosure is credible (e.g., Grossman, 1981; Milgrom, 1981). This is widely known as the "unraveling argument," the result of both a rational investor who undervalues the project that has no disclosed information and the firm that strategically discloses its information given the investor's valuation of the project.

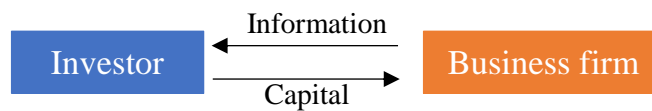


Figure 1.2: Financial and information flow in a capital market

However, the unraveling argument does not seem to be well supported empirically. For example, Kothari, Shu, and Wysocki (2009) shows that firms often withhold bad news, rather than revealing both good and bad news. The analytical literature on voluntary disclosure has shown various conditions under which partial revelation of a firm's private information holds true. Verrecchia (1983), for instance, shows that a firm discloses good news and withholds bad news in the presence of disclosure costs, and Dye (1985) and Jung and Kwon (1988) show that a firm can afford

to withhold bad news if it is common knowledge that a firm is endowed with information with some interior probability. Other papers show that uncertain investor response (e.g., Dutta and Trueman, 2002; Suijs, 2007, etc.) or uncertainty about managers' reporting incentives (e.g., Einhorn, 2007) can also explain why firms may not fully reveal their information to investors.

The archival literature on voluntary disclosure suggests that voluntary disclosure can be a useful way for firms to mitigate information asymmetry with investors. For example, Amihud and Mendelson (1986) shows that firms with more public disclosure can mitigate the lemons problem. Shroff et al. (2013) show that if firms can voluntarily disclose more information before equity offerings, they provide more pre-offering disclosures. Further, their findings suggest that these disclosures are associated with a reduction in information asymmetry and a reduction in the cost of raising equity capital. Schoenfeld (2017) shows that more voluntary disclosure is associated with increased stock liquidity, which is indicative of the reduction in the information asymmetry between firms and investors (e.g., Glosten and Milgrom, 1985). These studies have enhanced our understanding of the role of information disclosure in capital market as well as provided key policy implications. In the next subsection, I discuss the corporate finance literature on internal capital markets and related agency problems.

1.2.2 Internal Capital Markets

The corporate finance literature on internal capital markets investigates how a diversified firm allocates capital across its projects within the firm (e.g., Stein, 2003; Gertner and Scharfstein, 2012). The literature has focused mainly on the differences between internal capital allocation by a firm and an external-capital-markets benchmark; consequently, one of the key questions in this literature is whether firms allocate capital across multiple projects more efficiently than outside investors would. The literature has suggested several explanations that internal capital allocation can be either more or less efficient than an external-capital-markets benchmark.

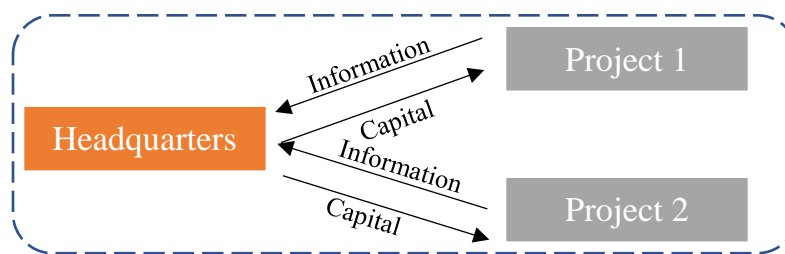


Figure 1.3: Financial and information flow in a diversified firm

The *bright* side of internal capital markets suggests that firms with multiple projects (i.e., diversified firms) are better than outside investors at allocating capital across multiple projects. This perspective has been discussed by Alchian (1969), Williamson (1975), and Stein (1997) and is based on two assumptions: First, firms know more about their projects than investors. Second, firms use their information when reallocating capital across their projects. With more information, firms can allocate capital to the best project more efficiently than the investors who may have less information about the projects; this process is often called “winner-picking and loser-

sticking” (e.g., Stein, 1997). These two assumptions are justified by the strong control rights held by the CEOs in an internal capital market (e.g., Gertner et al., 1994).

However, empirical evidence (e.g., Baker and Wruck 1989; Baker, 1992) suggests that firms are often worse at allocating capital across multiple projects than investors. This is often called the *dark* side of internal capital markets. Papers such as Rajan et al. (2000) and Scharfstein and Stein (2000) show the potential mechanisms through which firms allocate capital inefficiently, based on multi-layered agency conflicts between divisional managers and headquarters. That is, the divisional managers exert rent-seeking behavior, which leads to the distortion of capital allocation by headquarters away from the first-best benchmark, which lowers the return for the investors.

1.2.3 Discussion

The multi-layered process of capital investment implies that investors are concerned with the allocation of raised capital, and this concern affects firms’ disclosure incentives. Empirical evidence suggests that organizational structure and external disclosure behavior are related. For example, Bens, Berger, and Monahan (2011) show that firms that have investment projects in multiple industries (i.e., diversified firms) tend to withhold more information than a group of firms that operate in a single industry. Bens and Monahan (2004) show that firms with a better quality of voluntary disclosure tend to allocate capital more efficiently across their internal projects.

Compared to the empirical literature, the analytical literature has paid relatively little attention to the possible interaction between organizational structure and external disclosure. However, the analytical approach can be helpful in understanding the endogenous nature of the interaction, given its comparative advantage in generating counter-factual analysis. This approach also helps us interpret the empirical evidence in the literature.

In the next section, I propose an analytical framework based on a variation of the existing models on internal capital allocation and voluntary disclosure. The proposed framework is more generalized in Chapter 2 to deliver empirical predictions. In Chapter 3, I explore a possible extension of the model in Chapter 2 and alternative assumptions for robustness checks.

1.3 Analytical Framework

I propose an analytical framework to jointly investigate the disclosure behavior of a firm that has multiple projects under the same roof. In particular, I identify conditions under which there are benefits to having multiple projects under the same roof. The identification of these conditions is important, because if no such conditions exist, no firms will choose to have multiple projects under the same roof, and, as a result, there will be no such thing as a disclosure strategy of diversified firms.

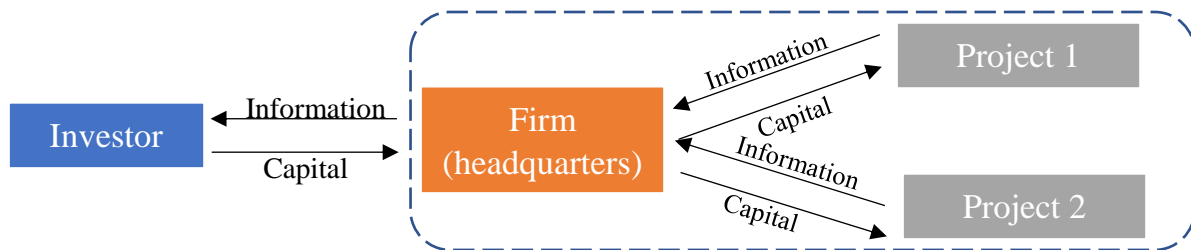


Figure 1.4: A Two-project Firm

I first investigate two models separately: one regarding internal capital allocation and the other regarding voluntary disclosure. The model of internal capital allocation is a variation of Stein (1997). The model of voluntary disclosure is based on the unraveling argument in the spirit of Grossman (1981) and Milgrom (1981). After analysis of the two models, I combine the two and show that disclosure friction that prevents the firms from disclosing private information to the investors is crucial to explaining the benefit of having multiple projects under the same roof.

1.3.1 Analytical Framework – Internal Capital Allocation

Stand-alone firm benchmark

Setup. A firm owns a single project that requires a fixed investment of capital \$0.7. At $t = 1$, the investors decide whether to invest capital. The firm implements the project if capital is raised, which is a common assumption in the literature on internal capital markets (e.g., Scharfstein and Stein, 2000). For the sake of completeness, I consider a more refined financial contract in Chapter 3. At $t = 2$, if implemented, the project generates cash flows \$2 with probability $p \in \{0.5, 0\}$, where $\Pr(p = 0.5) = \frac{1}{2}$. The firm observes p . The financial contract in this model is as follows: if the project generates \$2, the investors receive $\$R_\ell \in [0, 2]$ and the firm receives $\$2 - \R_ℓ . If the project generates \$0, both receive \$0.

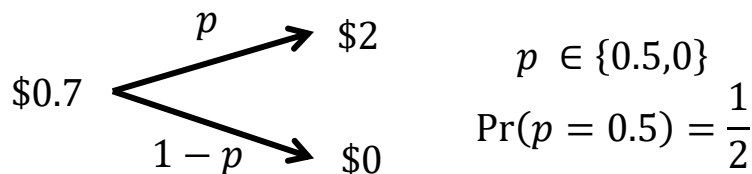


Figure 1.5: An investment project

The capital market is competitive, in that investors break even in expectation. That is, R_ℓ is determined so that $E_I[p] \times R_\ell - 0.7 = 0$, where I represents the information set of the investors. The following table depicts the timeline of the model:

$t = 1$	$t = 2$
R_ℓ is determined so that $E_I[p] \times R_\ell = 0.7$.	If project generates \$2, investors receive
Investors decide to invest capital \$0.7.	$\$R_\ell$ and the firm receives $\$2 - \R_ℓ .
	Both receive \$0 in case of failure.

Figure 1.6: Timeline – a stand-alone firm model

Analysis. At $t = 1$, the investors decide whether to invest \$0.7. They know that $p = 0.5$ with probability $\frac{1}{2}$, and the expected payoff for the investors is $\frac{1}{2} \times 0.5 \times R_\ell$. Therefore, even if R_ℓ is at the highest level (i.e., $R_\ell = \$2$), the expected payoff is $\frac{1}{2} \times 0.5 \times \$2 = \$0.5$, which is lower than the cost \$0.7 of the investment. Thus, the investors cannot break even and choose not to invest capital. This implies that, even if the firm has a profitable project with $p = 0.5$, the project is not implemented. This is an under-investment problem. The next example shows that the under-investment problem can be partially mitigated by having multiple projects under the same roof.

Two-project firm model

Setup. A firm owns project $i \in \{1,2\}$. Each project requires a fixed investment of \$0.7 and has success probability $p_i \in \{0.5,0\}$. p_1 and p_2 are independent, and $p_i = 0.5$ with probability $1/2$. The firm observes p_1 and p_2 . At $t = 1$, the investors decide whether to invest \$1.4, \$0.7, or \$0 in the firm. At $t = 2$, if \$1.4 has been raised, the firm implements both projects. If \$0.7 has been raised, the firm decides which project to

implement. At $t = 3$, projects generate cash flows, which are distributed to the firm and the investors. The following table summarizes the timeline:

$t = 1$	$t = 2$	$t = 3$
Investors decide to invest capital.	The firm decides which project(s) to implement.	Cash flows from each project realized and distributed.
Financial contract signed.		

Figure 1.7: Timeline – a two-project firm model

Analysis. At $t = 2$, if \$1.4 has been raised, the two projects are implemented; the financial contract is the same as that of the stand-alone firm. If \$0.7 has been raised, the firm decides which one of the two projects to implement. Let R_ℓ be the repayment that the investors receive upon cash flow R from the implemented project. Therefore, the firm's expected payoff is $p_1 \times (2 - R_\ell)$ if project 1 is implemented and $p_2 \times (2 - R_\ell)$ if project 2 is implemented. Thus, the firm chooses to implement project 1 if $p_1 \geq p_2$. That is, the firm allocates \$0.7 to the best project, in a process often called “winner picking and loser sticking” (Stein, 1997). Williamson (1975) argues that “this assignment of cash flows to high yield uses is the most fundamental attribute of the M-form enterprise” (p. 148).

At $t = 1$, the investors decide to invest capital \$1.4, \$0.7, or \$0 in the firm. The investors do not want to invest \$1.4 in the firm, because the expected net present value of each project is negative, according to the analysis of the stand-alone firm. If the investors invest \$0.7 in the firm, the raised capital will be allocated by the firm to a

project that has a higher success probability. Given that the two projects are independent, the likelihood that the raised capital \$0.7 is allocated by the firm to a project with $p_i = 0.5$ is $1 - \left(\frac{1}{2}\right)^2 = \frac{3}{4}$, and the expected net present value of the investment of \$0.7 becomes

$$\left(1 - \left(\frac{1}{2}\right)^2\right) \times 0.5 \times 2 - 0.7 = 0.05 > 0.$$

The two-project firm can raise \$0.7, mitigating the under-investment problem faced by the stand-alone firm. The firm can raise capital even if $p_1 = p_2 = 0$; this is an over-investment problem. However, the benefit of mitigating the under-investment problem is greater than the cost of the over-investment problem, because the over-investment occurs with lower probability; that is, $(1/2)^2 = 1/4$. R_ℓ is determined so that

$$\left(1 - \left(\frac{1}{2}\right)^2\right) R_\ell - 0.7 = 0.$$

The discussion of the two models shows that firms that have multiple projects can partially overcome the underinvestment problem, because the investors are confident that the raised capital is more likely to be allocated to a profitable project.

1.3.2 Analytical Framework – Voluntary Disclosure

Setup. Consider again a stand-alone firm. Now, suppose that after observing p , the firm can credibly disclose information about p before raising capital. If $d = D$ is

chosen, $p \in \{0.5, 0\}$ is credibly disclosed to the investors. If $d = ND$ is chosen, $p \in \{0.5, 0\}$ is not observed by the investors. The new timeline is as follows.

$t = 1$	$t = 2$	$t = 3$
The firm chooses $d \in \{D, ND\}$.	Investors decide to invest capital. R_ℓ is determined so that $E_I[p] \times R_\ell = 0.7$.	If the project generates \$2, the investors obtain R_ℓ and the firm receives $\$2 - R_\ell$.

Figure 1.8: Timeline – a stand-alone firm model with voluntary disclosure

Analysis. At $t = 2$, the investors calculate the conditional expected success probability given $d \in \{D, ND\}$, $E[p|d \in \{D, ND\}]$. R_ℓ is determined such that

$$E[p|d \in \{D, ND\}] \times R_\ell = 0.7 \Rightarrow R_\ell = \frac{0.7}{E[p|d \in \{D, ND\}]}$$

R_ℓ decreases in $E[p|d \in \{D, ND\}]$, and with lower R_ℓ , the firm can enjoy higher payoff $\$2 - \R_ℓ in case of the success of the project. If $p = 0.5$, the firm has an incentive to choose $d = D$, because the highest value of the conditional expected success probability is 0.5. If $p = 0$, the firm is indifferent between $d = ND$ and $d = D$: if $d = D$, the investors observe $p = 0$ and choose not to finance the project; if $d = ND$, the investors know that $p = 0$, because the firm with $p = 0.5$ would have chosen $d = D$. This implies that the firm's private information about p is fully revealed to the investors. This is an example of the unraveling argument.

In the presence of credible communication between the firm and the investors, the stand-alone firm can implement its project if $p = 0.5$, whereas the firms without credible communication cannot. Thus, even with a single project, the firm can

completely overcome both the under-investment problem and the over-investment problem, and the benefit of having multiple projects under the same roof disappears.

This example shows that credible communication can potentially destroy any benefit that firms can enjoy from having multiple projects under the same roof. Yet, despite their ability to voluntarily disclose information, many firms still choose to have projects in more than one industry (e.g., Montgomery, 1994; Anjos and Fracassi, 2018). In the next section, I show that in the presence of disclosure friction, there still are benefits to having multiple projects under the same roof.

1.3.3 Analytical Framework – Internal Capital Allocation and Voluntary Disclosure

Consider an investment project with *three* success probabilities. The project requires a fixed investment of \$0.7. If implemented, the project generates either $R = 2$ or $R = 0$. $R = 2$ is realized with success probability $p \in \{1, 0.5, 0\}$, and $R = 0$ with probability $1 - p$. I assume that $\Pr(p = 0) = \Pr(p = 0.5) = \Pr(p = 1) = \frac{1}{3}$. As in the previous models, the investors invest capital in the firm as long as they can break even in expectation.

Stand-alone firm benchmark

Setup. At $t = 1$, the firm observes p and chooses its disclosure strategy $d \in \{D, ND\}$. I assume that, for some *exogenous* reason, the firm chooses $d = D$ if $p = 1$ and $d = ND$ if $p \in \{0.5, 0\}$. The voluntary disclosure literature has identified several

conditions under which firms withhold bad news (See Beyer et al., 2010; Stocken, 2012 for a review). In Chapter 2 and Chapter 3, I consider two settings (i.e., Dye, 1985; Verrecchia, 1983) in which nondisclosure is endogenously derived.

At $t = 2$, the investors decide to invest capital. At $t = 3$, if \$2 is generated, the investors receive R_ℓ and the firm receives $2 - R_\ell$. If $R = 0$, both parties receive zero.

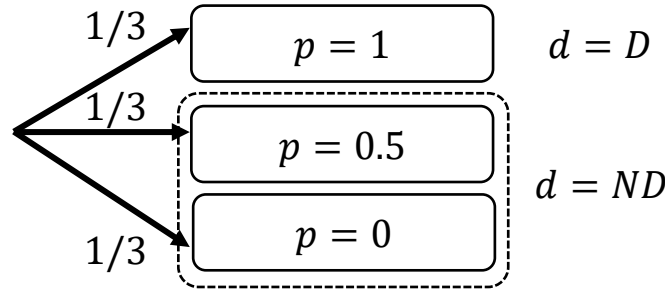


Figure 1.9: An investment project and firm's disclosure strategy

Analysis. Let us consider two cases: $p = 1$ and $p \neq 1$. If $p = 1$, the firm chooses $d = D$ by assumption. In this case, the investors know that they can break even with the investment of \$0.7. Thus, $R_\ell = 0.7$ is set at $t = 2$ so that the investors make zero profit. At $t = 3$, the project generates $R = 2$ with probability $p = 1$, and the firm enjoys $pR - 0.7 = 1.3$.

If p is either 0 or 0.5, the firm chooses $d = ND$. Therefore, upon $d = ND$, the investors know that p is either 0 or 0.5, and we have $\Pr(p = 0.5|d = ND) = \frac{1}{2}$. This makes the conditional expected net present value of the project negative:

$$\left(\frac{1}{2} \times 0.5 + \frac{1}{2} \times 0\right) \times 2 - 0.7 = -0.2.$$

Therefore, the investors choose not to invest capital \$0.7 in the firm. If $p = 0.5$, the firm suffers from the under-investment problem. This is because the firm cannot raise capital from the investors, even though the expected net present value of the firm with $p = 0.5$, $0.5 \times 2 - 0.7 = 0.3$, is positive.

From the ex-ante perspective, $p = 1$ (i.e., $d = D$) occurs with probability $\frac{1}{3}$, and the conditional expected net present value is 1.3. Thus, the ex-ante value of the firm becomes $\frac{1}{3} \times 1.3 = 0.43$, and the ex-ante value of the two stand-alone firms is 0.86.

Two-project firm model

Setup. Consider a firm that has project 1 and 2. Project $i \in \{1,2\}$ requires a fixed investment of \$0.7. If project i is implemented, the project generates cash flow $R_i \in \{0,2\}$ and $R_i = 2$ is realized with success probability $p_i \in \{0,0.5,1\}$. p_1 and p_2 are independent, and the probability distribution of the success probability of project i is as follows: $\Pr(p_i = 0) = \Pr(p_i = 0.5) = \Pr(p_i = 1) = \frac{1}{3}$. The firm observes p_1 and p_2 . Assume that, for some *exogenous* reason, the firm discloses $p_i = 1$ by choosing $d_i = D$ but withholds $p_i \in \{0,0.5\}$ by choosing $d_i = ND$.

$t = 1$	$t = 2$	$t = 3$	$t = 4$
The firm chooses $d_i \in \{D, ND\}$.	Investors decide to invest capital. Financial contract signed.	The firm decides which project to implement.	Cash flows are realized and distributed according to the contract.

Figure 1.10: Timeline – a two-project firm model with voluntary disclosure

Analysis. If $p_1 = p_2 = 1$, the firm discloses p_1 and p_2 by choosing $d_1 = d_2 = D$. The investors calculate the expected net present value of the two projects, which is $2 \times (2 - 0.7) = 2.6$. Because the net present value of each project is positive, the investors are willing to invest \$1.4 in the firm, and the firm implements both projects.

If $p_i = 1$ and $p_j \in \{0, 0.5\}$ where $i \neq j$, the firm chooses $d_i = D$ and $d_j = ND$. Then, the investors know that $p_i = 1$ and the net present value of the project i is $2 - 0.7 = 1.3$. However, the investors know that $p_j \in \{0, 0.5\}$, and the expected net present value of project j is $\left(\frac{1}{2} \times 0.5 + \frac{1}{2} \times 0\right) \times 2 - 0.7 = -0.2$. Thus, the investors choose to invest \$0.7 in the firm, and the firm implements the project that has $p_i = 1$ rather than the one with $p_i \in \{0, 0.5\}$, so that its expected payoff can be maximized.

If $p_i \in \{0, 0.5\}$ for $i \in \{1, 2\}$, the firm chooses $d_1 = d_2 = ND$. Hence, the investors know that $p_i \in \{0, 0.5\}$ for $i \in \{1, 2\}$. In addition, the investors know that if they were to provide \$0.7 to the firm, it would allocate \$0.7 to the project i with $p_i \geq p_j$, so that its expected payoff could be maximized. Therefore, the likelihood of capital \$0.7 being allocated to a project with $p_i = 0.5$ is $1 - \left(\frac{1}{2}\right)^2 = \frac{3}{4}$. This implies that the expected net present value of the investment \$0.7 in the firm is

$$\frac{3}{4} \times 0.5 \times 2 - 0.7 = 0.05 > 0.$$

Therefore, the investors are willing to invest \$0.7 in the firm upon $d_1 = d_2 = ND$, and the firm allocates \$0.7 to the project with the higher success probability. The following table summarizes the conditional expected values of the firm:

	$p_1 = 0$	$p_1 = 0.5$	$p_1 = 1$
$p_2 = 1$	$2 - 0.7 = 1.3$ $d_1 = ND; d_2 = D$		$2 \times (2 - 0.7) = 2.6$ $d_1 = D; d_2 = D$
$p_2 = 0.5$	$\frac{3}{4} \times 0.5 \times 2 - 0.7 = 0.05$ $d_1 = ND; d_2 = ND$		$2 - 0.7 = 1.3$ $d_1 = D; d_2 = ND$
$p_2 = 0$			

Figure 1.11: Conditional expected firm values

Remember that the stand-alone firm cannot raise capital upon $d = ND$. That is, the firm that has two projects under the same roof can partially mitigate the under-investment problem. The two-project firm cannot fully solve the under-investment problem, because the firm with $p_1 = p_2 = 0.5$ can raise capital for only one project. The firm can also raise capital \$0.7 even if $p_1 = p_2 = 0$; this is an over-investment problem. The benefit of mitigating the under-investment problem is greater than the cost of the over-investment problem, because the firm suffers from the over-investment problem with lower probability, which is $\left(\frac{1}{2}\right)^2 = \frac{1}{4}$.

From the ex-ante perspective, the state that $p_i = 1$ and $p_j \in \{0, 0.5\}$ for $i \neq j$ occurs with probability $\frac{1}{3} \times \frac{2}{3} + \frac{1}{3} \times \frac{2}{3} = \frac{4}{9}$. The state that $p_1 = p_2 = 1$ occurs with probability $\left(\frac{1}{3}\right)^2 = \frac{1}{9}$. The state that $p_i \in \{0, 0.5\}$ for $i \in \{1, 2\}$ occurs with probability $\left(\frac{2}{3}\right)^2 = \frac{4}{9}$. Thus, the ex-ante value of the firm becomes

$$\frac{4}{9} \times 1.3 + \frac{1}{9} \times 2.6 + \frac{4}{9} \times 0.05 = 0.87,$$

which is greater than the ex-ante value of two independent firms, 0.86. This example shows that there is value to having multiple projects under the same roof, if firms face disclosure frictions that prevent them from fully revealing their private information to investors.

1.3.4 Discussion

The analysis has shown that having multiple projects under the same roof may not be valuable in the presence of credible communication between firms and investors. In other words, in order to jointly investigate internal capital allocation and voluntary disclosure, there must be some form of limitation on the communication between the two parties. In the case of exogenous disclosure friction, I have shown that having multiple operations under the same roof is valuable in increasing the ex-ante value of the firm. In the following chapters, I consider models of voluntary disclosure where the withholding of information by the firm is endogenously derived.

1.4 Conclusion

In this section, I have briefly summarized the literature on voluntary disclosure and internal capital allocation. In addition, I have discussed an analytical framework with which internal capital allocation and voluntary disclosure can be investigated jointly. The analysis of the models shows that these two concepts can be studied simultaneously in the presence of disclosure friction.

The perspective that organizational structure and corporate disclosure closely interact with each other can be linked to a similar perspective in corporate finance. For example, Zingales (2000) argues that “Corporate finance is the study of the way firms are financed. Theory of the firm, thus, has a tremendous impact on the way we think about corporate finance, the way we do empirical research, the policy implications we derive, and the topics we choose to study” (p. 1624) The common theme in the two perspectives is the theory of the firm. Given that disclosure is essential in the process of capital investment, research opportunities regarding the interaction among corporate finance, disclosure, and the theory of the firm are abundant.

CHAPTER 2

Organizational Structure, Voluntary Disclosure, and Investment Efficiency

Abstract

Evidence on diversified firms that operate in multiple industries suggests that they often withhold information and appear to trade at a discount compared to a group of stand-alone firms. This raises the question of why firms choose to be diversified in the first place. To answer this question, I develop a model of voluntary disclosure that incorporates a key feature of diversified firms: internal capital allocation. My analysis demonstrates two main points. First, the ability to allocate capital internally can make a diversified firm more valuable than a group of stand-alone firms. This result holds true despite the fact that the diversified firm chooses to disclose less private information to the investors than stand-alone firms. Second, the first result holds true under a certain information environment a firm faces. Specifically, when it is moderately likely that the firm privately knows the profitability of its projects, the value of forming a diversified firm is higher than forming individual stand-alone ones. These results potentially explain why firms choose to be diversified even if the structure appears to be suboptimal.

2.1 Introduction

In corporate policy, disclosure is an important factor that affects investment efficiency and firm value. One effect of disclosure is that it reduces the information asymmetry and “lemons” problem (i.e., Akerlof, 1970) between firms with investment projects and investors, thereby increasing firm values. Thus, firms compare the benefits of more disclosure against its costs such as proprietary costs to determine their optimal disclosure policy.

A diversified firm is one that has investment projects in multiple industries. Evidence shows that the allocation of capital across projects within the same firm (i.e., internal capital allocation) affects both the value of a firm and its disclosure behavior. For example, compared to a group of stand-alone firms, a diversified firm, on average, appears to suffer from inefficient internal capital allocation (e.g., Gertner and Scharfstein, 2012), and firms with inefficient internal capital allocation tend to withhold information (e.g., Berger and Hann, 2007). This is related to an empirical regularity that diversified firms appear to trade at a discount (e.g., Berger and Ofek, 1995). However, this raises the question of why firms choose to operate in multiple industries in the first place (e.g., Campa and Kedia, 2002). Moreover, few studies have theoretically studied how internal capital allocation affects the value of a firm and its disclosure decisions. My paper provides a theoretical explanation that sheds light on these concerns by analyzing how diversified firms make *both* disclosure and internal capital allocation decisions.

In this paper, I address two questions. First, how does internal capital allocation across projects in multiple industries affect the value of a firm and its disclosure decisions? Second, under what conditions does internal capital allocation increase the value of a diversified firm relative to the value of a group of stand-alone firms?

To answer the research questions, I develop an analytical model based on three assumptions. First, I follow the common assumptions from the corporate finance literature (e.g., Tirole, 2006), which posits that firms are at least as much informed about the profitability of their projects as investors, and that firms seek funding from investors. Second, I follow the assumptions of Williamson (1975) about internal capital allocation, which states that firms use their information to reallocate raised capital across projects to maximize the expected cash flows from their projects. Last, I follow the assumptions of Dye (1985) and Jung and Kwon (1988) to capture firms' disclosure behavior. If firms are informed of the profitability of their projects, they can credibly disclose them; if firms are not informed, they cannot credibly reveal that they do not have information and thus remain silent about the profitability of their projects.

The model delivers two main results. First, the value of a diversified firm can be higher than a corresponding group of stand-alone firms, even though the diversified firm chooses to withhold more information. This can potentially explain why diversified firms continue to exist despite their seemingly inefficient disclosure behavior. Second, the first result holds true when both stand-alone and diversified firms are moderately likely to learn the profitability of their projects. If instead both stand-alone and diversified firms are highly likely to be informed, they make more disclosures and both share the same firm value. This is because stand-alone firms already enjoy high firm

value thanks to their abundant disclosure about their projects' profitability, and thus the hypothetical shift to a diversified structure would have no effect on its value. If firms choose the most efficient organizational structure, the result implies that firms that are moderately likely to be informed choose to be diversified. Thus, the likelihood of being informed about projects' profitability in the context of voluntary disclosure can potentially explain different firm values across different organizational structures.

I make the following modeling choices. A diversified firm, or two-division firm, has two divisions that operate in different industries, and it seeks funding from investors. A division in each industry has an investment project that generates cash flows with a success probability, which is initially unknown. I assume that the unconditional expected NPV of each project is positive. Then, the firm is randomly informed of the success probability of each project, all of which are independent. If informed of the success probability of a project, the firm can credibly disclose it to investors. However, if uninformed, the firm cannot disclose to investors that it is uninformed about the project, although the disclosure would signal to the investors that the expected NPV of the project remains positive. After the disclosure decision by the firm, investors decide whether to provide capital to the firm. If capital is raised, the firm decides which projects to implement. Finally, the cash flows from each project are generated with the corresponding success probability and distributed to both the firm and investors.

The intuition of the first result is as follows. As in Dye (1985) and Jung and Kwon (1988), the firm discloses the success probability of a project if it is high. However, the firm remains silent about the project if it is either uninformed or informed

that the success probability of the project is low. Recall that, with no news about a project, its expected NPV remains positive, but the firm cannot reveal that it is uninformed. Then, if there is no disclosure, the firm with two independent projects is more likely to have at least one positive-NPV project than the stand-alone firm. In addition, the two-division firm allocates capital to the best project to maximize its expected payoff. Thus, even if there is no disclosure, there exist conditions under which investors provide capital for one project at the two-division firm but not for the single project at the stand-alone firm, thereby mitigating the *under-investment* problem of the diversified firm. However, if informed of two low success probabilities, the diversified firm can *afford* to withhold them and still raise capital for one project. As a result, more information is withheld, leading to an *over-investment* problem of the diversified firm. The benefits of mitigating the under-investment problem outweigh the costs of the over-investment problem since the firm has a lower likelihood of having two low success probabilities

The intuition of the second result is as follows. Suppose that it is common knowledge that the two-division firm is moderately likely to be informed of the success probability of each project. Then, upon no disclosure, investors know that the firm is somewhat likely to allocate capital to at least one positive-NPV project and provide capital for one project at the two-division firm. However, the benefit of having two divisions under the same roof is not realized if a firm is either highly likely or not likely to be informed of each success probability. For example, if the two-division firm is highly likely to be informed, no disclosure is interpreted as the firm hiding low success probabilities. As a result, no capital is raised, rendering internal capital allocation

unviable. Since no disclosure leads to no investment, the firm discloses more information to avoid not receiving capital. In contrast, if the firm is not likely to be informed, no disclosure is interpreted as the firm having positive-NPV projects but no information. Thus, capital is raised for each project, rendering internal capital allocation irrelevant.

The model delivers additional results. First, I show that there is no added value for firms to be diversified if their projects generate either low or high cash flows upon success. For example, if the projects generate high cash flows upon success, the lack of disclosure does not deter investors from providing capital, making internal capital allocation irrelevant. Conversely, if the projects generate low cash flows upon success, no disclosure makes investors skeptical, leading to no investment. This makes internal capital allocation unviable. If the magnitude of cash flows upon success can be interpreted as a measure of productivity, the result predicts that firms that have moderately productive investment projects may choose to be diversified and firms that have either high or low productivity may choose to be stand-alone. If the population of low-productivity stand-alone firms is large compared to that of high-productivity stand-alone firms, this result can potentially explain Schoar's (2002) empirical evidence that diversified firms can be *more* productive than stand-alone firms.

An additional result is that diversified firms may pass up some positive-NPV projects. For example, suppose that a two-division firm is informed that the NPV of each project is just above zero. In this case, the two-division firm chooses to remain silent about its two projects and implements only one project, instead of implementing the two positive-NPV projects with disclosure. With no disclosure, the firm can pretend

that it has a project that has higher expected cash flows than the two mediocre projects. In addition, internal capital allocation makes the pooling easier. This result sheds light on why large organizations may pass up some positive-NPV projects (e.g, Berger et al., 1999). The result also implies that the disclosure strategies of two independent projects become *interdependent* due to internal capital allocation.

Related Papers

The ideas in this paper build on several earlier works. Conceptually, I follow Coase (1990), Sunder (1997), and Zingales (2000). Sunder (1997:13) emphasizes that “*to understand accounting, the firm itself must be understood.*” I follow this call by investigating accounting problems in the context of organizational structures. Specifically, my paper is related to four strands of literature: internal capital markets, voluntary disclosure, corporate financing under asymmetric information, and capital budgeting in the context of organizational structures.

The literature on internal capital markets focuses on whether internal capital markets perform better than external capital markets (see Gertner and Scharfstein, 2012 for a recent review). My paper contributes to the literature by investigating the roles of *disclosure* in explaining the relative efficiencies of internal capital markets. My paper extends Stein (1997)’s model of internal capital allocation by endogenizing firms’ disclosure decisions. Laux (2001) shows that organizing multiple projects under the same roof is beneficial because it becomes easier to incentivize the agent to exert effort. This effect comes from imperfect correlation among multiple projects, a diversification effect. My paper also depends on a diversification effect, but my focus is on how the diversification effect affects firms’ disclosure behavior.

The voluntary disclosure literature focuses on how firms strategically manage disclosure in the presence of rational investors (i.e., Stocken, 2012). I follow Dye (1985) and Jung and Kwon (1988) to capture disclosure friction in my model. Kirschenheiter (1997) and Pae (2005) consider a setting in which there are two signals to be disclosed. My contribution is that, despite the independence between the two signals, the disclosure strategy of each signal depends on the other due to internal capital allocation. Einhorn and Ziv (2007) investigate disclosure strategy of a diversified firm. They show that, if different activities cannot be measured with the same level of precision, the diversified firm discloses less information. My paper does not assume that different activities are measured with different precision. In addition, I compare both stand-alone and diversified firms, whereas their paper considers only diversified firms. The disclosure literature also considers how diversified firms can hide information through aggregation in various settings (see Arya and Glover 2014 for a recent review). My paper contributes to the literature by considering the effects of internal capital allocation on information withholding.

My paper is built upon the literature on corporate finance with asymmetric information. De Meza and Webb (1987) investigate the over-investment problem in the presence of information asymmetry between capital providers and firms. Accounting literature has investigated strategic disclosure in this setting. For example, Gox and Wagenhofer (2009) consider the optimal impairment rule and the optimal precision of accounting information in a setting in which a firm pledges its assets to raise capital for a risky project. Bertomeu et al. (2011) considers a model of financing that jointly investigates the capital structure, voluntary disclosure, and cost of capital of a firm.

Cheyne (2013) considers the general equilibrium effect of voluntary disclosure on the cost of capital and investment efficiency. Laux and Stocken (2018) considers how capital-raising and innovation activities are affected by the manipulation of accounting reports and the corresponding regulatory enforcement.

My paper is also related to the extensive literature on capital budgeting, which studies the capital investment decision within firms. Early papers that investigate the capital budgeting of diversified firms include Harris et al. (1982) and Arya et al. (1996). Other papers focus on the role of organizational structures in various investment settings. These papers include Melumad et al. (1992), Baiman and Rajan (1995), Ziv (2000), Arya et al. (2000), Arya et al. (2002), Baldenius et al (2002), Liang et al. (2008), and Dutta and Fan (2012). See Glover (2012) and Mookherjee (2013) for a recent review of related literature.

This paper is organized as follows. In Section 2, I describe the model setup for the stand-alone firm. In Section 3, I analyze the model of the stand-alone firm. In Section 4, I describe the model setup for the diversified firm and solve the model. Section 5 concludes the paper.

2.2 Stand-alone Firm Benchmark

2.2.1 Model: Stand-alone Firm



Figure 2.1: A Stand-alone Firm

Consider a stand-alone firm consisting of an *entrepreneur* and an investment project. The entrepreneur has no capital and must borrow capital K from *investors* to implement the project. Every player is risk-neutral, and the entrepreneur is protected by limited liability. The market interest rate is normalized at zero. I refer to the entrepreneur as “she” for convenience.

The investment project requires a fixed investment K . If capital K is invested in the project, it yields either cash flows R with probability p or zero cash flows with probability $1 - p$. Success probability p is uniformly distributed over $[0,1]$. I assume that the unconditional expected Net Present Value (NPV) of the project is positive:

$$E[p]R - K = \frac{1}{2}R - K > 0.$$

Let p_{BE} be defined such that

$$p_{BE}R - K = 0.$$

A project is positive expected NPV if $p \geq p_{BE}$ and negative expected NPV if $p < p_{BE}$.

Note that $\frac{R}{2} > K$ implies that $\frac{1}{2} > p_{BE}$.

The investors break even in expectation from the investment, following the common assumption in corporate finance literature (i.e., Tirole 2006). This assumption implies that the entrepreneur receives the entire ex-ante social surplus. Thus, I use the ex-ante payoff of the entrepreneur, the ex-ante value of the firm and the project interchangeably. The game has four dates.

Date 1 – Information Endowment. Nature picks success probability p from a uniform distribution over $[0,1]$. The entrepreneur *privately* observes a signal $s = p$ with probability γ . With probability $1 - \gamma$, she observes $s = \emptyset$ and remains uninformed about p . With $s = \emptyset$, the project is positive-NPV from the entrepreneur's information set since $E[p]R - K > 0$.

Date 2 – Voluntary Disclosure. The entrepreneur chooses $d \in \{D, ND\}$, which is observable to the investors. If $s = p$, she chooses $d \in \{D, ND\}$. If $d = D$ is chosen, the investors observe signal $s = p$; if $d = ND$ is chosen, the investors do not observe signal $s = p$. If $s = \emptyset$, the entrepreneur always chooses $d = ND$ and the investors do not observe $s = \emptyset$.

Date 3 – Investment. The investors calculate the expected success probability $E[p|d]$ given $d \in \{ND, D\}$. If $k = 1$ is chosen, they invest capital K in the project in return for repayment $R_\ell \in [0, R]$ upon cash flows R . If $k = 0$ is chosen, no investment is made, yielding zero return. The investors must be given enough repayment R_ℓ upon cash flows R to break even in expectation. Repayment R_ℓ satisfies the following break-even condition given $d \in \{D, ND\}$:

$$E[p|d] \times R_\ell = K.$$

Thus, given $p_{BE} = K/R$, the investors choose $k = 1$ if $E[p|d]R \geq K$ or $E[p|d] \geq p_{BE}$

because repayment $R_\ell \in [0, R]$ can be arranged so that $E[p|d] \times R_\ell = K$ holds.

However, if $E[p|d] < p_{BE}$, there is no repayment $R_\ell \in [0, R]$ satisfying the break-even condition. Thus, the investors choose $k = 0$.

Date 4 – Outcome. If cash flows R are generated from the project, repayment R_ℓ is distributed to the investors and cash $R - R_\ell$ is distributed to the entrepreneur. If cash flows R are not generated, all the players obtain zero cash flows.

$t = 1$	$t = 2$	$t = 3$	$t = 4$
<ul style="list-style-type: none"> Nature selects p from $U[0,1]$. Entrepreneur observes signal $s = p$ with probability γ. 	<ul style="list-style-type: none"> If $s = p$, she makes disclosure decision $d \in \{D, ND\}$. If $s = \emptyset$, $d = ND$. Investors observe $s = p$ if $d = D$. 	<ul style="list-style-type: none"> Investors make investment decision $k \in \{1, 0\}$. Repayment R_ℓ to investors is determined. 	<ul style="list-style-type: none"> Cash flows R generated with probability p. R_ℓ and $R - R_\ell$ distributed to investors and entrepreneur, respectively. No cash flows generated with probability $1 - p$.

Figure 2.2: Timeline – Stand-alone Firm

The Equilibrium Concept. The equilibrium solution concept is Perfect Bayesian Equilibrium (PBE). A PBE is characterized by a set of decisions and repayment R_ℓ such that

1. at date 2, $d^* = \arg \max_{d \in \{D, ND\}} E[R - R_\ell | d, s]$ maximizes the entrepreneur's expected payoff from the project given $s \in \{p, \emptyset\}$;
2. at date 3, $k^* = \arg \max_{k \in \{1, 0\}} \max\{(E[R_\ell | d] - K) \times k, 0\}$ maximizes the investors' expected return given $d \in \{ND, D\}$;
3. at date 3, repayment $R_\ell \in [0, R]$ satisfies the break-even condition of the investors given $d \in \{ND, D\}$: $K = E[p | d] \times R_\ell$;
4. the players have rational expectations at each date. The entrepreneur's and investors' beliefs about each other's strategies are consistent with the Bayes rule, if possible.

I assume that $d = ND$ is chosen if the entrepreneur expects not to raise capital from the investors upon the disclosure of signal $s = p$ (e.g., if it is slightly costly to disclose, as in Cheynel 2013).

2.2.2 Analysis: Stand-alone Firm

I derive the ex-ante value of the stand-alone firm. This section serves as the benchmark for analysis of the two-division firm in section 4.

Benchmark – No Disclosure Friction

I consider two cases with no disclosure friction. First, signal $s \in \{p, \emptyset\}$ is public. Second, the entrepreneur observes signal $s \in \{p, \emptyset\}$ and can credibly disclose $s \in \{p, \emptyset\}$ to the investors. I show that signal $s \in \{p, \emptyset\}$ has productive use in increasing ex-ante

firm value. In addition, both settings result in the same ex-ante firm value. All proofs are in the appendix.

Lemma 1. *Suppose that the entrepreneur is endowed with one investment project.*

(i) *Suppose that both the entrepreneur and the investors observe signal $s \in \{p, \emptyset\}$.*

Then, the ex-ante value of the stand-alone firm is $\frac{1}{2}R - K + \gamma \frac{K^2}{2R}$.

(ii) *Suppose that the entrepreneur privately observes $s \in \{p, \emptyset\}$ and can credibly disclose both $s = p$ and $s = \emptyset$. Then, the ex-ante value of the stand-alone firm*

is $\frac{1}{2}R - K + \gamma \frac{K^2}{2R}$.

Part (i) shows that the ex-ante firm value increases with probability γ of observing signal $s = p$. This shows that information helps society to allocate capital to profitable projects, thereby increasing investment efficiency. For example, if $\gamma = 1$, the investors always observe success probability p and invest only in a project with $p \geq p_{BE}$ (i.e., a positive-NPV project), thereby maximizing investment efficiency. If $\gamma = 0$, the investors invest capital in the project without observing p . Thus, with positive probability, capital is invested in a negative-NPV project. This is an *over-investment* problem with limited information (e.g., De Meza and Webb, 1987).

Part (ii) shows that the ex-ante firm value does not change if the entrepreneur privately observes signal s and both $s = p$ and $s = \emptyset$ can be credibly disclosed. This is because private information is ultimately revealed by an unraveling argument (i.e.,

Grossman, 1981; Milgrom, 1981), and any positive-NPV projects are implemented as a result.

Main Analysis – Stand-alone Firm

Suppose that the entrepreneur of the stand-alone firm privately observes signal $s \in \{p, \emptyset\}$. I assume that the entrepreneur can credibly disclose $s = p$ but cannot credibly disclose $s = \emptyset$ and chooses $d = ND$, following the assumptions of Dye (1985) and Jung and Kwon (1988). I use backward induction to derive the ex-ante value of the stand-alone firm.

Date 4 – Cash Flows. If $k = 1$ was chosen at date 3, the project generates cash flows R with probability p . In this case, the investors receive repayment R_ℓ and the entrepreneur receives the residual cash flows $R - R_\ell$. In every other case, both players receive zero cash flows.

Date 3 – Investment. The investors calculate $E[p|d]$, the conditional expected success probability given the disclosure decision $d \in \{D, ND\}$ by the entrepreneur. If $E[p|d] \geq p_{BE}$, the investors believe that the project is positive-NPV and decides to invest by choosing $k = 1$. Then, R_ℓ satisfies $K = E[p|d]R_\ell$. If $E[p|d] < p_{BE}$, the investors believe that the project is negative-NPV and decides not to invest by choosing $k = 0$. $E[p|d]$ is calculated in lemma 2.

Date 2 – Disclosure. If $s = p$, the entrepreneur chooses $d \in \{D, ND\}$. If she observes $s = \emptyset$, she always decides not to disclose by choosing $d = ND$. Lemma 2 summarizes both the disclosure strategy by the entrepreneur and the investment strategy by the investors.

Lemma 2. Suppose the entrepreneur of the stand-alone firm decides $d \in \{ND, D\}$ at date 2 and that the investors decide $k \in \{0,1\}$ at date 3. $p^*(\gamma)$ is defined in Lemma A1 in the appendix.

- (i) Suppose that $p^*(\gamma) \geq p_{BE}$. The investors' belief is as follows: $E[p|d = D] = p$ and $E[p|d = ND] = p^*(\gamma)$. At date 3, the investors choose $k = 1$. The entrepreneur chooses $d = D$ for $s \geq p^*(\gamma)$ and $d = ND$ for $s < p^*(\gamma)$ at date 2.
- (ii) Suppose that $p^*(\gamma) < p_{BE}$. The investors' belief is as follows: $E[p|d = D] = p$ and $E[p|d = ND] = \frac{p_{BE}}{2}$. At date 3, the investors choose $k = 1$ if signal $s \geq p_{BE}$ is disclosed and $k = 0$ if either $s < p_{BE}$ is disclosed or $d = ND$. The entrepreneur chooses $d = D$ for $s \geq p_{BE}$ and $d = ND$ for $s < p_{BE}$ at date 2.

Disclosure of Signal $s = p$. Lemma 2 shows that the entrepreneur prefers to disclose a good signal (i.e., high $s = p$) so that she can raise capital with a lower repayment R_ℓ upon success to the investors. Recall the break-even condition of the investors given $d \in \{ND, D\}$:

$$E[p|d] \times R_\ell = K.$$

Thus, if $d = D$ and $s = p$ is disclosed, the break-even condition becomes $pR_\ell = K$.

Thus, the disclosure of a high signal $s = p$ increases the entrepreneur's payoff upon success, $R - R_\ell$, by lowering repayment $R_\ell = K/p$ to the investors.

Withholding of Signal $s = p$. Part (i) of lemma 2 shows that the entrepreneur who is less likely to observe $s = p$ (i.e., a lower γ) can raise capital upon $d = ND$. If the entrepreneur is unlikely to observe $s = p$, the investors believe that $d = ND$ is most likely due to the arrival of $s = \emptyset$. Since the project is positive-NPV with $s = \emptyset$ (i.e., $E[p]R - K > 0$), the conditional NPV of the project upon $d = ND$ is close to $E[p]R - K > 0$ and positive. Thus, the investors are willing to provide capital to the entrepreneur upon $d = ND$. If the entrepreneur learns that the project is negative-NPV (i.e., $s < p_{BE}$), the entrepreneur can raise capital by choosing $d = ND$. This is an *over-investment* problem for the stand-alone firm.

Part (ii) of lemma 2 holds if γ is high, and the entrepreneur cannot raise capital upon $d = ND$. If the entrepreneur is highly likely to be informed of $s = p$, the investors believe that $d = ND$ is most likely due to the arrival of a low signal $s < p_{BE}$ rather than $s = \emptyset$. Thus, the investors become skeptical about the profitability of the project upon $d = ND$ and choose not to invest. As a result, if the entrepreneur observes $s = \emptyset$ and chooses $d = ND$, she cannot raise capital K for the positive-NPV project, thereby lowering investment efficiency. This is an *under-investment* problem for the stand-alone firm. However, if the entrepreneur observes a signal $s < p_{BE}$ and chooses $d = ND$, the negative-NPV project is efficiently liquidated, thus increasing investment efficiency.

Date 1 – Information Endowment. Probability p is drawn from a uniform distribution over $[0,1]$, and the entrepreneur observes $s = p$ with probability γ and $s = \emptyset$ with $1 - \gamma$. Based on Lemma 2, Proposition 1 derives the ex-ante value of the stand-alone firm.

Proposition 1. Suppose the entrepreneur of the stand-alone firm chooses $d \in \{D, ND\}$ if $s = p$ and $d = ND$ if $s = \emptyset$.

- (i) Define $\gamma^*(R, K) \equiv \frac{R(R-2K)}{(R-K)^2}$. $\gamma^*(R, K)$ increases in cash flows R and decreases in investment costs K .
- (ii) If $\gamma \leq \gamma^*(R, K)$, the project is always implemented and the ex-ante value of the stand-alone firm is the same as the unconditional expected NPV of the project, $\frac{1}{2}R - K$.
- (iii) For $\gamma > \gamma^*(R, K)$, the project is implemented only if signal $s \geq p_{BE}$ is disclosed. The ex-ante value of the stand-alone firm is $\gamma \frac{(R-K)^2}{2R} > \frac{1}{2}R - K$.
- (iv) $\gamma \frac{(R-K)^2}{2R} - \left(\frac{1}{2}R - K\right)$ increases in γ . It decreases in R and increases in K .

If the entrepreneur cannot disclose signal s (i.e., $d = ND$ for any $s \in \{p, \emptyset\}$), the ex-ante firm value is the same as the unconditional expected NPV of the project, which is $\frac{R}{2} - K$.

Likelihood γ of Observing $s = p$. Part (ii) of proposition 1 shows that, with a low γ , the project is *always* implemented, regardless of $d \in \{ND, D\}$. In this case, voluntary disclosure does not increase the ex-ante firm value and only determines how cash flows R are shared between the entrepreneur and the investors. In contrast, part (iii) shows that a higher γ leads to an increase in the ex-ante firm value. Upon $d = ND$, the investors believe that the firm with a higher γ is more likely to have observed a signal $s < p_{BE}$ than $s = \emptyset$ and refuse to invest. No investment upon $d = ND$ is more

likely to result in the efficient liquidation of a negative-NPV project than the inefficient liquidation of a positive-NPV project, thereby increasing the ex-ante firm value.

Cash Flows R and Investment Costs K . Part (i) and (ii) show that a higher profit margin (i.e., higher cash flows or lower investment costs) renders voluntary disclosure ineffective in increasing ex-ante firm value. With a higher profit margin, the investors *always* choose to invest because the higher profit margin makes the investors optimistic about the project upon $d = ND$. In contrast, part (i) and part (iii) show that, with a lower profit margin, the investors become skeptical about the project upon $d = ND$ and choose not to invest. This is more likely to result in an efficient liquidation of a negative-NPV project, increasing the ex-ante firm value.

Part (iv) shows that the benefit of voluntary disclosure relative to the case in which the entrepreneur cannot disclose any signal s (i.e., $d = ND$ for any $s \in \{p, \emptyset\}$) is higher with either a higher γ or a lower profit margin (i.e., lower cash flows R or higher investment costs K).

2.3 Two-Division Firm

2.3.1 Model: Two-Division Firm

Thus far, we have focused on the investment for a single project. In this section, I consider an entrepreneur with project 1 *and* 2. Like the project in the stand-alone firm, project $i \in \{1,2\}$ requires a fixed investment K , and project i generates cash flows R with success probability p_i and zero cash flows with probability $1 - p_i$. p_1 and p_2 are *independent*, and each follows a uniform distribution over $[0,1]$. The entrepreneur

observes signal $s_i = p_i$ with probability γ and $s_i = \emptyset$ with probability $1 - \gamma$ for $i \in \{1, 2\}$.

If $s_i = p_i$, the entrepreneur decides to disclose s_i by choosing $d_i \in \{D, ND\}$; if $s_i = \emptyset$, $d_i = ND$ is chosen. After d_1 and d_2 are chosen, the investors decide to provide capital $k \times K$ to the entrepreneur by choosing $k \in \{0, 1, 2\}$. If $k = 1$, the investors invest capital K in return for repayment R_ℓ upon cash flows R from one project. If $k = 2$, the investors invest capital K in each project in return for repayment $R_\ell \in [0, R]$ upon cash flows R from each project.

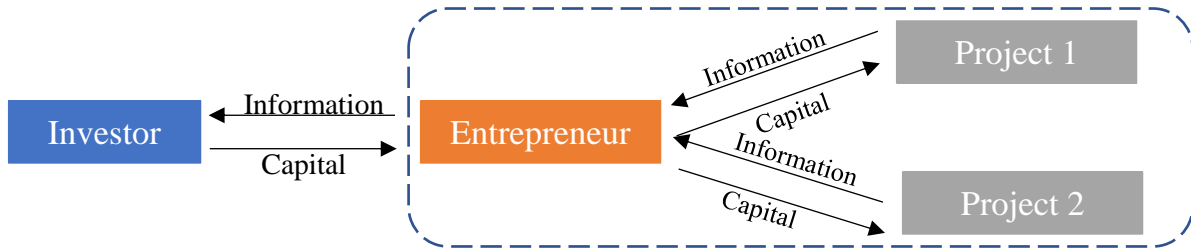


Figure 2.3: A Two-division Firm

The two-division firm has *two* features that are absent in the stand-alone firm. First, the entrepreneur has a higher likelihood of having at least one positive-NPV project with $s_i = \emptyset$, which is an example of the *diversification effect* (e.g, Adams and Yellen, 1976). That is, the entrepreneur is uninformed of both success probabilities with probability $(1 - \gamma)^2$, informed of one success probability with $2\gamma(1 - \gamma)$, and informed of both success probabilities with γ^2 . Then, the probability of observing at least one $s_i = \emptyset$ is $(1 - \gamma)^2 + 2\gamma(1 - \gamma) = 1 - \gamma^2$, which is greater than $1 - \gamma$ with which the entrepreneur of the stand-alone firm observes $s = \emptyset$. Second, the entrepreneur can allocate raised capital across the two projects after raising capital (e.g., Williamson, 1975; Stein, 1997). After k is chosen, the entrepreneur decides to allocate

capital $I_i \times K$ to project i by choosing $I_i \in \{0,1\}$. The new timeline is as follows:

$t = 1$	$t = 2$	$t = 3$	$t = 4$
<ul style="list-style-type: none"> ▪ Nature independently selects p_1 and p_2 from $U[0,1]$. ▪ Entrepreneur observes s_1 and s_2. 	<ul style="list-style-type: none"> ▪ The entrepreneur makes disclosure decision $d_1, d_2 \in \{D, ND\}$. ▪ Investors observe $s_i = p_i$ if $d_i = D$. 	<ul style="list-style-type: none"> ▪ Investors make investment decision $k \in \{0,1,2\}$. ▪ Repayment R_ℓ to investors is determined. ▪ Entrepreneur chooses $I_1, I_2 \in \{0,1\}$. 	<ul style="list-style-type: none"> ▪ Cash flows generated, distributed to entrepreneur and investors.

Figure 2.4: Timeline – Two-division Firm

2.3.2 Analysis: Two-Division Firm

No Credit Rationing

Suppose that $\gamma \leq \gamma^*(R, K)$ holds for project $i \in \{1,2\}$, where $\gamma^*(R, K)$ is defined in proposition 1. The entrepreneur is less likely to learn $s_i = p_i$, and part (ii) of proposition 1 implies that capital is always raised, leading to no credit rationing. Therefore, the ex-ante value of the two-division firm is twice as much as the ex-ante value of the stand-alone firm. That is,

$$2 \times \left(\frac{1}{2} R - K \right).$$

Internal Capital Allocation

Suppose $\gamma > \gamma^*(R, K)$ holds so that the entrepreneur of the two-division firm is highly likely to observe signal $s_i = p_i$. Part (iii) of proposition 1 suggests that the stand-alone firm cannot implement the positive-NPV project with $s = \emptyset$ and suffers from the under-investment problem. I investigate whether the two-division firm can mitigate the under-investment problem through internal capital allocation. I use backward induction to solve the model.

Date 4 – Cash Flows. If $k = 2$, the investors and the entrepreneur receive R_ℓ and $R - R_\ell$, respectively, upon cash flows R from each project at the two-division firm. If $k = 1$, the investors and the entrepreneur receive R_ℓ and $R - R_\ell$ upon cash flows R from one project.

Date 3 – Capital Allocation. After the investors make their investment decision, the entrepreneur decides to allocate capital across the two projects. The following lemma summarizes the entrepreneur's optimal capital allocation strategy.

Lemma 3. *Suppose that the entrepreneur of the two-division firm has two symmetric projects with independent success probabilities p_1 and p_2 .*

- (i) *Suppose $k = 1$. Then, the entrepreneur chooses $I_i = 1$ and $I_j = 0$ if one of the following is satisfied: (a) $s_i > s_j$, (b) $s_i = \emptyset$, and $s_j < \frac{1}{2}$. If $s_i = s_j$, the entrepreneur chooses $I_i = 1$ with an arbitrary probability.*
- (ii) *If $k = 2$, $I_1 = I_2 = 1$. If $k = 0$, $I_1 = I_2 = 0$.*

Lemma 3 summarizes the optimal capital allocation strategy of the entrepreneur if the investors provide capital K to the entrepreneur. Intuitively, the entrepreneur allocates capital to the most profitable project to maximize her expected payoff. This is a formalization of the bright side of internal capital markets in the spirit of Williamson (1975:148): “In many respects, this assignment of cash flows to high yield uses is the most fundamental attribute of the M-form enterprise...”. M-form refers to multidivisional or diversified form.

Date 3 – Investment. The investors calculate $E[p_i|d_1, d_2]$ for $i \in \{1, 2\}$, the conditional expected success probability p_i given $d_1, d_2 \in \{D, ND\}$. $k = 2$ is chosen if the two conditional expected probabilities are greater than p_{BE} . $k = 1$ is chosen if $E[p_i|d_1, d_2] \geq p_{BE}$ and $E[p_j|d_1, d_2] < p_{BE}$ for $i \neq j$. $k = 0$ is chosen if $E[p_1|d_1, d_2]$ and $E[p_2|d_1, d_2]$ are less than p_{BE} .

Date 2 – Disclosure. The entrepreneur decides whether to disclose signal $s_i = p_i$ to the investors. If she observes $s_i = \emptyset$, she chooses $d_i = ND$. Recall that $\gamma > \gamma^*(R, K)$ implies that the entrepreneur of the stand-alone firm cannot raise capital for the positive-NPV project with $s = \emptyset$. This is the under-investment problem for the stand-alone firm discussed in section 3.

However, with two projects under the same roof, the entrepreneur of the two-division firm can raise capital K upon $d_1 = d_2 = ND$ for *two* reasons: the diversification effect and internal capital allocation. Intuitively, upon $d_1 = d_2 = ND$, the entrepreneur of the two-division has a higher likelihood of having at least one positive-NPV project with $s_i = \emptyset$. In addition, the entrepreneur maximizes her expected

payoff by allocating raised capital to the best project, making investors more confident about investing capital K in the two-division firm.

Let V_{ND} denote the conditional expected NPV of one project at the two-division firm if $d_1 = d_2 = ND$. That is,

$$V_{ND} = E[p|d_1 = d_2 = ND, k = 1]R - K.$$

If $V_{ND} > 0$, the entrepreneur can raise capital K for one project. For now, I assume that $V_{ND} > 0$ and investigate the effects of $V_{ND} > 0$ on disclosure and investment behavior in Lemma 4. In Proposition 2, I will derive the condition under which $V_{ND} > 0$.

Lemma 4. *Suppose that $\gamma > \gamma^*(R, K)$. Let $p^{**} \in [p_{BE}, 1/2]$ and V_{ND} be given such that $V_{ND} = p^{**}R - K > 0$. The disclosure strategy of the entrepreneur of the two-division firm and the investment strategy of the investors are as follows.*

- (i) *If the entrepreneur observes $s_i = p_i$ and $s_j = \emptyset$, she chooses $d_i = ND$ for $s_i < p^{**}$, $d_i = D$ for $s_i \geq p^{**}$, and $d_j = ND$.*
- (ii) *If the entrepreneur observes $s_1 = p_1$ and $s_2 = p_2$,*
 - a. *she chooses $d_1 = d_2 = ND$ for $s_1, s_2 < p^{**}$ and $s_1 + s_2 < p^{**} + p_{BE}$.*
 - b. *she chooses $d_i = D$ and $d_j = ND$ for $s_i \geq p^{**}$ and $s_j < p_{BE}$.*
 - c. *she chooses $d_1 = d_2 = D$ for $s_1, s_2 \geq p_{BE}$ and $s_1 + s_2 \geq p^{**} + p_{BE}$.*
- (iii) *The investors choose $k = 2$ if $d_1 = d_2 = D$ and $k = 1$ otherwise.*

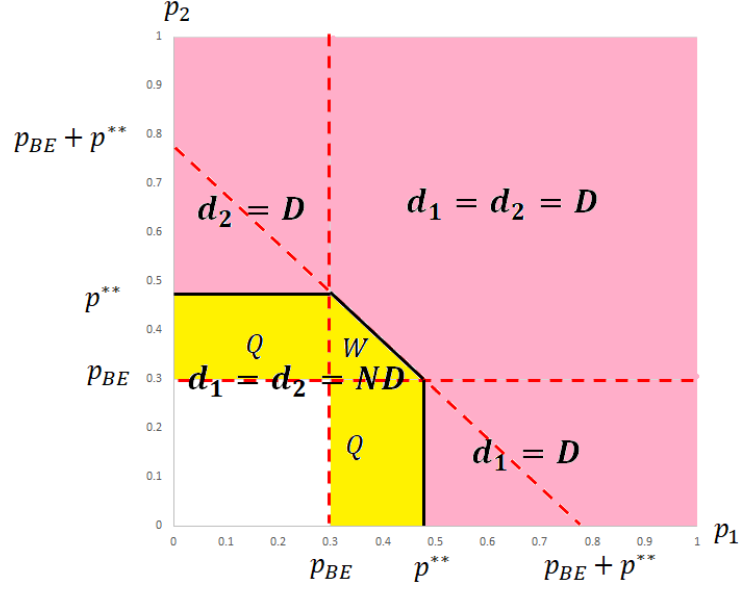


Figure 2.5: Nondisclosure set upon $s_1 = p_1$ and $s_2 = p_2$

Part (i) shows that if the entrepreneur has observed $s_i = p_i$ and $s_j = \emptyset$, her disclosure strategy of signal s_i is a threshold strategy p^{**} under which signal $s_i = p_i$ is withheld. Threshold p^{**} is chosen to satisfy $p^{**}R - K = V_{ND} > 0$. By assumption, $s_j = \emptyset$ leads to $d_j = ND$.

Part (ii) summarizes the disclosure strategies of the entrepreneur upon $s_1 = p_1$ and $s_2 = p_2$. She chooses $d_i = D$ and $d_j = ND$ if

$$s_i R - K \geq V_{ND} \text{ and } s_j < p_{BE}.$$

The intuition is as follows. $d_i = D$ is chosen if the disclosure of signal s_i results in a higher expected net present value than V_{ND} , that is, $s_i \geq p^{**}$. With the disclosure of s_i , the investors treat project j as if it is a stand-alone firm. Thus, the threshold for signal s_j is equal to p_{BE} in the stand-alone firm case. This is described in region Q of Figure 2.5.

The entrepreneur chooses $d_1 = d_2 = ND$ if the following two conditions are satisfied. First, $s_i < p^{**}$ for $i \in \{1,2\}$. Second, the entrepreneur's expected payoff of implementing both projects upon $d_1 = d_2 = D$ must be less than expected NPV of one project at the two-division firm upon $d_1 = d_2 = ND$. That is,

$$(s_1 + s_2)R - 2K < V_{ND} = p^{**}R - K \Rightarrow s_1 + s_2 < p^{**} + p_{BE}. \quad (1)$$

This inequality implies that the sum of the two signals must be high enough so that implementing the two projects with $d_1 = d_2 = D$ is more worthwhile than implementing one project with $d_1 = d_2 = ND$. It suggests that, although signals s_1 and s_2 are independent, the disclosure decisions of both signals are *interdependent*. This is described in region W in Figure 2.5. In addition, region W implies that, even if the entrepreneur learns that she has two positive-NPV projects (i.e., $s_1, s_2 > p_{BE}$), she chooses $d_1 = d_2 = ND$ and implements only one positive expected-NPV project with signal $s_i > s_j$. By doing so, the entrepreneur enjoys even higher expected payoff.

The result suggests that diversified firms choose not to implement every positive-NPV project if the expected NPV of each project is moderate. Evidence suggests that large organizations often choose not to undertake positive-NPV projects due to “organizational diseconomies” (e.g., Berger et al., 1999). The analysis of the model suggests that one reason for organizational diseconomies comes from the firm's incentive to withhold information. That is, if a firm with two projects have a moderate level of NPV, the firm chooses to withhold information to pretend that it has a single good project and obtain a favorable financial contract from the investors.

The following corollary shows that the entrepreneur of the two-division firm withholds more information than the entrepreneurs of the two stand-alone firms, and this result is mainly due to $p^{**} \geq p_{BE}$.

Corollary 1. *Suppose that $\gamma > \gamma^*(R, K)$. Let $p^{**} \in [p_{BE}, 1/2]$ and V_{ND} be given such that $V_{ND} = p^{**}R - K > 0$. The entrepreneur of the two-division firm withholds more signals than the entrepreneurs of two stand-alone firms.*

The result suggests that the entrepreneur with two projects withholds more bad news than the two entrepreneurs with a single project, if $V_{ND} > 0$ and entrepreneurs share the same likelihood γ of being informed. Withholding more information stems from agency conflicts with respect to information asymmetry between firms and investors. However, the entrepreneur can *afford* to withhold bad news. This is because, upon no disclosure, the investors believe that the entrepreneur of a diversified firm is more likely to allocate capital to a positive-NPV project than the stand-alone firm.

The following proposition derives the condition under which the entrepreneur can engage in internal capital allocation.

Proposition 2. Let $\gamma^{**}(R, K) \equiv \sqrt{\frac{3(R-2K)}{3(R-2K) + \frac{2K^3}{R^2}}}$.

- (i) $\gamma^*(R, K) < \gamma^{**}(R, K)$ for $R > 2K$ and $\gamma^*(R, K) = \gamma^{**}(R, K)$ for $R = 2K$.
- (ii) $p^{**} \in [p_{BE}, \frac{1}{2}]$ exists if $\gamma \geq \gamma^*(R, K)$ and $\gamma \leq \gamma^{**}(R, K)$.

No Internal Capital Allocation. Proposition 2 shows that, if the entrepreneur is highly likely to be informed of signal $s_i = p_i$ (i.e., $\gamma > \gamma^{**}(R, K)$), there does not exist p^{**} such that $V_{ND} > 0$. Intuitively, if the entrepreneur is highly likely to be informed of $s_i = p_i$, the investors perceive $d_1 = d_2 = ND$ as the entrepreneur hiding low $s_i = p_i$ rather than $s_i = \emptyset$. This makes the expected NPV of one project at the two-division firm negative. As a result, no capital is raised, making internal capital allocation upon no disclosure unviable. Without internal capital allocation across divisions, the two-division firm is technically the same as the two stand-alone firms. If the entrepreneur is less likely to be informed (i.e., $\gamma < \gamma^*(R, K)$), the entrepreneur can always raise capital K for each project, rendering internal capital allocation irrelevant.

Internal Capital Allocation. Proposition 2 shows that, if the entrepreneur learns each signal s_i with probability γ such that $\gamma \geq \gamma^*(R, K)$ and $\gamma \leq \gamma^{**}(R, K)$, there exists p^{**} such that $V_{ND} \geq 0$. Thus, the entrepreneur can raise capital for one project upon $d_1 = d_2 = ND$. This is because of (i) the diversification effect and (ii) internal capital allocation across the two projects.

Both effects can be seen as follows. Upon $d_1 = d_2 = ND$, the project with the highest expected success probability is the project with $s_i = \emptyset$ for two reasons. First, $E[p_i | s_i = \emptyset] = 1/2$. Second, the entrepreneur discloses any signal $s_i \geq p^{**}$, where $p^{**} \leq 1/2$. Recall that the entrepreneur with two projects observes at least one $s_i = \emptyset$ with probability

$$(1 - \gamma)^2 + 2\gamma(1 - \gamma) = 1 - \gamma^2 > 1 - \gamma.$$

This shows that the entrepreneur with two independent projects is more likely to observe signal $s_i = \emptyset$ than the entrepreneur with a single project. Thus, with the diversification effect, the investors become more confident that the entrepreneur with two projects has at least one positive-NPV project with $s_i = \emptyset$. Moreover, from lemma 3, the investors know that the entrepreneur allocates capital to the most profitable project, and, the project with $s_i = \emptyset$ is the most profitable in expectation upon $d_1 = d_2 = ND$. Thus, the combination of the effects of diversification and internal capital allocation makes the conditional success probability upon $d_1 = d_2 = ND$ and $k = 1$, $E[p|d_1 = d_2 = ND, k = 1]$, higher, where

$$E[p|d_1 = d_2 = ND, k = 1] = \left[\frac{1 - \gamma^2}{1 - \gamma^2 + \gamma^2 B(p^{**})} \frac{1}{2} + \frac{\gamma^2 B(p^{**})}{1 - \gamma^2 + \gamma^2 B(p^{**})} A(p^{**}) \right].$$

$B(p^{**})$ is the probability that $s_1 = p_1$ and $s_2 = p_2$ are withheld given p^{**} , and $A(p^{**})$ is the corresponding conditional expected success probability. p^{**} is determined so that the equation below is satisfied:

$$V_{ND}(p^{**}) = \left[\frac{1 - \gamma^2}{1 - \gamma^2 + \gamma^2 B(p^{**})} \frac{1}{2} + \frac{\gamma^2 B(p^{**})}{1 - \gamma^2 + \gamma^2 B(p^{**})} A(p^{**}) \right] R - K = p^{**} R - K > 0.$$

Date 1 – Information. I calculate the ex-ante value of the two-division firm and show that it is higher than the ex-ante value of a portfolio of two separate stand-alone firms for $\gamma \in [\gamma^*(R, K), \gamma^{**}(R, K)]$. Proposition 3 summarizes the results.

Proposition 3. *Suppose that projects held by firms are symmetric and independent.*

- (i) *The ex-ante value of a two-division firm is higher than the ex-ante value of two stand-alone firms if $\gamma^*(R, K) \leq \gamma \leq \gamma^{**}(R, K)$ holds.*
- (ii) *The ex-ante value of a two-division firm and the ex-ante value of two stand-alone firms are the same if either $\gamma < \gamma^*(R, K)$ or $\gamma > \gamma^{**}(R, K)$.*

Part (i) shows that the two-division firm performs better than the two stand-alone firms in terms of ex-ante value, if firms are *moderately* likely to learn success probabilities. This can potentially explain why we observe diversified firms in the first place. As shown in the analysis, the two-division firm withholds more bad news and sometimes foregoes a positive-NPV project. However, with the help of the diversification effect and internal capital allocation, the two-division firm can raise capital for one project upon $d_1 = d_2 = ND$, thereby mitigating the under-investment problem. Part (ii) shows that if firms are either highly likely or unlikely to be informed of success probabilities, the two-division firms share the same ex-ante value as the two stand-alone firms.

Empirical Implications. Suppose that entrepreneurs can choose to organize two projects under the same roof (i.e., a two-division firm) or two separate stand-alone firms. In addition, suppose that entrepreneurs are evenly distributed with respect to likelihood γ_i of observing $s_i = p$ from $\gamma_i = 0.4$ to $\gamma_i = 1$. Figure 2.6 suggests that (i) entrepreneurs with $\gamma_i \in (0.4, 0.8)$ choose a two-division structure and (ii) entrepreneurs with $\gamma_i > 0.8$ find no reason to choose a two-division structure, and I assume that entrepreneurs choose stand-alone firms (e.g., if there are small costs of having

diversified structure). If we take the average of the ex-ante value of a two-division firm and the average of the ex-ante value of two stand-alone firms, Figure 2.6 suggests that the average ex-ante value of a two-division firm is lower than the average ex-ante value of two stand-alone firms. This can potentially explain why diversified firms appear to be traded at a discount compared to a portfolio of stand-alone firms (e.g., Berger and Ofek, 1995). According to Villalonga (2004), this is a weak-form discount in the sense that “the existence of a diversification discount is consistent with value-maximizing behavior.” The analysis suggests that one source of a value discount for diversified firms may come from their relative inability to learn the profitability of their investment projects. Still, under the *same* conditions (e.g., likelihood γ_i of observing $s_i = p_i$), the ex-ante value of a diversified firm is higher than the ex-ante value of the two stand-alone firms.

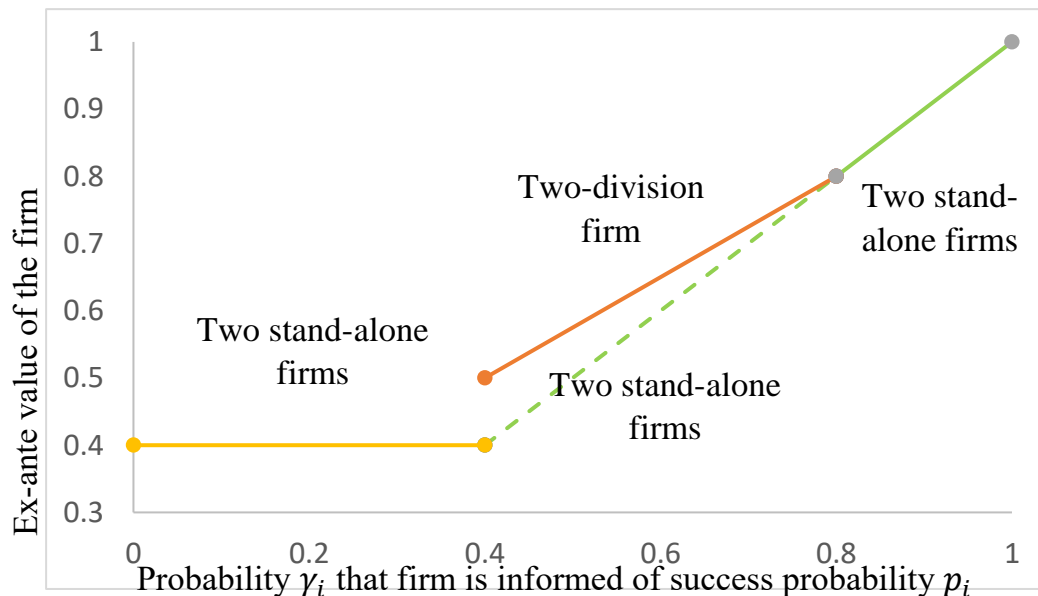


Figure 2.6: Ex-ante value of stand-alone and two-division firms

The following corollary shows how cash flows R upon success affects the value of internal capital allocation, given a fixed γ .

Corollary 2. Let $\gamma \in (0,1)$ be given such that $\gamma^*(R^*, K) = \gamma^{**}(R^{**}, K) = \gamma$ for R^* , $R^{**} > 0$.

- (i) $R^* > R^{**} > 0$;
- (ii) The ex-ante value of the two-division firm and the ex-ante value of the two stand-alone firms are the same if cash flows R are either lower than R^{**} or higher than R^* .
- (iii) The ex-ante value of the two-division firm is higher than the ex-ante value of the two stand-alone firms if $R \in (R^{**}, R^*)$.

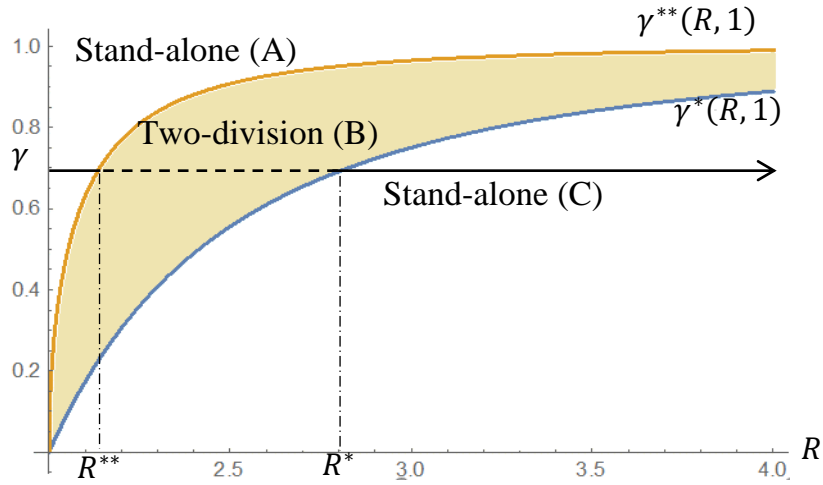


Figure 2.7: The graph of $\gamma^{**}(R, K)$ and $\gamma^{*}(R, K)$ with $K = 1$

Let $\gamma \in (0,1)$ be given. With low cash flows R , the firm is in region A in Figure 2.7, and we have $\gamma > \gamma^{**}(R^{**}, K)$. Part (ii) of proposition 3 indicates that the ex-ante

value of the two-division firm is the same as the ex-ante value of the two stand-alone firms. Intuitively, with low cash flows R , the investors become skeptical about the expected profitability of the two-division firm, leading to no-investment upon $d_1 = d_2 = ND$ and rendering internal capital allocation unviable. As cash flows R increases, γ lies in $(\gamma^*(R, K), \gamma^{**}(R, K))$. That is, the firm is in region B in Figure 2.7, and part (i) of proposition 3 indicates that the ex-ante value of the two-division firm is higher than the ex-ante value of the two stand-alone firms. With high R , the firm is in region C of Figure 2.7, and the entrepreneur always raises capital for two projects, and both organizational structures deliver the same ex-ante firm value.

If cash flows R can be interpreted as indicative of productivity and R is bounded above by a reasonable number, my analysis suggests that firms that have productive projects may choose to hold them under the same roof. With higher productivity, these firms can easily attract capital from the investors upon no disclosure and enjoy the benefit of internal capital allocation.

2.4 Conclusion

In this paper, I jointly consider both firms' disclosure and their internal capital allocation decisions. I show that diversified firms withhold more information than stand-alone firms. Despite less disclosure, diversified firms may enjoy higher firm values because of internal capital allocation across divisions. This result can potentially explain why firms choose to be diversified even if the diversified structure may lead to the withholding of more information.

This paper also investigates conditions under which the value of a diversified firm is higher than the value of a comparable set of stand-alone firms. What determines the value of the firm is the likelihood of being informed of the profitability of each divisional project. With higher likelihood of being informed, firms disclose abundant information to investors. With more information to investors, capital is efficiently allocated to profitable projects by external markets, leading to an increase in firm value. As a result, the benefit of running an internal capital market is reduced. However, with moderate likelihood of being informed, firms do not disclose abundant information to investors, and diversified structure leads to even less disclosure. Thus, the external investors cannot make efficient investment decisions, and firm value suffers as a result. However, the relative benefit of running an internal capital market increases, which induces firms to be diversified. Thus, the different likelihood of being informed of divisional profitability may explain heterogeneous firm values across different organizational structures.

The paper has two additional results. First, I show that diversified firms may choose not to implement every positive-NPV project if the expected NPV of each project is moderate. The result also implies that the disclosure strategies of two independent projects can become *interdependent* due to internal capital allocation. Second, firms choose to be diversified if their projects generate a moderate level of cash flows upon success. This result can be used to think about why diversified firms can be more productive, if cash flows upon success can be interpreted as indicative of productivity.

2.5 Appendix

Proof of Lemma 1

(i) If $s \geq p_{BE}$, the investors can break even and $k = 1$. The entrepreneur's expected payoff upon signal $s \geq p_{BE}$ becomes $s(R - R_\ell) = sR - K$, and $E[p(R - R_\ell)|s \geq p_{BE}] = \frac{p_{BE} + 1}{2}R - K$. If $s < p_{BE}$, the investors cannot break even and choose $k = 0$. If $s = \emptyset$, $E[p|s = \emptyset] = \frac{1}{2} > p_{BE}$. Thus, the investors choose $k = 1$. The entrepreneur's expected payoff becomes $E[p(R - R_\ell)|s = \emptyset] = \frac{1}{2}R - K$. At date 1, every player observes signal $s = p$ with probability γ and $s = \emptyset$ with probability $1 - \gamma$. Then, the ex-ante value of the project is calculated as follows:

$$\gamma \Pr(s \geq p_{BE}) \left(\frac{p_{BE} + 1}{2}R - K \right) + (1 - \gamma) \left(\frac{1}{2}R - K \right) = \frac{1}{2}R - K + \frac{\gamma K^2}{2R},$$

proving part (i).

(ii) Suppose that the entrepreneur of the stand-alone firm can credibly disclose both $s = p$ and $s = \emptyset$. Then, I show that the following equilibrium exists:

a) The investors' belief about p is as follows: Given $d = D$, $E[p|s] = s$ if $s \neq \emptyset$

and $E[p|s = \emptyset] = \frac{1}{2}$. Given $d = ND$, $E[p|s \leq p_{BE}] = \frac{p_{BE}}{2}$.

b) The investors choose $k = 1$ upon $s \geq p_{BE}$ or $s = \emptyset$. The investors choose $k = 0$ upon $d = ND$.

c) The entrepreneur chooses $d = ND$ if $s \leq p_{BE}$ and $d = D$ if either $s > p_{BE}$ or $s = \emptyset$.

First, given investors' belief, we have $E[p|d = ND] = p_{BE}/2 \leq p_{BE}$ upon $d = ND$. Then, the investors choose $k = 0$ if they observe either $d = ND$ or $s \leq p_{BE}$. The investors choose $k = 1$ if they observe $s > p_{BE}$ or $s = \emptyset$. Given the investors' strategy, the entrepreneur with $s > p_{BE}$ chooses $d = D$ to enjoy higher valuation $s > p_{BE} \geq E[p|d = ND]$. The entrepreneur with $s \leq p_{BE}$ is indifferent between $d = D$ and $d = ND$ because the investors cannot break even and choose $k = 0$, regardless of $d \in \{D, ND\}$. Given the indifference between $d = D$ and $d = ND$, $d = ND$ is chosen by the assumption that the entrepreneur chooses $d = ND$ if she expects not to raise capital from the investors. Thus, the investors' belief and the entrepreneur's strategy are consistent.

I show that the entrepreneur's disclosure strategy is unique. Let a compact set A denote the equilibrium nondisclosure set such that the entrepreneur chooses $d = ND$ if $s \in A$ and $d = D$ if $s \notin A$. Then, I show that $A = [0, p_{BE}]$. Suppose that there exists $s^* = \sup A$ such that $s^* > p_{BE}$ and $[0, p_{BE}] \subset A$. Then, the investors believe that either $s \in [0, p_{BE}]$ or $s \in A \setminus [0, p_{BE}]$. Thus, $E[p|d = ND] < s^*$. Then, the entrepreneur has an incentive to disclose s^* , contradicting that $s^* \in A$.

Since any positive-NPV projects (either $s = \emptyset$ or signal $s \geq p_{BE}$) are implemented and any negative-NPV project (i.e., $s < p_{BE}$) is not implemented, the first-best investment efficiency is achieved as in part (i).

Lemma A1. Let $p^*(\gamma)$ and $\theta(\gamma, p)$ be defined as follows:

$$p^*(\gamma) \equiv \frac{\sqrt{1-\gamma} - (1-\gamma)}{\gamma} \text{ and } \theta(\gamma, p) \equiv \frac{1-\gamma}{1-\gamma+\gamma p} \times \frac{1}{2} + \frac{\gamma p}{1-\gamma+\gamma p} \times \frac{p}{2}.$$

Then, $p^*(\gamma)$ is the unique solution to $\theta(\gamma, p) = p$ for $p \in [0,1]$, and $p^*(\gamma)$ decreases in γ .

Proof of Lemma A1

Let $\gamma, p \in [0,1]$ be given. Note that $\theta(\gamma, 0) = \frac{1}{2} > 0$ and $\theta(\gamma, 1) = \frac{1}{2} < 1$. The solution of $\theta(\gamma, p) = p$ is uniquely found as $p = \frac{\sqrt{1-\gamma} - (1-\gamma)}{\gamma} = p^*(\gamma)$, after discarding the negative root. Thus, we have $\theta(\gamma, p) > p$ for $p < p^*(\gamma)$ and $\theta(\gamma, p) < p$ for $p > p^*(\gamma)$.

We have $\frac{\partial}{\partial \gamma} p^*(\gamma) = \frac{2\sqrt{1-\gamma} + \gamma - 2}{2\sqrt{1-\gamma}^2}$. Note that $2\sqrt{1-\gamma} + \gamma - 2 < 0$ since

$2\sqrt{1-\gamma} < 2 - \gamma \Leftrightarrow 4(1-\gamma) < (2-\gamma)^2 = 4 - 4\gamma + \gamma^2 \Leftrightarrow 0 < \gamma^2$, which is always true. Thus, $\frac{\partial}{\partial \gamma} p^*(\gamma) < 0$. **End of Proof of Lemma A1**

Proof of Lemma 2

(i) Suppose that $p^*(\gamma) > p_{BE}$ and the investors' belief about success probability p is as follows. Given $d = ND$, $E[p|s \leq p^*(\gamma)] = \theta(\gamma, p^*(\gamma))$; given $d = D$, $E[p|d = D] = p$. I show that the investors choose $k = 1$. Given $d = ND$, we have $E[p|d = ND] = \theta(\gamma, p^*(\gamma)) = p^*(\gamma)$ by Lemma A1. Since $p^*(\gamma) > p_{BE}$, the investors choose $k = 1$. Given $d = D$, $E[p|d = D] = s \geq p^*(\gamma) > p_{BE}$. Thus, the investors choose $k = 1$.

If $s \leq p^*(\gamma) = E[p|ND]$, the entrepreneur chooses $d = ND$. The entrepreneur chooses $d = D$ for $s \geq E[p|ND]$ because $sR - K \geq E[p|ND]R - K$. Thus, the investors' belief is consistent with the strategies of the entrepreneur. In addition, the entrepreneur's disclosure strategy is unique since $p^*(\gamma)$ is uniquely defined by part (i).

(ii) Suppose that $p^*(\gamma) < p_{BE}$. Suppose that the investors' belief about success probability p is as follows: Upon $d = ND$, $E[p|d = ND] < p_{BE}$; $E[p|d = D, s] = s$. Then, the investors choose $k = 1$ if $s > p_{BE}$. If $s \leq p_{BE}$ is disclosed, the investors choose $k = 0$. If signal s is withheld, $E[p|d = ND] < p_{BE}$ and the investors choose $k = 0$.

Given the investors' belief, $d = D$ is chosen for $s > p_{BE} \geq E[p|d = ND]$. If $s \in A$ or $s \notin A$ and $s < p_{BE}$, the entrepreneur is indifferent between $d = ND$ and $d = D$ since both actions result in $k = 0$. So, the entrepreneur chooses $d = ND$ by the assumption that the entrepreneur chooses $d = ND$ if she expects not to raise capital from the investors. Thus, the entrepreneur's disclosure strategy is consistent with the investors' belief about success probability p .

I show that the entrepreneur's disclosure strategy is unique. Let a compact set A denote the equilibrium nondisclosure set such that the entrepreneur chooses $d = ND$ if $s \in A$ and $d = D$ if $s \notin A$. Then, I show that $A = [0, p_{BE}]$. Suppose that there exists $s^* = \sup A$ such that $s^* > p_{BE}$ and $[0, p_{BE}] \subset A$. Then, the investors believe that either $s \in [0, p_{BE}]$ or $s \in A \setminus [0, p_{BE}]$. Thus, $E[p|d = ND] < s^*$. Then, the entrepreneur has an incentive to disclose s^* , contradicting that $s^* \in A$.

Proof of Proposition 1

- (i) Suppose that $\gamma \leq \frac{R(R-2K)}{(R-K)^2}$. By rearranging, we have $p^*(\gamma) \geq p_{BE}$. This implies that nondisclosure of signal s does not lead to credit rationing by the investors due to part (ii) of lemma 2. Then, the ex-ante value of the project becomes

$$\begin{aligned} & \gamma(1 - p^*(\gamma)) \left(\frac{1 + p^*(\gamma)}{2} R - K \right) + (1 - \gamma(1 - p^*(\gamma))) \left(\theta(\gamma, p^*(\gamma)) \frac{R}{2} - K \right) \\ &= \frac{1}{2} R - K. \end{aligned}$$

- (ii) Suppose that $\gamma > \gamma^* = \frac{R(R-2K)}{(R-K)^2}$. By rearranging, we have $p^*(\gamma) < p_{BE}$. Thus, part (iii) of lemma 2 shows that, with nondisclosure of signal $s < p_{BE}$, the entrepreneur faces credit rationing by the investors. Then, with $p_{BE} = K/R$, the date-1 expected value of the project becomes

$$\gamma \left\{ (1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right) + p_{BE} \times 0 \right\} = \gamma \frac{(R - K)^2}{2R},$$

which is increasing in γ . Note that, with $\gamma = \frac{R(R-2K)}{(R-K)^2}$, we have $\gamma \frac{(R-K)^2}{2R} = \frac{1}{2} R - K$. That

is, $\gamma \frac{(R-K)^2}{2R}$ is bounded below by $\frac{1}{2} R - K$ at $\gamma = \frac{R(R-2K)}{(R-K)^2}$.

$$(iii) \frac{\partial}{\partial R} \left(\frac{R(R-2K)}{(R-K)^2} \right) = \frac{2R^2}{(R-K)^3} > 0 \text{ and } \frac{\partial}{\partial K} \left(\frac{R(R-2K)}{(R-K)^2} \right) = -\frac{2KR}{(R-K)^3} < 0.$$

- (iv) Note that $p_{BE}X = K$. Then, $p_{BE} = K/R$. Then, $\gamma(1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right) - \left(\frac{1}{2} R - K \right)$ increases in γ . In addition, we have

$$\frac{\partial}{\partial R} \left[\gamma(1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right) - \left(\frac{1}{2} R - K \right) \right] = - \frac{K^2 \gamma + (1 - \gamma) R^2}{2R^2} < 0$$

$$\frac{\partial}{\partial K} \left[\gamma(1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right) - \left(\frac{1}{2} R - K \right) \right] = 1 - \gamma(1 - p_{BE}) > 0,$$

proving part (iv).

Proof of Lemma 3

(i) If $k = 1$, the entrepreneur allocates capital K to one project. Then, she chooses either $I_1 = 1$ and $I_2 = 0$ or $I_1 = 0$ and $I_2 = 1$. The entrepreneur's payoff of $I_i = 1$ and $I_j = 0$ for $i \neq j$ is $E[p_i|s_i](R - R_\ell)$, where $R_\ell \in [0, R]$ is repayment to the investors upon cash flows R . Thus, she chooses $I_i = 1$ and $I_j = 0$ if $E[p_i|s_i] > E[p_j|s_j]$. $E[p_i|s_i] > E[p_j|s_j]$ happens in two cases. First, with $s_i > s_j$, we have $E[p_i|s_i] = s_i > s_j = E[p_j|s_j]$. Second, if $s_j < \frac{1}{2}$ and $s_i = \emptyset$, $E[p_i|s_i = \emptyset] = \frac{1}{2} > s_j = E[p_j|s_j]$. If the entrepreneur is indifferent between the two projects, I assume $I_i = 1$ with probability $1/2$. This happens if $s_i = s_j$.

(ii) The implementation of the project i yields $E[p_i|s_i](R - R_\ell)$, which is greater than zero payoff upon no implementation. Thus, if $k = 2$, $I_1 = I_2 = 1$ is chosen. If $k = 0$, $I_1 = I_2 = 0$ is chosen due to the lack of capital.

Proof of Lemma 4

Let ND^p be the set of signal s_i that is withheld by the entrepreneur who has observed $s_i = p_i$ and $s_j = \emptyset$. Let ND^f be the set of signal (s_1, s_2) such that, if $(s_1, s_2) \in ND^f$, the entrepreneur who has observed $s_1 = p_1$ and $s_2 = p_2$ withholds both signals.

I first derive the investors' optimal investment strategy given their belief about the success probability. Then, I derive the optimal disclosure strategy of the entrepreneur. Lastly, I show that the investors' belief is consistent with the entrepreneur's disclosure strategy.

*Let $p^{**} \in [p_{BE}, 1/2]$ be given, and suppose that the investors' belief about success probabilities p_1 and p_2 is as follows:*

- a) With $s_i = p_i$ and $s_j = \emptyset$ for $i \neq j$, the entrepreneur chooses $d_i = ND$ for $s_i = p_i \leq p^{**}$, $d_i = D$ for $s_i = p_i > p^{**}$ and $d_j = ND$.*
- b) With $s_1 = p_1$ and $s_2 = p_2$, the entrepreneur picks $d_1 = d_2 = ND$ for $s_i \leq p^{**}$, $i \in \{1, 2\}$ and $s_1 + s_2 \leq p^{**} + p_{BE}$. The entrepreneur chooses $d_i = D$ and $d_j = ND$ for $s_i \geq p^{**}$ and $s_j < p_{BE}$. The entrepreneur chooses $d_1 = d_2 = D$ for $s_i \geq p^{**}$, $i \in \{1, 2\}$ and $s_1, s_2 > p^{**} + p_{BE}$.*

Then, given investors' belief, I show $k = 2$ is chosen upon $d_1 = d_2 = D$ and $k = 1$ otherwise.

- a) The investors choose $k = 2$ if $s_1, s_2 \geq p_{BE}$ are disclosed.*
- b) If $s_i > p^{**}$ is disclosed and s_j is withheld, the investors choose $k = 1$ for the two reasons. First, we have $s_i > p^{**} \geq p_{BE}$, and the investors can break even. Second, I*

show that $E[p_j | s_i, d_j = ND] < p_{BE}$. The investors believe that, if the entrepreneur is informed, $s_j < p_{BE}$. Then, we have

$$E[p_j | s_i, d_j = ND] = \theta(\gamma, p_{BE}) < p_{BE},$$

due to (i) $p^*(\gamma) < p_{BE}$, and (ii) $\theta(\gamma, p_{BE}) < p_{BE}$ for $p_{BE} > p^*(\gamma)$ from part (i) of lemma 2.

c) Suppose that $d_1 = d_2 = ND$. Let $B(p^{**})$ denote the probability of $d_1 = d_2 = ND$ upon $\sigma_1 = p_1$ and $s_2 = p_2$. The investors believe that the entrepreneur has observed $s_1 = s_2 = \emptyset$ with probability $\frac{(1-\gamma)^2}{(1-\gamma)^2 + 2\gamma(1-\gamma) + \gamma^2 B(p^{**})}$ and the conditional expected success probability for either project is $1/2$. Then, internal capital allocation leads to investment in the project with $p_i = \emptyset$. The investors believe that, with probability $\frac{2\gamma(1-\gamma)}{(1-\gamma)^2 + 2\gamma(1-\gamma) + \gamma^2 B(p^{**})}$, the entrepreneur has observed $s_i \leq p^{**} \leq 1/2$ and $s_j = \emptyset$, and the entrepreneur allocates capital K to project j with $s_j = \emptyset$ due to part (i) of lemma 3. Then, the conditional expected success probability is also $1/2$. The investors believe that, with probability $\frac{\gamma^2 B(p^{**})}{(1-\gamma)^2 + 2\gamma(1-\gamma) + \gamma^2 B(p^{**})}$, the entrepreneur has observed $s_1 = p_1$ and $s_2 = p_2$, and the entrepreneur allocates capital K to the project with $s_i \geq s_j$ due to part (i) of lemma 3. Given the investors' belief, we have

$$\begin{aligned} B(p^{**}) &= (p_{BE})^2 + 2 \times p_{BE}(p^{**} - p_{BE}) + \frac{(p^{**} - p_{BE})^2}{2} \\ &= \frac{(p^{**})^2 + 2p^{**}p_{BE} - (p_{BE})^2}{2}. \end{aligned}$$

Let $A(p^{**})$ denote the expected success probability upon $d_1 = d_2 = ND$ and $s_1 = p_1$ and $s_2 = p_2$. $A(p^{**})$, along with V_{ND} , will be derived in proposition 2. For now, assume

that $A(p^{**})$ is given so that $V_{ND} > 0$. Then, the expected value of the project upon $d_1 = d_2 = ND$ and $k = 1$, $V_{ND}(p^{**})$, is

$$V_{ND}(p^{**}) = \left[\frac{1 - \gamma^2}{1 - \gamma^2 + \gamma^2 B(p^{**})} \frac{1}{2} + \frac{\gamma^2 B(p^{**})}{1 - \gamma^2 + \gamma^2 B(p^{**})} A(p^{**}) \right] R - K.$$

By assumption, p^{**} satisfies $V_{ND}(p^{**}) > 0$. Thus, the investors indeed choose $k = 1$.

The conditions under which $V_{ND}(p^{**}) > 0$ holds is shown in proposition 2.

I derive the entrepreneur's optimal disclosure strategy given the investors' belief and show that the investors' belief is consistent with the entrepreneur's disclosure strategy.

a) Suppose that the entrepreneur has observed $s_i = p_i$ and $s_j = \emptyset$. Then, $d_j = ND$. If $s_i < p_{BE}$, the entrepreneur chooses $d_i = ND$ to raise capital K given that the investors invest capital K upon no disclosure of both signals. With $d_i = D$, the entrepreneur cannot raise capital. Suppose that the entrepreneur has observed $s_i \geq p_{BE}$. If $s_i \geq p_{BE}$ is disclosed and $d_j = ND$, the investors choose $k = 1$ and the expected payoff becomes

$$s_i R - K.$$

Since $s_i R - K$ is increasing in s_i , the entrepreneur who has observed s_i withholds the signal if and only if it is less than or equal to a cutoff value, which I denote p^{**} . That is, $ND^p = [0, p^{**}]$. Since $V_{ND}(p^{**})$ is the expected value of the diversified firm upon $d_1 = d_2 = ND$ and $k = 1$, p^{**} satisfies

$$p^{**} R - K = V_{ND}(p^{**}).$$

Thus, the investors' belief about disclosure threshold p^{**} is consistent with the entrepreneur's disclosure strategy.

b) Suppose that the entrepreneur has observed $s_1 = p_1$ and $s_2 = p_2$. Then, given that $V_{ND}(p^{**})$ is the equilibrium project value given no disclosure and $k = 1$, $(s_1, s_2) \in ND^f$ must satisfy the following incentive compatibility conditions:

$$s_i R - K \leq V_{ND}(p^{**}) = p^{**} R - K, i \in \{1, 2\}$$

$$(s_1 + s_2)R - 2K \leq V_{ND} = p^{**} R - K \Rightarrow s_1 + s_2 \leq p^{**} + p_{BE}$$

Thus, $ND^f = \{(s_1, s_2) | s_1 \leq p^{**}, s_2 \leq p^{**}, \text{ and } s_1 + s_2 \leq p^{**} + p_{BE}\}$. The entrepreneur has an incentive to disclose s_i and withhold s_j if $s_i \geq p^{**}$ and $s_j < p_{BE}$. The entrepreneur enjoys $s_i R - K \geq V_{ND}$ with disclosure of s_i and V_{ND} with the withholding of s_i . The entrepreneur has no incentive to disclose s_j since the disclosure of $s_j < p_{BE}$ leads to zero payoff.

Note that $p^{**} \geq p_{BE}$ for the equilibrium to exist. Recall that $p^{**} R - K = V_{ND}(p^{**})$. This implies that p^{**} needs to be greater than p_{BE} so that $V_{ND} \geq 0$. If $p^{**} < p_{BE}$, $V_{ND} < 0$ and the investors chooses $k = 0$ upon no-disclosure of either both signals or one signal

Proof of Corollary 1

I consider three cases: (i) $s_1 = s_2 = \emptyset$, (ii) $s_i = p_i$ and $s_j = \emptyset$ for $i \neq j$, and (iii) $s_1 = p_1$ and $s_2 = p_2$. In each case, I show that the entrepreneur of the two-division firm withholds more information than the entrepreneurs of the two stand-alone firms.

First, upon $s_1 = s_2 = \emptyset$, the entrepreneur of the two-division firm and the entrepreneurs of stand-alone firm 1 and 2 remain silent.

Second, upon $s_i = p_i$ and $s_j = \emptyset$, the entrepreneur of the two-division firm withholds $s_i < p^{**}$ from part (i) of Lemma 4. The entrepreneur of stand-alone firm i withholds $s_i < p_{BE}$ from part (iii) of Lemma 2. Since $p^{**} > p_{BE}$, the entrepreneur of the two-division firm withholds more information.

Last, upon $s_1 = p_1$ and $s_2 = p_2$, the entrepreneur of stand-alone firm 1 and 2 withhold $s_i < p_{BE}$ from part (iii) of lemma 2. Part (ii) of Lemma 4 implies that the entrepreneur of the two-division firm withholds at least as much as $s_i \leq p_{BE}$.

Therefore, the entrepreneur of the two-division firm withholds more signals than the entrepreneurs of the two stand-alone firms.

Proof of Proposition 2

(i) I show that $\gamma^{**}(R, K) - \gamma^*(R, K) = \sqrt{\frac{3(R-2K)}{3(R-2K) + \frac{2K^3}{R^2}}} - \frac{R(R-2K)}{(R-K)^2} > 0$ for $R > 2K$.

(a) The unique solution to $\gamma^{**}(R, K) = \gamma^*(R, K)$, given K , is $R = 2K$. That is, $\gamma^{**}(R, K) = \gamma^*(R, K)$ only when $R = 2K$. Recall that $\frac{1}{2}R - K > 0$. Thus, the minimum possible R is $R = 2K$. Then, $\gamma^*(R, K) = \gamma^{**}(R, K)$ when R is at the lowest possible value, which is $R = 2K$.

(b) Both $\gamma^*(R, K)$ and $\gamma^{**}(R, K)$ increase in R for $R \geq 2K$: $\frac{\partial}{\partial R} \left(\frac{R(R-2K)}{(R-K)^2} \right) =$

$$\frac{2K^2}{(R-K)^2} > 0 \text{ and } \frac{\partial}{\partial R} \sqrt{\frac{3(R-2K)}{3(R-2K) + \frac{2K^3}{R^2}}} > 0.$$

$$(c) \frac{\partial}{\partial R} \left(\frac{R(R-2K)}{(R-K)^2} \right) = \frac{2K^2}{(R-K)^2} = \frac{2}{K} \text{ at } R = 2K, \text{ and } \frac{\partial}{\partial R} \sqrt{\frac{3(R-2K)}{3(R-2K) + \frac{2K^3}{R^2}}} \text{ at } R = 2K \text{ is}$$

infinity.

(c) implies that the slope of $\gamma^{**}(R, K)$ is higher than the slope of $\gamma^*(R, K)$ at $R = 2K$. Thus, there exists $\epsilon > 0$ such that $\gamma^{**}(R + \epsilon, K) > \gamma^*(R + \epsilon, K)$ for $R = 2K$.

(a) and (b) together imply that either $\gamma^*(R, K) - \gamma^{**}(R, K) > 0$ or $\gamma^*(R, K) - \gamma^{**}(R, K) < 0$ for $R > 2K$, and $\gamma^*(R, K) = \gamma^{**}(R, K)$ for $R = 2K$.

Thus, (a), (b), and (c) together imply that $\gamma^{**}(R, K) > \gamma^*(R, K)$ for $R > 2K$ and $\gamma^*(R, K) = \gamma^{**}(R, K)$ for $R = 2K$.

(ii) I first calculate the expected value of the project upon no $d_1 = d_2 = ND$ and $k = 1$, that is, $V_{ND}(p^{**})$. Recall $B(p^{**})$, the probability of $d_1 = d_2 = ND$ upon $s_1 = p_1$ and $s_2 = p_2$. There are three cases to consider.

a. With probability $(p_{BE})^2 / B(p^{**})$, $s_1, s_2 \leq p_{BE}$. Then, the entrepreneur allocates capital K to the project with the highest expected cash flows. That is,

$$E[\max\{p_1, p_2\} | s_1, s_2 \leq p_{BE}] = \frac{2}{3} p_{BE}.$$

b. With probability $2 \times \frac{p_{BE}(p^{**} - p_{BE})}{B(p^{**})}$, $s_i \leq p_{BE}$ and $s_j \in (p_{BE}, p^{**}]$. Thus, $I_i = 0$,

$I_j = 1$ and

$$E[p_j | s_j \in (p_{BE}, p^{**}]] = \frac{p_{BE} + p^{**}}{2}.$$

c. With probability $\frac{(p^{**}-p_{BE})^2}{2}/B(p^{**})$, $s_1, s_2 \geq p_{BE}$ such that $s_1 + s_2 \leq p_{BE} + p^{**}$.

With probability $1/2$, $s_1, s_2 \in \left[p_{BE}, \frac{p_{BE}+p^{**}}{2}\right]$ and the entrepreneur picks the project with the highest expected cash flows. That is,

$$\begin{aligned} E\left[\max\{s_1, s_2\} \middle| s_1, s_2 \in \left[p_{BE}, \frac{p_{BE}+p^{**}}{2}\right]\right] &= \frac{p_{BE} + p^{**}}{2} \frac{2}{3} + \frac{1}{3} p_{BE} \\ &= \frac{1}{3} [2p_{BE} + p^{**}]. \end{aligned}$$

With probability $1/4$, $s_1 \in \left[\frac{p_{BE}+p^{**}}{2}, p^{**}\right]$ and $s_2 \in \left[p_{BE}, \frac{p_{BE}+p^{**}}{2}\right]$ and the entrepreneur chooses $I_1 = 1$ and $I_2 = 0$. The same calculation is performed for

$s_2 \in \left[\frac{p_{BE}+p^{**}}{2}, p^{**}\right]$ and $s_1 \in \left[p_{BE}, \frac{p_{BE}+p^{**}}{2}\right]$ Then, we have

$$E\left[p_i \middle| s_i \in \left[\frac{p_{BE}+p^{**}}{2}, p^{**}\right]\right] = \frac{p_{BE} + 3p^{**}}{4}$$

Then, the expected cash flows upon $s_1, s_2 \geq p_{BE}$ and $s_1 + s_2 \leq p_{BE} + p^{**}$ is

$$\frac{1}{2} \left[\frac{2p_{BE} + p^{**}}{3} + \frac{p_{BE} + 3p^{**}}{4} \right] = \frac{11p_{BE} + 13p^{**}}{24}.$$

Then, the expected success probability $A(p^{**})$ upon $s_1 = p_1$ and $s_2 = p_2$ is

$$\begin{aligned} A(p^{**}) \equiv \frac{1}{B(p^{**})} &\left[(p_{BE})^2 \frac{2}{3} p_{BE} + 2p_{BE}(p^{**} - p_{BE}) \frac{p_{BE} + p^{**}}{2} \right. \\ &\left. + \frac{(p^{**} - p_{BE})^2}{2} \frac{11p_{BE} + 13p^{**}}{24} \right]. \end{aligned}$$

Then, we have

$$V_{ND}(p^{**}) = \left[\frac{1 - \gamma^2}{1 - \gamma^2 + \gamma^2 B(p^{**})} \frac{1}{2} + \frac{\gamma^2 B(p^{**})}{1 - \gamma^2 + \gamma^2 B(p^{**})} A(p^{**}) \right] R - K.$$

The equilibrium threshold p^{**} satisfies $V_{ND}(p^{**}) = p^{**}R - K$. By rearranging, we have

$$\frac{1 - \gamma^2}{1 - \gamma^2 + \gamma^2 B(p^{**})} \frac{1}{2} + \frac{\gamma^2 B(p^{**})}{1 - \gamma^2 + \gamma^2 B(p^{**})} A(p^{**}) = p^{**}. \quad (\text{AA.1})$$

At $p^{**} = 1/2$, the left-hand side of the equation in (AA.1) is less than $1/2$, because

$A(1/2) \leq 1/2$. At $p^{**} = p_{BE}$, the left-hand side of the equation in (AA.1) becomes

$$\frac{3 - (3 - 4(p_{BE})^3)\gamma^2}{6 - 6(1 - (p_{BE})^2)\gamma^2}.$$

Note that $\frac{\partial}{\partial \gamma} \left(\frac{3 - (3 - 4(p_{BE})^3)\gamma^2}{6 - 6(1 - (p_{BE})^2)\gamma^2} \right) = \frac{p^2(4p_{BE} - 3)\gamma}{3(1 + ((p_{BE})^2 - 1)\gamma^2)^2} < 0$ since $p_{BE} \leq \frac{1}{2}$ and $4p_{BE} - 3 \leq$

0. Then, γ needs to be low enough so that $\frac{3 - (3 - 4(p_{BE})^3)\gamma^2}{6 - 6(1 - (p_{BE})^2)\gamma^2} > p_{BE}$. By solving

$\frac{3 - (3 - 4(p_{BE})^3)\gamma^2}{6 - 6(1 - (p_{BE})^2)\gamma^2} = p_{BE}$, we get

$$\gamma^{**}(R, K) \equiv \sqrt{\frac{3(R - 2K)}{3(R - 2K) + \frac{2K^3}{R^2}}}. \quad (\text{AA.2})$$

Then, if $\gamma < \gamma^{**}(R, K)$, we have

$$\frac{(1 - \gamma)(1 + \gamma)}{(1 - \gamma)(1 + \gamma) + \gamma^2 B(p_{BE})} \frac{1}{2} + \frac{\gamma^2 B(p_{BE})}{(1 - \gamma)(1 + \gamma) + \gamma^2 B(p_{BE})} A(p_{BE}) > p_{BE}, \text{ and}$$

$$\frac{(1 - \gamma)(1 + \gamma)}{(1 - \gamma)(1 + \gamma) + \gamma^2 B\left(\frac{1}{2}\right)} \frac{1}{2} + \frac{\gamma^2 B\left(\frac{1}{2}\right)}{(1 - \gamma)(1 + \gamma) + \gamma^2 B\left(\frac{1}{2}\right)} A\left(\frac{1}{2}\right) < \frac{1}{2}$$

Thus, there exists $p^{**} \in [p_{BE}, 1/2]$ that satisfies the equation in (AA.1). p^{**} that

satisfies the cubic equation in (AA.1) is the unique real solution.

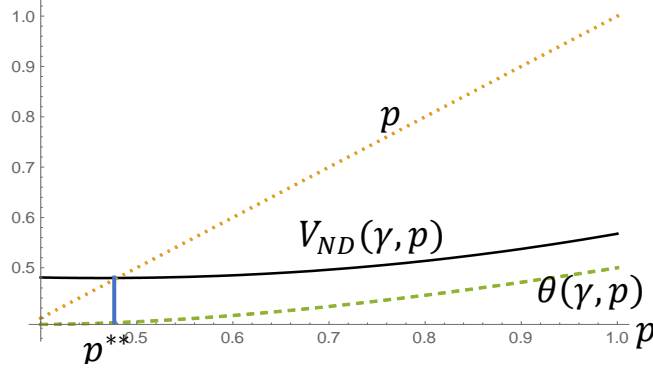


Figure A.1.: The plot of p , $V_{ND}(\gamma, p)$ and $\theta(\gamma, p)$ with $\gamma = 0.6$.

Proof of Proposition 3

(i) With probability $(1 - \gamma)^2$, the entrepreneur observes $s_1 = s_2 = \emptyset$. Then, the entrepreneur chooses $d_1 = d_2 = ND$, and the expected value of the project becomes V_{ND} .

With probability $2\gamma(1 - \gamma)$, the entrepreneur observes $s_i = p_i$ and $s_j = \emptyset$ for $i \neq j$. Then, the entrepreneur chooses $d_j = ND$, and she chooses $d_i = D$ if $s_i \geq p^{**}(\gamma)$ and $d_i = ND$ if $s_i < p^{**}(\gamma)$. Then, the expected value of the projects becomes

$$\begin{aligned} & (1 - p^{**}(\gamma))(E[p_i | s_i \geq p^{**}(\gamma)]R - K) + p^{**}V_{ND} \\ &= (1 - p^{**})\left(\frac{1 + p^{**}}{2}X - K\right) + p^{**}V_{ND}. \end{aligned}$$

With probability γ^2 , the entrepreneur observes both signal $s_1 = p_1$ and $s_2 = p_2$. Then, the entrepreneur chooses $d_1 = d_2 = D$ if $s_1, s_2 \geq p^{**}(\gamma)$, and this is realized with probability $(1 - p^{**})^2$. Then, the expected value of the projects conditional on $s_1, s_2 \geq p^{**}(\gamma)$ becomes

$$\frac{1 + p^{**}(\gamma)}{2}R - K.$$

With probability $2 \times (1 - p^{**})p_{BE}$, $s_i \in [p^{**}, 1]$ and $s_j < p_{BE}$. Then, the entrepreneur chooses $d_i = D$ and $d_j = ND$ and the expected value of the project is $\frac{1+p^{**}}{2}R - K$. With probability $2 \times (p^{**} - p_{BE})(1 - p^{**})$, $s_i \in [1 - p^{**}, 1]$ and $s_j \in [p_{BE}, p^{**}]$, and the entrepreneur chooses $d_1 = d_2 = D$, and the expected value of the projects is

$$\left(\frac{1 + p^{**}}{2} + \frac{p^{**} + p_{BE}}{2}\right)R - 2K.$$

With probability $\frac{(p^{**} - p_{BE})^2}{2}$, $s_1, s_2 \leq p^{**}$ such that $s_1 + s_2 \geq p_{BE} + p^{**}$. Then, the entrepreneur chooses $d_1 = d_2 = D$, and the expected value of the projects is calculated as follows. We know that $p_{BE} + p^{**} - s_1 \leq s_2 \leq p^{**}$ and $p_{BE} \leq s_1 \leq p^{**}$. Then, $E[s_2|s_1] = \frac{p_{BE} + 2p^{**} - s_1}{2}$. Then, $E[E[s_2|s_1]] = E[s_2] = \frac{p_{BE} + 2p^{**}}{2} - \frac{1}{2}E[s_1]$. By symmetry, $E[s_1] = E[s_2]$. Thus, we have $E[s_i] = \left(\frac{p_{BE} + 2p^{**}}{3}R - K\right)$. Since there are two implemented projects, we have

$$2 \times \left(\frac{p_{BE} + 2p^{**}}{3}R - K\right).$$

With probability $(p^{**})^2 - \frac{(p^{**} - p_{BE})^2}{2}$, the entrepreneur chooses $d_1 = d_2 = ND$, and the expected value of the project is V_{ND} . Then, the expected value of the projects is calculated as follows:

$$\begin{aligned}
& \gamma^2 \left[2(1-p^{**})^2 \left(\frac{1+p^{**}}{2} R - K \right) + 2p_{BE}(1-p^{**}) \left(\frac{1+p^{**}}{2} R - K \right) \right. \\
& \quad + 2(1-p^{**})(p^{**} - p_{BE}) \left(\left(\frac{1+p^{**}}{2} + \frac{p^{**} + p_{BE}}{2} \right) R - 2K \right) \\
& \quad + \frac{(p^{**} - p_{BE})^2}{2} 2 \times \left(\frac{p_{BE} + 2p^{**}}{3} R - K \right) + \left\{ (p^{**})^2 - \frac{(p^{**} - p_{BE})^2}{2} \right\} V_{ND} \Big] \\
& \quad + 2\gamma(1-\gamma) \left[(1-p^{**}) \left(\frac{1+p^{**}}{2} X - K \right) + p^{**} V_{ND} \right] + (1-\gamma)^2 V_{ND}.
\end{aligned}$$

By rearranging, we have

$$\begin{aligned}
& 2\gamma(1-p^{**}) \left(\frac{1+p^{**}}{2} R - K \right) \\
& \quad + \left[\{1 - \gamma(1-p^{**})\}^2 + \gamma^2(p^{**} - p_{BE})(1-p^{**}) \right. \\
& \quad \left. + \frac{\gamma^2(p^{**} - p_{BE})^2}{6} \right] V_{ND}.
\end{aligned}$$

Subtracting the ex-ante value of the two separate stand-alone firms $2\gamma(1-p_{BE}) \left(\frac{1+p_{BE}}{2} R - K \right)$ from the ex-ante value of the diversified firm, we have

$$[1 - \gamma(1-p_{BE})](1 - \gamma(1-p^{**}))V_{ND} + \gamma^2(p^{**} - p_{BE})^2 \frac{V_{ND}}{6} \geq 0. \quad (\text{AA.3})$$

Thus, the ex-ante value of the diversified firm is higher than the ex-ante value of the two

stand-alone firms for $\gamma \leq \sqrt{\frac{3(R-2K)}{3(R-2K) + \frac{2K^3}{R^2}}}$. Note that at $\gamma = \sqrt{\frac{3(R-2K)}{3(R-2K) + \frac{2K^3}{R^2}}}$, we have $p^{**} =$

p_{BE} and the ex-ante value of the diversified firm is the same as the two stand-alone firms:

$$2\gamma(1-p_{BE}) \left(\frac{1+p_{BE}}{2} R - K \right).$$

(ii) If $\gamma < \gamma^*(R, K)$, part (ii) of proposition 1 implies that the entrepreneur can always raise capital for each project. Then, the ex-ante value of the two-division firm is $2 \times \left(\frac{1}{2}R - K\right)$, as in section 4.1. $\gamma > \gamma^{**}(R, K)$, proposition 2 implies that there does not exist $p^{**} \in \left[p_{BE}, \frac{1}{2}\right]$ such that results in lemma 4 hold. Then, with $\gamma > \gamma^*(R, K)$, part (iii) of proposition holds for each project in the two-division firm. Thus, and the ex-ante value of the two-division firm is the same as the ex-ante value of the two stand-alone firms.

Proof of Corollary 2

(i) Part (i) of Proposition 2 implies that $\gamma^{**}(R, K) > \gamma^*(R, K)$ for $R > 2K$. Also, note that $\gamma^{**}(R, K)$ and $\gamma^*(R, K)$ increase in R , and $\lim_{R \rightarrow \infty} \gamma^*(R, K) = \lim_{R \rightarrow \infty} \gamma^{**}(R, K) = 1$ for $K > 0$. This implies that for R^{**} such that $\gamma = \gamma^{**}(R, K)$, we can find $R^* > R^{**}$ such that $\gamma = \gamma^{**}(R^{**}, K) = \gamma^*(R^*, K) < 1$.

(ii) For $R \leq R^{**}$, we have $\gamma \geq \gamma^{**}(R, K)$. For $R \geq R^*$, we have $\gamma \leq \gamma^*(R, K)$. Part (ii) of proposition 3 implies that the ex-ante value of the two-division firm is the same as the ex-ante value of the two stand-alone firms.

(iii) For $R \in (R^{**}, R^*)$, Part (i) of proposition 3 implies that the ex-ante value of the two-division firm is higher than the ex-ante value of the two stand-alone firms.

CHAPTER 3

Extensions and Alternative Approaches

3.1 Introduction

In this chapter, I discuss a potential extension of the model in Chapter 2. In addition, I consider alternative approaches to understanding voluntary disclosure and organizational structure in the context of investment efficiency.

In section 3.2, I consider multi-layered agency conflicts, which have received much attention in the literature on internal capital markets. In particular, I investigate a model in which external disclosure and internal information production interact with each other. I show that, under certain conditions, external disclosure encourages more information production by divisional managers. This is mainly due to the unraveling argument in the voluntary disclosure literature. That is, the divisional managers exert more effort to generate information so that the firm can avoid credit rationing upon no disclosure. This approach may help us understand how managerial and financial accounting reporting interact with each other.

In section 3.3, I consider another disclosure friction in the spirit of Verrecchia (1983) to investigate whether the main results in Chapter 2 are sensitive to a specific form of disclosure friction. I show that in the presence of disclosure costs, there exist conditions under which having multiple projects under the same roof is valuable in terms of ex-ante firm value, and multi-divisional firms withhold more information than

a comparable group of stand-alone firms. That is, much of the main results in Chapter 2 may hold true under an alternative assumption about disclosure friction.

In section 3.4, instead of considering voluntary disclosure, I investigate a contractual approach to mitigating the information asymmetry between firms and investors. I show that the first-best ex-ante outcome can be achieved with the contractual approach, under certain conditions. I also discuss possible limitations on the proposed contract.

3.2 Information Acquisition and Disclosure

3.2.1 Introduction

Chapter 2 analyzes the disclosure strategy of a multi-divisional firm in the context of investment efficiency, with a focus on the communication between the firm and the investors. However, other stakeholders may also be affected by corporate disclosure – one important group of stakeholders comprises people who work within the firm. For example, Ferreira and Rezende (2007) develop a theoretical model that shows that external disclosure helps a CEO not to change her course of action, which encourages the employees of the firm to make firm-specific investments. However, Healy and Palepu (2001) argue that “there has been relatively little research on these types of voluntary disclosures” (p. 406). One reason this perspective has not received much attention is the lack of theoretical framework, but research opportunities in this direction are potentially abundant.

The perspective that external disclosure can affect the incentives of internal employees is helpful in understanding the agency conflicts within organizations in a

more holistic way. The corporate finance literature has investigated the agency conflict between a firm's headquarters and the divisional managers to explain why multi-divisional firms may allocate capital inefficiently. For example, the CEO of a multi-divisional firm is vulnerable to either lobbying (e.g., Stein and Scharfstein, 2000; Rajan et al., 2000; Wulf, 2009) or a free-riding problem by divisional managers (e.g., Rotemberg and Saloner, 1994; De Motta, 2003; Brusco and Panunzi, 2005). However, the literature has not considered external measures such as disclosure to mitigate inefficient internal capital allocation. By investigating disclosure problems in the context of the multi-layered agency conflicts, we can better understand, for instance, how and when external governance measures such as disclosure could mitigate these conflicts.

In this section, I consider a model of voluntary disclosure where there is an internal agent who exerts effort to generate information about its divisional project. I show that voluntary disclosure by the firm and information acquisition by the internal agent can complement each other due to the unraveling argument (e.g., Milgrom 1981, etc.). If the firm does not have information, it remains silent in the spirit of Dye (1985) and Jung and Kwon (1988). Because no disclosure can be negatively viewed by the investors and lead to credit rationing, the divisional managers who prefer more to less capital investment exert effort to maximize the likelihood of being informed, to lower the likelihood of no disclosure and credit rationing. In this model, voluntary disclosure acts as a commitment device for the firm not to implement the project upon no information. This is a credible threat to the divisional managers who prefer more to less investment, and it thereby encourages more information production on the part of the

divisional managers. Section 3.2.2 describes the modeling setup. Section 3.2.3 conducts the analysis of the model. Section 3.2.4 concludes.

3.2.2 Model

Consider an *entrepreneur* who has an investment project but no capital and a limited amount of time to generate information about the project. Thus, the entrepreneur needs to raise capital from a group of *investors* and hire an *agent* who can gather information about the project. The agent prefers more to less capital to be invested in the project (i.e., empire builder), and his reservation wage is normalized to zero. The capital market is competitive, and the investors require zero expected return from their investment in the project. All players in the model are risk-neutral.

The investment project requires capital $K > 0$. If K is invested in the project, cash flow $R > 0$ is generated with probability $p \in [0,1]$ and no cash flow is generated with probability $1 - p$. I assume that p follows a uniform distribution over the unit interval: $p \sim U[0,1]$. In addition, $E[p]R - K = \frac{1}{2}R - K > 0$, meaning that the project is profitable in expectation. Let $p_{BE} \in (0,1)$ be defined such that $p_{BE}R - K = 0$, and $p_{BE} = K/R$ is the lowest probability that makes the investment project profitable in expectation. The game has four dates.

Date 1 – Information Generation. The agent makes a private effort choice $a \in [0, 1 - \gamma]$ at a private cost of $c(a)$, where $c'(a), c''(a) > 0$, and $\gamma \in (0,1)$. In addition, $c(0) = 0$ and $\lim_{a \rightarrow 1-\gamma} c(a) = \infty$. With probability $\gamma + a$, signal $s = p$ is observed by both the entrepreneur and the agent. Note that even with $a = 0$, signal $s = p$ is observed with probability $\gamma > 0$. γ can be interpreted as the quality of the information

system of the firm or the level of perceived expertise of the agent or the entrepreneur in the project. With probability $1 - \gamma - a$, $s = \emptyset$ is observed, and both the agent and the entrepreneur remain uninformed about success probability p .

Date 2 – Disclosure. The entrepreneur chooses $d \in \{D, ND\}$. If the entrepreneur has observed signal $s = p$, she chooses either $d = D$ or $d = ND$. If $d = D$ is chosen, signal $s = p$ is disclosed and observed by the investors; if $d = ND$ is chosen, signal $s = p$ is not observed by the investors. The disclosure of signal $s = p$ is truthful in the spirit of Dye (1985) and Jung and Kwon (1988). If the entrepreneur has observed signal $s = \emptyset$, she always chooses $d = ND$.

Date 3 – Investment. The investors decide whether to invest capital K in the project. The investors choose $k \in \{1, 0\}$. If $k = 1$ is chosen, the investors invest capital K in the project in return for repayment $R_\ell \in [0, R]$ upon cash flow R ; if $k = 0$, the investors do not invest capital in the project. The investors behave competitively in the capital market, and they require zero expected return from the investment. Thus, R_ℓ satisfies (i) $K = E[p|d, a] \times R_\ell$, and (ii) $R_\ell \in [0, R]$. I show in the analysis that the entrepreneur fails to raise capital from the investors if either condition is not fulfilled.

Date 4 – Outcome. With $k = 1$, the project is implemented and generates cash flow R with probability p . If cash flow R is generated, the entrepreneur and the investors receive $R - R_\ell$ and R_ℓ , respectively. If either $k = 0$ is chosen or no cash flow is generated, both the investors and the entrepreneur receive zero cash flow.

The Equilibrium Concept. The equilibrium solution concept is a Perfect Bayesian Equilibrium (PBE). A PBE is characterized by the set of decisions such that

1. $a^* = \arg \max_{a \in [0,1]} E[K; a] - c(a)$ maximizes the expected utility of the agent at date 1;
2. $d^* = \arg \max_{d \in \{D, ND\}} E[R - R_\ell; d] \times k(d)$ maximizes the entrepreneur's expected payoff from the project at date 2;
3. $k^* = \arg \max_{k \in \{1,0\}} \max\{(E[R_\ell; d, a] - K) \times k, 0\}$ maximizes the expected return of the investors at date 3;
4. The repayment R_ℓ satisfies the break-even condition: $K = E[p|d, a] \times R_\ell$ at date 3;
5. The players have rational expectations at each date. In particular, investors' beliefs about probability a are consistent with the Bayes rule, if possible.

$t = 1$	$t = 2$	$t = 3$	$t = 4$
<ul style="list-style-type: none"> ▪ Agent chooses a. ▪ With $\gamma + a$, signal $s = p$ is observed by agent and entrepreneur. 	<ul style="list-style-type: none"> ▪ Entrepreneur chooses $d \in \{D, ND\}$. ▪ Investors observe $s = p$ if $d = D$. 	<ul style="list-style-type: none"> ▪ Investors choose $k \in \{1,0\}$. ▪ If $k = 1$, repayment R_ℓ is determined. 	<ul style="list-style-type: none"> ▪ With cash flow R, entrepreneur and investors receive $R - R_\ell$ and R_ℓ, respectively. ▪ With zero cash flow, both receive zero return.

Figure 3.1: The timeline

3.2.3 Analysis

First-Best Case: Full Disclosure and Information Production by Entrepreneur

Suppose that signal $s \in \{p, \emptyset\}$ is always disclosed to the investors. In addition, the entrepreneur has no capital and can set probability $a \in [0, 1 - \gamma]$ at private cost $c(a)$. The investors make investment decisions contingent on the disclosed information. I show that the entrepreneur can achieve the first-best expected payoff.

At date 3, after observing $s \in \{p, \emptyset\}$, the investors decide whether to invest capital K by choosing $k \in \{0, 1\}$. If $s = p$ and $p \geq p_{BE}$, the investors choose $k = 1$ because they can break even and $pR_\ell = K$. Therefore, the entrepreneur's payoff upon cash flow R becomes $p(R - R_\ell) = pR - K$. Note that $pR - K$ is the expected payoff for the entrepreneur who invests her own capital upon signal $s = p$. With $s = \emptyset$, the investors still choose $k = 1$, because $E[p]R > p_{BE}R = K$. Then, we have $\frac{1}{2}R_\ell = K$, and the entrepreneur's expected payoff becomes $\frac{1}{2}(R - R_\ell) = \frac{1}{2}R - K$, which is also the same as the expected payoff for the entrepreneur who invests her *own* capital upon $s = \emptyset$. Thus, the entrepreneur who has no capital K can enjoy the same level of expected payoff as the entrepreneur who owns capital K .

At date 1, the entrepreneur chooses probability a . With the choice of a , signal $s = p$ is observed with probability $\gamma + a$, and the project is implemented if $p \geq p_{BE}$. Signal $s = \emptyset$ is observed with probability $1 - \gamma - a$, and the project is implemented. Hence, the objective function of the entrepreneur at date 1 becomes

$$\begin{aligned}
& (\gamma + a) \Pr(s \geq p_{BE}) (E[p|s \geq p_{BE}]R - K) + (1 - \gamma - a)(E[p]R - K) \\
& = (1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right) + (1 - \gamma - a) \left(\frac{1}{2} R - K \right) - c(a)
\end{aligned}$$

By rearranging, we have

$$\frac{R}{2} - K + (\gamma + a)p_{BE} \left[K - p_{BE} \frac{R}{2} \right] - c(a).$$

Because $K - p_{BE} \frac{R}{2} > K - p_{BE} R = 0$, the entrepreneur picks $a_{FB} \in (0, 1 - \gamma)$ such that

$$p_{BE} \left[K - p_{BE} \frac{R}{2} \right] = c'(a_{FB}).$$

The analysis shows that information has productive use. With signal $s = \emptyset$, the entrepreneur cannot fine-tune her investment decision and always chooses $k = 1$.

However, with signal $s = p < p_{BE}$, the entrepreneur learns that the project is not profitable in expectation and chooses not to invest capital K . Thus, signal $s = p$ helps the entrepreneur save investment spending.

No disclosure and information production by entrepreneur

Suppose signal $s \in \{p, \emptyset\}$ is not disclosed to the investors, but the entrepreneur can still choose a at private cost $c(a)$. Consequently, the investors cannot make their investment decisions contingent on the disclosed information.

At date 3, the investors decide whether to invest capital K in the project. They conjecture that the entrepreneur chooses $a = a^*$. The investors then calculate the expected cash flow of the project as follows. With probability $\gamma + a^*$, signal $s = p$ is observed by the entrepreneur, and the conditional expected cash flow of the project

becomes $E[p|s = p] = p$. With probability $1 - \gamma - a^*$, the entrepreneur observes signal $s = \emptyset$, and the expected cash flow of the project is $E[p] = \frac{1}{2}$. Hence, the expected cash flow becomes

$$(\gamma + a^*)E[E[p|s = p]]R + (1 - \gamma - a^*)E[p]R = \frac{1}{2}R,$$

and repayment R_ℓ satisfies $\frac{1}{2}R_\ell = K$. This implies that the investors always invest capital K in the firm. The date-1 expected payoff for the entrepreneur becomes

$$\begin{aligned} & (\gamma + a)E[E[p|s = p]](R - R_\ell) + (1 - \gamma - a)E[p](R - R_\ell) - c(a) \\ &= \frac{1}{2}R - K - c(a). \end{aligned}$$

Note that the expected payoff, $\frac{1}{2}R - K$, is independent of a , and the entrepreneur chooses $a = 0$. The investors' conjecture is set at $a^* = 0$.

No disclosure and information production by agent

In this section, in addition to assuming no capital endowment of the entrepreneur and no disclosure, I assume that the division manager picks a at a private cost of $c(a)$. I show that the result is the same as the previous case in which $a = 0$.

Date 3 – Investment. The investors do not observe signal s . Let a^* denote the investors' conjecture about the agent's choice of probability a . Thus, the expected cash flow from the project is

$$(\gamma + a^*)E[E[p|s = p]]R + (1 - \gamma - a^*)E[p]R = \frac{1}{2}R > K.$$

The expected cash flow is greater than the cost of investment K , so the investors decide to invest capital K in the project. Repayment R_ℓ satisfies

$$(\gamma + a^*)E[E[p|s = p]]R_\ell + (1 - \gamma - a^*)E[p]R_\ell = \frac{1}{2}R_\ell = K,$$

and the entrepreneur receives $R - R_\ell = R - 2K$ upon cash flow R .

Note that the expected payoff for the entrepreneur is independent of probability $\gamma + a^*$ that signal $s = p$ is generated. This implies that the investors' conjecture a^* does not play any role in affecting the investors' decision on $k \in \{0,1\}$.

Date 2 – Disclosure. Under no disclosure regime, the entrepreneur always chooses $d = ND$, and no signal s is observed by the investors.

Date 1 – Information Generation. At private cost $c(a)$, the agent chooses effort $a \in [0, 1 - \gamma]$ to increase probability $\gamma + a$ so that signal $s = p$ is observed by both the entrepreneur and the agent. Specifically, the agent maximizes the expected amount of capital investment K less the private cost of increasing a . Because the investors choose to invest capital K at date 3 regardless of their conjecture a^* , the agent's objective function is

$$K - c(a).$$

The agent sets $a = 0$ to maximize his utility, and the investors' conjecture a^* is set at zero to satisfy the rational expectation equilibrium. Therefore, the date-1 expected value of the project is $\frac{1}{2}(R - 2K) = \frac{1}{2}R - K > 0$. The following lemma summarizes the analysis of a stand-alone firm with no external disclosure.

Lemma 3.1. *Suppose the entrepreneur cannot disclose signal s to the investors.*

- (i) *The agent sets probability $a^* = 0$.*
- (ii) *The investors always choose $k^* = 1$.*
- (iii) *Repayment R_ℓ satisfies $R_\ell = 2K$.*
- (iv) *The date-1 expected value of the firm is $\frac{1}{2}R - K$.*

The intuition is as follows: Because the entrepreneur cannot disclose additional information about the project at date 2, the investors utilize only prior knowledge when deciding to invest capital in the project at date 3. Because the project is profitable in expectation, the investors always invest capital in the project. In addition, because the investors always invest capital K in the project, the agent chooses not to exert effort to save a private effort cost at date 1.

External Disclosure and Information Production by Agent

In this section, I consider the case in which the entrepreneur can voluntarily disclose signal $s = p$ to the investors but cannot reveal $s = \emptyset$. In addition, the agent exerts private effort $c(a)$ to increase the probability that signal $s = p$ is generated.

Date 2 and 3 – Disclosure and Investment. The entrepreneur decides to disclose signal $s = p$ to investors. I follow the disclosure model of Dye (1985) and Jung and Kwon (1988). That is, disclosure is truthful, and the entrepreneur can choose to withhold signal $s = p$. The following lemma summarizes both the disclosure strategy by the entrepreneur and the investment strategy by the investors. Proofs are found in the appendix.

Lemma 3.2. *Suppose that the entrepreneur can disclose signal $s = p$ but cannot disclose $s = \emptyset$ at date 2. Let $a^* \in [0, 1 - \gamma]$ be given and define s^* as*

$$s^*(\gamma, a^*) \equiv \frac{\sqrt{1 - \gamma - a^*} - (1 - \gamma - a^*)}{\gamma + a^*}.$$

- (i) *If $s^* > p_{BE}$, the entrepreneur chooses $d = D$ for $s \geq s^*$ and $d = ND$ for $s < s^*$ at date 2. The investors choose $k = 1$ at date 3.*
- (ii) *If $s^* < p_{BE}$, the entrepreneur chooses $d = D$ for $s \geq p_{BE}$ and $d = ND$ for $s < p_{BE}$ at date 2. At date 3, the investors choose $k = 1$ if signal $s = p$ is disclosed and $k = 0$ if $s = p$ is not disclosed.*
- (iii) *$s^*(\gamma, a^*)$ decreases in γ and a^* .*

Part (i) of lemma 3.2 confirms the standard result in the disclosure literature.

The entrepreneur discloses good signal $s = p \geq s^*$ so that the repayment amount to the investors can be lowered. The entrepreneur has an incentive to withhold signal $s = p < s^*$ so that the entrepreneur can pool with investment projects that have higher expected success probability. Note that the investors always choose to invest their capital in the project, because the project is still profitable upon no disclosure of signal $s = p$.

Part (ii) shows that the investors do not invest their capital in the project upon no disclosure of signal $s = p$ if $s^* < p_{BE}$, and part (iii) shows that s^* is lower with higher γ . Intuitively, with higher γ , the investors think that no disclosure of signal $s = p$ is more likely due to the result of low signal $s = p$ than no signal. Thus, if probability γ is high enough, we have $s^* < p_{BE}$ due to part (iii), and part (ii) shows that the investors refuse to invest their capital in the project upon no disclosure of signal $s = p$.

Date 1 – Information Generation. The agent decides to incur private cost $c(a)$ to increase a . Lemma 3.2 shows that the investors refuse to invest in the project, if γ is high enough. This has a direct implication for the incentive of the agent to generate signal $s = p$. The following proposition shows that the agent has an incentive to generate information if γ is high enough.

Proposition 3.3.

- (i) Define $\gamma^* \equiv \frac{R(R-2K)}{(R-K)^2}$. For $\gamma \leq \gamma^*$, the agent sets $a = 0$. The date-1 expected value of the project is $\frac{1}{2}R - K$.
- (ii) For $\gamma \geq \gamma^*$, the agent sets $a^* > 0$. The date-1 expected value of the project is $(\gamma + a^*)(1 - p_{BE}) \left(\frac{1+p_{BE}}{2} R - K \right)$.
- (iii) $\frac{R(R-2K)}{(R-K)^2}$ increases in R and decreases in K .

Proposition 3.3 shows that firms with external disclosure encourage more information production. The reason comes from the possibility of credit rationing upon no disclosure of signal s . Because firms without external disclosure always raise capital from investors, the agent knows that he will enjoy capital investment regardless of his effort to generate signal s . However, the agent of a firm with external disclosure faces a possibility of credit rationing upon no disclosure. Thus, the agent has an incentive to generate signal $s = p$ so that credit rationing occurs with lower probability. This shows that external disclosure has dual roles: disclosure not only provides information to the investors, but it also incentivizes internal agents to work harder.

Comparison

Part (iv) of lemma 3.1 shows that the expected value of the project with no disclosure is $\frac{1}{2}R - K$. Part (i) of proposition 3.3 shows that the expected value of the project with external disclosure is $\frac{1}{2}R - K$ if γ is low enough. Thus, if γ is low, voluntary disclosure does not add value to the project. However, part (ii) of proposition 3.3 shows that if γ is high enough, the expected value of the project with external disclosure becomes $(\gamma + a^*)(1 - p_{BE})\left(\frac{1+p_{BE}}{2}R - K\right)$. Therefore, firms that have both high γ and external disclosure enjoy higher expected payoff than firms with no external disclosure if

$$(\gamma + a^*)(1 - p_{BE})\left(\frac{1+p_{BE}}{2}R - K\right) > \frac{1}{2}R - K.$$

The following corollary summarizes the conditions under which external disclosure increases the ex-ante value of the firm relative to the no-disclosure benchmark.

Corollary 3.4.

- (i) *The expected values of the project under no disclosure and external disclosure are the same for $\gamma \leq \frac{R(R-2K)}{(R-K)^2}$.*
- (ii) *Firms with either higher γ or higher K or lower R may prefer adopting external disclosure.*

The corollary shows that firms with lower γ are indifferent between disclosure and no disclosure regimes in terms of the expected value of the project. If a firm can incur a cost in order to install the disclosure technology in the spirit of Dye (1985), the result suggests that firms with lower γ may choose not to incur a cost at all.

Part (ii) of the corollary shows that firms with higher γ may choose to incur a cost to install the disclosure technology of Dye (1985), because the disclosure technology helps these firms to fine-tune their investment decisions based on the project state. In addition, firms with a higher profit margin (higher R and lower K) are not likely to incur a cost to install Dye's (1985) disclosure technology. The intuition is as follows: With external disclosure, firms that have either higher γ or lower expected profit (lower R and higher K) are more vulnerable to credit rationing, which induces the agent to set $a^* > 0$. With higher a^* , the entrepreneur can fine-tune her investment decisions. Thus, the results predict that firms that have either higher internal information quality or lower profit margin may adopt more voluntary disclosure policies.

3.2.4 Discussion

This section discusses a possible extension of the model in Chapter 2. I specifically investigate the interaction between voluntary disclosure and investment decisions. I show that voluntary disclosure makes firms more vulnerable to credit rationing by the investors, but it induces division managers to generate more information about the projects, which improves the quality of investment decisions. This model can be extended even further so that we can better understand the interaction between managerial and financial reporting.

3.3 Voluntary Disclosure: Alternative Disclosure Friction

3.3.1 Introduction

The model in Chapter 2 is based on the assumption of Dye (1985) and Jung and Kwon (1988). Another well-known disclosure friction in the corporate disclosure literature is disclosure cost (i.e., Verrecchia, 1983). That is, the firm incurs a fixed cost if it decides to disclose information to the investors. This is often interpreted as the proprietary cost of corporate disclosure, and the literature on the proprietary cost of disclosure has received much attention (See Beyer et al., 2010 for a review).

In this section, I discuss an example to show that, in the presence of a disclosure cost, there exist conditions under which having multiple projects under the same roof is valuable in terms of ex-ante firm value. I also show that multi-divisional firms withhold more information than a comparable group of stand-alone firms. That is, much of the main results in Chapter 2 may hold true under an alternative assumption about disclosure friction.

3.3.2 Model

Consider two independent investment projects. Each project requires a fixed investment of $K = 1$. If implemented, project $i \in \{1, 2\}$ generates either $R_i = 3$ or $R_i = 0$. For each project $i \in \{1, 2\}$, $R_i = 3$ is realized with success probability $p_i \in \left\{1, \frac{1}{2}, 0\right\}$, and I assume that $\Pr(p_i = 1) = \Pr\left(p_i = \frac{1}{2}\right) = \Pr(p_i = 0) = \frac{1}{3}$, and p_1 and p_2 are independent. The firm always implements projects if capital has been raised, and the investors break even in expectation. The game has four dates.

$t = 1$	$t = 2$	$t = 3$	$t = 4$
The firm chooses $d_i \in \{D, ND\}$.	Investors decide to invest capital.	The firm decides which project to implement.	Project i generates $R_i = 3$ with p_i and $R_i = 0$ with $1 - p_i$. Each party receives cash flows based on the contract.

Figure 3.2: timeline

At $t = 1$, the firm chooses $d_i \in \{D, ND\}$ for each project $i \in \{1, 2\}$. If $d_i = D$ is chosen, success probability p_i is revealed to the investors, and the firm incurs disclosure cost $c = 0.5$. However, if $d_i = ND$ is chosen, success probability p_i is not revealed to the investors, and the firm does not incur disclosure cost c . If the firm is indifferent between $d_i = D$ and $d_i = ND$, I assume that the firm chooses $d_i = ND$.

At $t = 2$, the investors decide whether to invest capital. At $t = 3$, the firm decides which project to implement if \$1 has been raised. At $t = 4$, projects generate cash flows, which are distributed according to the financial contract.

3.3.3 Analysis

Stand-alone firm benchmark

Let me first consider a firm that has a single project. I show the following observation of the model; the proof is in the appendix.

Observation 3.5. *The firm sets $d = ND$ if $p = 0$ and $d = D$ if $p \in \{\frac{1}{2}, 1\}$. The investors choose not to invest capital \$1 upon $d = ND$ and to invest capital \$1 if $d = D$.*

Thus, with $p = 0$, the firm chooses $d = ND$ and there is no investment. The reasons for no disclosure include low success probability and disclosure cost c . With $p = \frac{1}{2}$, the firm chooses $d = D$, and the expected firm value becomes

$$\frac{1}{2} \times R - K - c = 0.$$

With $p = 1$, the firm chooses $d = D$, and the expected firm value becomes

$$1 \times R - K - c = 1.5.$$

From the ex-ante perspective, the firm chooses $d = ND$ with probability $\frac{1}{3}$ and $d = D$ with probability $\frac{2}{3}$, and the ex-ante value of the firm becomes

$$\frac{1}{3} \times (0 + 0 + 1.5) = 0.5,$$

and the ex-ante value of the two stand-alone firms becomes 1. Note that the ex-ante value of the stand-alone firm without disclosure is also 0.5:

$$E[p] \times 3 - 1 = 0.5.$$

Two-project firm model

The following table summarizes the disclosure strategies, d_1 and d_2 , and the expected net present value of the firm conditional on success probability p_1 and p_2 :

	$p_1 = 0$	$p_1 = 0.5$	$p_1 = 1$
$p_2 = 1$	$d_1 = ND$ and $d_2 = D$; Expected NPV: 1.5	$d_1 = D$ and $d_2 = D$; $1.5 + 0 = 1.5$	$d_1 = D$ and $d_2 = D$; $1.5 + 1.5 = 3$
$p_2 = 0.5$	$d_1 = d_2 = ND$ Expected NPV: 0.125		$d_1 = D$ and $d_2 = D$; $1.5 + 0 = 1.5$
$p_2 = 0$			$d_1 = D$ and $d_2 = ND$; 1.5

Figure 3.3: Conditional expected firm values

i) $p_1 = p_2 = 1$. In this case, the firm chooses $d_i = D$, because $p_i = 1$ is the best news the firm can get from each project.

ii) $p_i = 1$ and $p_j \neq 1$. In this case, the firm chooses $d_i = D$. The disclosure strategy for project j , where $j \neq i$, follows the same strategy of observation 1. That is, $d_j = ND$ if $p_j = 0$ and $p_j = D$ if $p_j = \frac{1}{2}$. In these cases, the disclosure strategies of the two projects are independent.

iii) $p_i \in \left\{0, \frac{1}{2}\right\}$ for $i \in \{1, 2\}$. In this case, the firm chooses $d_1 = d_2 = ND$. I show that this result is due to internal capital allocation by the firm, and the result is consistent with the result in Chapter 2 that internal capital allocation leads to less disclosure. Suppose that $d_i = ND$ if $p_i \in \left\{0, \frac{1}{2}\right\}$ and $d_i = D$ if $p_i = 1$ for $i \in \{1, 2\}$. Upon $d_1 = d_2 = ND$, the investors know that $p_i \in \left\{0, \frac{1}{2}\right\}$ for $i \in \{1, 2\}$. In addition, the investors know that, if they were to provide \$1 to the firm, it would allocate \$1 to the project i with $p_i \geq p_j$ so that its expected payoff could be maximized. Thus, the

likelihood of capital \$1 being allocated to a project with $p_i = \frac{1}{2}$ is $1 - \left(\frac{1}{2}\right)^2$, and the likelihood of capital \$1 being allocated a project with $p_i = 0$ is $\left(\frac{1}{2}\right)^2$. Therefore, the expected net present value of the firm given $d_1 = d_2 = ND$ is

$$\left(1 - \left(\frac{1}{2}\right)^2\right) \times \frac{1}{2} \times R - K = 0.125.$$

Note that even if the firm discloses $p_1 = p_2 = \frac{1}{2}$, the expected net present value of the firm is

$$2 \times \left(\frac{1}{2} \times R - K - c\right) = 0,$$

which is less than 0.125. Thus, the firm has an incentive to choose $d_1 = d_2 = ND$.

From the previous discussion, we know that stand-alone firms choose $d_i = D$ if $p_i = \frac{1}{2}$, whereas the two-project firm chooses $d_i = ND$ if $p_1, p_2 \in \left\{0, \frac{1}{2}\right\}$. This result shows that the firm with two projects under the same roof discloses less information for two reasons. First, the firm can save a disclosure cost. Second, even without disclosure, the investors are relatively confident that the capital that they provide will be allocated to a better project.

Note that $p_i \in \left\{0, \frac{1}{2}\right\}$ for $i \in \{1, 2\}$ occurs with probability $\frac{4}{9}$, and $p_i = 1$ and $p_j = \frac{1}{2}$ occur with probability $\frac{2}{9}$. $p_i = 1$ and $p_j = 0$ occur with probability $\frac{2}{9}$ and $p_1 = p_2 = 1$ occurs with probability $\frac{1}{9}$. Hence, the ex-ante value of the firm becomes

$$\frac{4}{9} \times 0.125 + \frac{2}{9} \times (1.5 + 0) + \frac{2}{9} \times (1.5) + \frac{1}{9} \times (1.5 + 1.5) = 1.0556.$$

This is greater than 1, which is the ex-ante value of the two stand-alone firms. This shows that, although firms with two projects under the same roof may disclose less information, the firm value is higher due to internal capital allocation. This is also consistent with the main result in Chapter 2.

3.3.4 Conclusion

In this section, I have shown that much of the main results in Chapter 2 holds true in the case of an alternative assumption about disclosure friction. Specifically, this section considers disclosure costs in the spirit of Verrecchia (1983). Thus, the key assumption that generates the benefit of having multiple projects in the context of voluntary disclosure may be the existence of disclosure friction, not a specific form of disclosure friction.

3.4 Optimal Financial Contract

3.4.1 Introduction

An implicit assumption in Chapter 2 is that the entrepreneur of a firm always invests raised capital in her projects even if the projects are negative-NPV. This behavior is consistent with the assumption that the entrepreneurs prefer more to less investment (i.e., empire builder).

In this section, I consider a setting in which the firm signs a refined financial contract so that the firm is induced not to invest capital in a negative-NPV project.

Based on Maskin and Tirole (1992) and Tirole (2006), this discussion shows that the firm may achieve the first-best outcome with the help of a refined financial contract, under certain conditions

I discuss conditions under which the main results of Chapter 2 hold true, even if a refined financial contract is available, based on the assumption about an empire-building manager. An empire-building manager is a common assumption in the literature on internal capital markets (See Gertner and Scharfstein, 2012 for a review).

3.4.2 Financial Contracting Approach

Consider an entrepreneur who possesses an investment project but no capital. Thus, the entrepreneur needs to raise capital from the investors to implement the project. As in Chapter 2, the risk-neutral investors break even in expectation.

The investment project requires a fixed investment K . If capital K is invested in the project, it generates either cash flows R with probability p or 0 with probability $1 - p$. The success probability p is either p_1 or p_2 , where $1 > p_1 > p_2 > 0$. $\Pr(p = p_1) = \beta$ and $\Pr(p = p_2) = 1 - \beta$, where $\beta \in (0,1)$. In addition, I assume that the project with $p = p_1$ is profitable, whereas the project with $p = p_2$ is not profitable. That is,

$$p_1 R - K > 0 \text{ and } p_2 R - K < 0. \quad (3.1)$$

Date 1 – Information Endowment. Nature picks success probability $p \in \{p_1, p_2\}$, and the entrepreneur observes the success probability.

Date 2 – Contract. The entrepreneur offers a financial contract to the investors.

The contract is written based on three verifiable events: positive cash flow R at date 4, zero cash flow date 4, or no investment at date 3.

Date 3 – Investment. The investors decide whether to accept the financial contract proposed by the entrepreneur. If they accept the contract, capital is provided to the entrepreneur, who then decides whether to implement the project.

Date 4 – Outcome. The project generates cash flows, which are then distributed to the entrepreneur and the investors according to the financial contract.

$t = 1$	$t = 2$	$t = 3$	$t = 4$
<ul style="list-style-type: none"> ▪ Nature selects $p \in \{p_1, p_2\}$. ▪ Entrepreneur observes p. 	<ul style="list-style-type: none"> ▪ The entrepreneur offers a financial contract to the investors. 	<ul style="list-style-type: none"> ▪ Investors decide whether to accept the contract. ▪ The entrepreneur takes an action. 	<ul style="list-style-type: none"> ▪ Cash flows R generated with probability p. ▪ No cash flows generated with probability $1 - p$.

Figure 3.4: Timeline

No information asymmetry

At date 1, nature picks success probability $p \in \{p_1, p_2\}$, and both the entrepreneur and the investors observe the success probability. If $p = p_1$, the project is profitable in expectation due to (3.1). The entrepreneur can then write a financial contract such that the investors break even in expectation at $t = 3$. That is, if $p_1 R_\ell - K = 0$ and the investors are paid $R_\ell \in [0, R]$ upon cash flow R , the investors are willing

to accept the contract and provide capital K at $t = 3$. Thus, the entrepreneur's expected payoff at date 3 becomes

$$p_1(R - R_\ell) = p_1R - p_1 \times \frac{K}{p_1} = p_1R - K.$$

If $p = p_2$, the project is not profitable in expectation and the investors cannot break even in expectation. In this case, there is no investment and both parties obtain zero payoff. Thus, the investors do not provide capital. Because $p = p_1$ occurs with probability β , the ex-ante expected value of the project becomes $\beta(p_1R - K)$.

A refined financial contract

In this section, I investigate a variant of the mechanism proposed by Maskin and Tirole (1992) to show that the first-best outcome can be achieved even if there is information asymmetry between the entrepreneur and the investors. Let me introduce two concepts necessary for the analysis.

Let an *allocation* be a pair of type-contingent contracts (c_1, c_2) ; c_1 is the contractual terms for the entrepreneur with $p = p_1$, and c_2 is the contractual terms for the entrepreneur with $p = p_2$.

At date 2, the entrepreneur offers an *option contract* (c_1, c_2) . If the investors sign the contract, the entrepreneur chooses the contractual term between c_1 and c_2 and takes the action according to the chosen contractual term at date 3.

Contractual term c_i consists of y_i, R_i^S, R_i^F, R_i^0 for $i \in \{1, 2\}$. y_i is the probability that the entrepreneur implements the project. R_i^S is the compensation for the entrepreneur in case of success. R_i^F is the compensation for the entrepreneur (paid by

the investors) in case of failure. R_i^0 is the compensation for the entrepreneur in case of no investment. If the entrepreneur with $p = p_i$ chooses contract $c_i = \{y_i, R_i^S, R_i^F, R_i^0\}$, the expected payoff for the entrepreneur with $p = p_i$, $U_i(c_i)$, is

$$U_i(c_i) = y_i\{p_i R_i^S + (1 - p_i)R_i^F\} + (1 - y_i)R_i^0.$$

An allocation (c_1, c_2) is *incentive compatible* if the entrepreneur with $p = p_1$ prefers c_1 to c_2 and the entrepreneur with $p = p_2$ prefers c_2 to c_1 . That is,

$$U_i(c_i) \geq U_i(c_j) \text{ and } U_j(c_j) \geq U_j(c_i) \text{ for } i \neq j.$$

The entrepreneur with $p = p_1$ solves the following program:

$$\max_{\{c_1, c_2\}} U_1(c_1) \text{ such that}$$

$$\text{IC } (p_1): U_1(c_1) \geq U_1(c_2) \text{ and IC } (p_2): U_2(c_2) \geq U_2(c_1).$$

IR for the investors:

$$\beta\{y_1(p_1 R - K) - U_1(c_1)\} + (1 - \beta)\{y_2(p_2 R - K) - U_2(c_2)\} \geq 0.$$

The following proposition summarizes the option contract (c_1, c_2) that delivers the first-best ex-ante value of the firm.

Proposition 3.6. *The option contract (c_1, c_2) is offered by the entrepreneur such that*

$$c_1 = \{y_1, R_1^S, R_1^F\} \text{ such that } y_1 = 1, R_1^S = \frac{\beta(p_1 R - K)}{\beta p_1 + (1 - \beta)p_2}, \text{ and } R_1^F = 0$$

$$c_2 = \{y_2, R_2^0\} \text{ such that } y_2 = 0 \text{ and } R_2^0 = p_2 R_1^S = p_2 \frac{\beta(p_1 R - K)}{\beta p_1 + (1 - \beta)p_2}.$$

With the above contract, the ex-ante value of the firm is at the first-best level.

The intuition is as follows. The financial contract is structured to minimize the inefficiency that comes from the entrepreneur undertaking a negative-NPV project. This is accomplished by rewarding entrepreneurs who report negative-NPV project at the expense of lower compensation for entrepreneurs who generate cash flows from positive-NPV projects. This logic is generalized to a continuous $p \sim U[0,1]$.

Proposition 3.7. *Suppose that $p \sim U[0,1]$. A financial contract is offered by the entrepreneur such that*

$$R^S = \frac{(1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right)}{(1 - p_{BE}) \frac{1 + p_{BE}}{2} + (p_{BE})^2}, R^F = 0, \text{ and}$$

$$R^0 = p_{BE} \frac{(1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right)}{(1 - p_{BE}) \frac{1 + p_{BE}}{2} + (p_{BE})^2},$$

where R^S is the compensation for the entrepreneur upon positive cash flows from the project, R^F is the compensation for the entrepreneur upon zero cash flows from the project, and R^0 is the compensation for the entrepreneur if the project is not implemented. With this contract, the ex-ante value of the firm is at the first-best level.

3.4.3 Discussion

The analysis of the refined financial contract suggests that the main results of the model in Chapter 2 hold true if the proposed contract is not feasible. One condition in which the proposed contract is not feasible is that the manager of a firm prefers more capital investment, which is a common assumption in the literatures on internal capital

markets (see Stein, 2003; Gertner and Scharfstein, 2012). In the context of the model in Chapter 2, I discuss a possible setting in which the manager of a firm is an empire builder. The setting is based on the assumptions from Stein (1997) and Stein (2002).

An entrepreneur owns two investment projects, 1 and 2. To implement each project, they must be combined with both managerial labor and a fixed investment $\$K$, but the entrepreneur lacks both, as in Stein (1997). Thus, the entrepreneur needs to hire a manager and raise capital from a group of investors. The entrepreneur derives utility from the cash flows from the projects, net of payment to the investors, or wages to the manager. The reservation wage of the manager is zero. I assume that the manager prefers more capital investment (i.e., empire building), but given the capital investment, he maximizes the net cash flows for the entrepreneur, as in Stein (2002). The investors break even in expectation, and the market interest rate is normalized at zero.

The manager privately observes success probability p_i with probability γ , whereas both the entrepreneur and the investors do not. Following Stein (1997), I refer to the entrepreneur and investors collectively as “outside investors.” In general, an incentive scheme can be written for the manager to reveal her private information and not implement an unprofitable project. However, the empire-building manager has an incentive to overstate p_i to attract capital investment, and it is costly to elicit the manager’s information. Instead, the manager can voluntarily disclose information, as in Dye (1985) and Jung and Kwon (1988). That is, if informed, the manager chooses either $d_i = D$ to credibly reveal p_i or $d_i = ND$ to remain silent. If uninformed, the manager always chooses $d_i = ND$. The financial contract is the same as in the model in Chapter 2. The investors choose to invest either $2K$, K , or 0 in the firm by choosing $k \in \{2,1,0\}$.

If $k = 1$, the manager decides which project to implement: if $I = 1$, project 1 is implemented; if $I = 0$, project 2 is implemented. The game has four dates:

$t = 1$	$t = 2$	$t = 3$	$t = 4$
<ul style="list-style-type: none"> ▪ Manager observes p_i with γ. ▪ Manager chooses $d_i \in \{D, ND\}$. 	<ul style="list-style-type: none"> ▪ R_ℓ is determined. ▪ Investors choose $k \in \{2, 1, 0\}$. 	<ul style="list-style-type: none"> ▪ If $k = 1$, manager chooses $I \in \{1, 0\}$. 	<ul style="list-style-type: none"> ▪ Cash flows generated and distributed.

Figure 3.5: Timeline

Based on this modeling setup, the main results of the model in Chapter 2 hold true. One exception is that W in figure 2.5 disappears, because the empire-building manager chooses to disclose information to implement two projects rather than withholding both success probabilities and implementing one project.

3.5 Appendix

Proof of Lemma 3.2

(i) Suppose $s^* > p_{BE}$ and the entrepreneur withholds $s = p < s^*$. Let a^* denote the investors' conjecture about probability a chosen by the agent. Then, the expected success probability in terms of the investors' belief is calculated as follows. The investors believe that the entrepreneur observes signal $s = \emptyset$ with probability $1 - \gamma - a^*$ and does not update her belief in probability p ; the investors believe that the entrepreneur observes signal $s < s^*$ with probability $(\gamma + a^*) \times F(s^*) = (\gamma + a^*)s^*$ and $E[p|s < s^*] = \frac{s^*}{2}$. Then, using Bayes rule, the investors' belief about the expected success probability upon no disclosure becomes

$$E[p|d = ND] = \frac{1 - \gamma - a^*}{1 - \gamma - a^* + (\gamma + a^*)s^*} \times \frac{1}{2} + \frac{(\gamma + a^*)s^*}{1 - \gamma - a^* + (\gamma + a^*)s^*} \times \frac{s^*}{2}.$$

In equilibrium, the entrepreneur is indifferent between disclosing and withholding signal s at s^* . Thus, s^* is determined by the following equilibrium condition.

$$\frac{1 - \gamma - a^*}{1 - \gamma - a^* + (\gamma + a^*)s^*} \times \frac{1}{2} + \frac{(\gamma + a^*)s^*}{1 - \gamma - a^* + (\gamma + a^*)s^*} \times \frac{s^*}{2} = s^*.$$

Then, we have

$$s^* = \frac{\sqrt{1 - \gamma - a^*} - (1 - \gamma - a^*)}{\gamma + a^*}.$$

With $s^* > p_{BE}$, the entrepreneur can raise capital K upon disclosure of $s = p > s^*$, because the pledgeable income, pR , is higher than the initial outlay K . In this case, repayment R_ℓ satisfies $pR_\ell = K$ and the entrepreneur's expected payoff becomes

$p(R - R_\ell) = pR - K > p_{BE}X - K = 0$. The entrepreneur can also raise capital K by withholding signal $s = p < s^*$, because the expected pledgeable income, s^*R , is higher than initial outlay K : $s^*R > p_{BE}R = K$. In this case, the investors invest capital K in the project in return for R_ℓ satisfying $s^*R_\ell = K$, and the entrepreneur's expected payoff upon no disclosure of signal σ becomes $s^*(R - R_\ell) = s^*R - K > p_{BE}R - K = 0$.

(ii) Suppose $s^* < p_{BE}$. I show $d = ND$ for $p < p_{BE}$ and $d = D$ for $p \geq p_{BE}$ is the equilibrium strategy for the entrepreneur, and $k = 1$ given $d = D$ and $k = 0$ given $d = ND$ is the equilibrium strategy for the investors.

Suppose the investors conjecture that $d = ND$ for $p < p_{BE}$ and $d = D$ for $p > p_{BE}$.

Then, the investors choose $k = 0$ upon $d = ND$. Note that we have the investors' belief on the expected success probability upon no disclosure

$$E[p|d = ND] = \frac{1 - \gamma - a^*}{1 - \gamma - a^* + (\gamma + a^*)p_{BE}} \times \frac{1}{2} + \frac{(\gamma + a^*)p_{BE}}{1 - \gamma - a^* + (\gamma + a^*)p_{BE}} \times \frac{p_{BE}}{2} < p_{BE},$$

because $s^* < p_{BE}$. Then, the entrepreneur is indifferent between $d = ND$ and $d = D$ for $s = p < p_{BE}$, because both strategies lead to low pledgeable income and $k = 0$ by the investors: with disclosure, $p < p_{BE}R = K$; with nondisclosure, $E[p|d = ND]R < p_{BE}R = K$. Suppose $d = ND$ is chosen for $p < p_{BE}$. Then, with $d = ND$, the investors know that $p < p_{BE}$, and the investors choose $k = 0$ due to lower expected pledgeable income: $E[p|d = ND]R < p_{BE}R = K$.

Upon disclosure of $p > p_{BE}$, the investors choose $k = 1$ because $pR - K > p_{BE}R - K = 0$. Then, $d = ND$ is not optimal for $p > p_{BE}$ since the investors choose $k = 0$ upon no disclosure.

$d = D$ is not an equilibrium strategy for $p < p_{BE}$. Suppose $d = D$ is chosen for $p < p_{BE}$. Then, the investors believe that $d = ND$ happens if the entrepreneur observes signal $s = \emptyset$, and the investors' belief about probability p upon $d = ND$ becomes $E[p] = 1/2$. Then, the investors choose $k = 1$ upon $d = ND$, since $E[p]R > K$. Then, the entrepreneur who has observed $s = p < p_{BE} < 1/2$ has an incentive to deviate from $d = D$ to choose $d = ND$ to pool with entrepreneurs with signal $s = \emptyset$.

(iii) Let $A \equiv \gamma + a^*$. Then, $s^* = \frac{\sqrt{1-A}-(1-A)}{A}$. We have $\frac{\partial}{\partial A} \left(\frac{\sqrt{1-A}-(1-A)}{A} \right) = \frac{2\sqrt{1-A}+A-2}{2\sqrt{1-A}A^2}$.

Note that $2\sqrt{1-A} + A - 2 < 0$ since $2\sqrt{1-A} < 2 - A \leftrightarrow 4(1-A) < (2-A)^2 = 4 - 4A + A^2 \leftrightarrow 0 < A^2$ and $A > 0$. Since $\frac{\partial}{\partial \gamma} A(\gamma, a^*) = 1 > 0$ and $\frac{\partial}{\partial a^*} A(\gamma, a^*) = 1 > 0$, by chain rule, $s^*(\gamma, a^*)$ increases in γ and a^* ■

Proof of Proposition 3.3

(i) Suppose $\gamma \leq \frac{R(R-2K)}{(R-K)^2}$ and the investors conjecture that $a^* = 0$. I will show that $a^* = 0$ is the equilibrium strategy by the agent. With $a^* = 0$, the financing condition upon no disclosure of signal s is

$$\frac{\sqrt{1-\gamma} - (1-\gamma)}{\gamma} R \geq K.$$

By rearranging, we have $\gamma \leq \frac{R(R-2K)}{(R-K)^2}$, which is satisfied by the assumption. This implies

that nondisclosure of signal s does not lead to credit rationing by the investors, and the agent can enjoy capital investment of K . Then, the agent maximizes

$$(\gamma + a)pK + (1 - \gamma - a)K - c(a) = (\gamma p + 1 - \gamma)K - (1 - p)aK - c(a),$$

which is maximized at $a = 0$. Thus, $a = 0$ is the equilibrium strategy by the agent, and the agent enjoys the expected utility of

$$(\gamma p + 1 - \gamma)K.$$

The expected value of the project becomes

$$\begin{aligned} & \gamma(1 - s^*) \left(\frac{1 + s^*}{2} R - K \right) + (1 - \gamma(1 - s^*))s^* \\ &= \gamma(1 - s^*) \left(\frac{1 + s^*}{2} R - K \right) \\ &+ (1 - \gamma(1 - s^*)) \left(\frac{1 - \gamma}{1 - \gamma(1 - s^*)} \times \frac{R}{2} + \frac{\gamma s^*}{1 - \gamma(1 - s^*)} \times \frac{s^*}{2} R - K \right) \\ &= \frac{1}{2} R - K. \end{aligned}$$

(ii) Suppose $\gamma \geq \frac{R(R-2K)}{(R-K)^2}$ and the investors conjecture a^* such that $(1 - p_{BE})K =$

$c'(a^*)$. By rearranging, we have

$$\frac{\sqrt{1 - \gamma - a^*} - (1 - \gamma - a^*)}{\gamma + a^*} R = s^* R < K.$$

This implies that $s^* < p_{BE}$, because $p_{BE}R = K$. Thus, part (ii) of lemma 2 shows that, with nondisclosure of signal $s = p < p_{BE}$, the entrepreneur faces credit rationing by the investors. Then, the agent maximizes

$$(\gamma + a)(1 - p_{BE})K - c(a),$$

which is maximized at a^* such that $(1 - p_{BE})K = c'(a^*)$. Signal is disclosed with probability $(\gamma + a^*) \times (1 - p_{BE})$, and $E[p|s = p > p_{BE}] = \left(\frac{1+p_{BE}}{2}R - K\right)$. Thus, the expected value of the firm becomes $(\gamma + a^*)(1 - p_{BE})\left(\frac{1+p_{BE}}{2}R - K\right)$.

$$(iii) \frac{\partial}{\partial X} \left(\frac{R(R-2K)}{(R-K)^2} \right) = \frac{2K^2}{(R-K)^3} > 0 \text{ and } \frac{\partial}{\partial K} \left(\frac{R(R-2K)}{(R-K)^2} \right) = -\frac{2KR}{(R-K)^3} < 0 \blacksquare$$

Proof of Corollary 3.4

(i) The proof directly comes from Proposition 3.

(ii) Note that $p_{BE}R = K$. Then, $p_{BE} = K/R$. Then,

$(\gamma + a^*)(1 - p_{BE})\left(\frac{1+p_{BE}}{2}R - K\right) - \left(\frac{1}{2}R - K\right)$ increases in γ . In addition, we have

$$\frac{\partial}{\partial R} \left[(\gamma + a^*)(1 - p_{BE})\left(\frac{1+p_{BE}}{2}R - K\right) - \left(\frac{1}{2}R - K\right) \right] = -\frac{K^2(\gamma + a^*) + (1 - \gamma - a^*)R^2}{2R^2} < 0, \text{ and}$$

$$\begin{aligned} & \frac{\partial}{\partial K} \left[(\gamma + a^*)(1 - p_{BE})\left(\frac{1+p_{BE}}{2}R - K\right) - \left(\frac{1}{2}R - K\right) \right] \\ &= \frac{2R - 2(R - K)(a^{*'}(K) + \gamma) + (R - K)^2 a^{*'}(K)}{2R} > 0 \blacksquare \end{aligned}$$

Proof of Observation 3.5

Suppose that $d = ND$ for any $p \in \left\{1, \frac{1}{2}, 0\right\}$. Then, the expected value of the firm becomes

$$E[p] \times R - K = 0.5.$$

However, the firm has an incentive to choose $d = D$ if $p = 1$ because the expected value with disclosure becomes

$$R - K - c = 1.5,$$

which is greater than 0.5.

Suppose that the firm chooses $d = ND$ for $p \in \left\{\frac{1}{2}, 0\right\}$ and $d = D$ for $p = 1$.

Upon $d = ND$, the expected NPV of the firm becomes

$$\left(\frac{1}{2} \times \frac{1}{2} + \frac{1}{2} \times 0\right) \times R - K = \frac{1}{4} \times 3 - 1 < 0,$$

However, if $p = \frac{1}{2}$ and the firm chooses $d = D$, the expected NPV of the firm becomes

$$\frac{1}{2} \times R - K - c = 1.5 - 1 - 0.5 = 0.$$

Thus, the investors' belief that the firm chooses $d = ND$ if $p \in \left\{\frac{1}{2}, 0\right\}$ is not consistent with the firm's disclosure strategy.

Suppose that the firm $d = ND$ if $p = 0$ and $d = D$ if $p \in \left\{\frac{1}{2}, 1\right\}$. Then, upon $d = ND$, the expected net present value of the investment is

$$E[p|d = ND] \times 2 - K = 0 \times 3 - 1 = -1.$$

Since the expected NPV is negative, the investors choose not to invest capital and both parties obtain zero payoff. If $p = 0$ and $d = D$, the expected net present value of the investment is

$$0 \times R - K - c = -1.5.$$

Since the expected NPV of the project is negative, the investors choose not to invest capital and both parties obtain zero payoff. Since disclosure decision makes no difference with respect to the expected payoff, the firm chooses $d = ND$ by assumption.

With $p = \frac{1}{2}$ and $d = D$, the expected net present value of the firm becomes

$$\frac{1}{2} \times R - K - c = 0.$$

With $p = 1$ and $d = D$, the expected net present value of the firm becomes

$$R - K - c = 1.5.$$

Note that the expected values of the firm in both cases are greater than -1, which is the expected net present value of the firm with $d = ND$. Thus, the firm's disclosure strategy $d = ND$ if $p = \frac{1}{2}$ and $d = D$ if $p \in \left\{\frac{3}{4}, 1\right\}$ is the equilibrium disclosure strategy, and the investors choose not to invest upon $d = ND$ and invest upon $d = D$ ■

Proof of Proposition 3.6

Consider IC (p_2) constraint. Note that we have

$$U_2(c_1) = y_1\{p_2R_1^S + (1 - p_2)R_1^F\} + (1 - y_1)R_1^0 = U_1(c_1) - y_1(p_1 - p_2)(R_1^S - R_1^F).$$

Then, IC (p_2) constraint can be rewritten as

$$U_2(c_2) \geq U_2(c_1) \Rightarrow U_2(c_2) \geq U_1(c_1) - y_1(p_1 - p_2)(R_1^S - R_1^F) \quad (3.2)$$

Note that IR constraint binds so that the investors break even in expectation and the entrepreneur with p_1 can extract all the expected surplus. The entrepreneur with p_1 tries to maximize $U_1(c_1)$ subject to IR constraint, and she can do so by minimizing $U_2(c_2)$. Thus, IC (p_2) also binds so that $U_2(c_2)$ is minimized. Then, with the binding IC (p_2) constraint, IR constraint can be rewritten as

$$\beta y_1(p_1R - K) + (1 - \beta)y_2(p_2R - K) - U_1(c_1) + (1 - \beta)y_1(p_1 - p_2)(R_1^S - R_1^F) = 0.$$

By rearranging, we have

$$U_1(c_1) = \underbrace{\beta y_1(p_1R - K)}_{\text{positive}} + (1 - \beta)y_2 \underbrace{(p_2R - K)}_{\text{negative}} + (1 - \beta)y_1 \underbrace{(p_1 - p_2)}_{\text{positive}} (R_1^S - R_1^F).$$

The entrepreneur with p_1 maximizes her expected payoff by setting $y_2 = 0$, $y_1 = 1$, and $R_1^F = 0$. $y_1 = 1$ implies that R_1^0 is irrelevant, and $y_2 = 0$ implies that R_2^S and R_2^F are irrelevant. With $y_2 = 0$, $y_1 = 1$, and $R_1^F = 0$, we have $U_1(c_1) = p_1R_1^S$ and IR constraint can be rewritten as

$$\beta(p_1R - K) - p_1R_1^S + (1 - \beta)(p_1 - p_2)R_1^S = 0,$$

Thus, we have $R_1^S = \frac{\beta(p_1 R - K)}{\beta p_1 + (1 - \beta)p_2}$, and we have $c_1 = \{y_1, R_1^S, R_1^F\}$ such that

$$y_1 = 1, R_1^S = \frac{\beta(p_1 R - K)}{\beta p_1 + (1 - \beta)p_2}, \text{ and } R_1^F = 0.$$

Thus, the expected payoff for the entrepreneur with $p = p_1$ becomes

$$p_1 \times \frac{\beta(p_1 R - K)}{\beta p_1 + (1 - \beta)p_2}.$$

Consider IC (p_2) again:

$$y_2\{p_2 R_2^S + (1 - p_2)R_2^F\} + (1 - y_2)R_2^0 \geq y_1\{p_2 R_1^S + (1 - p_2)R_1^F\} + (1 - y_1)R_1^0.$$

With $y_2 = 0$, $y_1 = 1$, and $R_1^F = 0$, and the constraint binding, we have

$$R_2^0 = p_2 R_1^S.$$

Thus, we have $c_2 = \{y_2, R_2^0\}$ such that $y_2 = 0$ and $R_2^0 = p_2 R_1^S = p_2 \frac{\beta(p_1 R - K)}{\beta p_1 + (1 - \beta)p_2}$. Thus,

the expected payoff for the entrepreneur with $p = p_2$ becomes

$$p_2 \frac{\beta(p_1 R - K)}{\beta p_1 + (1 - \beta)p_2}.$$

From the ex-ante perspective, the entrepreneur has the project with $p = p_1$ with probability β and the project with $p = p_2$ with probability $1 - \beta$. Then, the ex-ante payoff for the entrepreneur becomes

$$\beta \times p_1 \times \frac{\beta(p_1 R - K)}{\beta p_1 + (1 - \beta)p_2} + (1 - \beta) \times p_2 \frac{\beta(p_1 R - K)}{\beta p_1 + (1 - \beta)p_2} = \beta(p_1 R - K),$$

which is the same as the ex-ante payoff for the entrepreneur under the symmetric information case ■

Proof of Proposition 3.7

The entrepreneur with $p \geq p_{BE}$ has an incentive to implement the project, because

$$p \times R^S = p \frac{(1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right)}{(1 - p_{BE}) \frac{1 + p_{BE}}{2} + (p_{BE})^2} > p_{BE} \frac{(1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right)}{(1 - p_{BE}) \frac{1 + p_{BE}}{2} + (p_{BE})^2} = R^0.$$

The entrepreneur with $p < p_{BE}$ has an incentive to report that she has a negative-NPV project, because

$$R^0 = p_{BE} \frac{(1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right)}{(1 - p_{BE}) \frac{1 + p_{BE}}{2} + (p_{BE})^2} > p \frac{(1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right)}{(1 - p_{BE}) \frac{1 + p_{BE}}{2} + (p_{BE})^2} = p \times R^S.$$

The investors break even in expectation, because

$$(1 - p_{BE}) \times \left(\frac{1 + p_{BE}}{2} \times (R - R^S) - K \right) - p_{BE} \times R^0 = 0.$$

The ex-ante value of the project is

$$(1 - p_{BE}) \times \frac{1 + p_{BE}}{2} \times R^S + p_{BE} \times R^0 = (1 - p_{BE}) \left(\frac{1 + p_{BE}}{2} R - K \right),$$

which is the first-best ex-ante value of the project ■

Concluding Remarks

A firm is an organization that employs productive resources to generate a profit. Two firms may have the same set of assets, yet their respective organizational structures can lead to widely varied levels of performance, which can also result in two firms exhibiting different disclosure behaviors. This dissertation takes an analytical approach to *jointly* investigate firms' disclosure behaviors and organizational structure from the perspective of the theory of the firm.

In the first chapter, I propose an analytical framework to jointly investigate a firm's disclosure behavior and organizational structure, based on the discussion about policy-related issues and related literatures. The discussion shows that internal capital allocation is an important task of multi-divisional firms, but the analytical disclosure literature lacks a framework to understand the disclosure behavior of multi-divisional firms engaging in internal capital allocation. Therefore, I propose an analytical framework that enables us to jointly consider firms' disclosure behavior and internal capital allocation. This becomes the basis for my analysis in Chapter 2.

In the second chapter, I analytically investigate how external accounting disclosure can affect the optimal approach to organizing investment projects within firms. I show various conditions under which diversified firms enjoy higher investment efficiency than stand-alone firms. A diversified firm can internally allocate capital across divisions, which increases investment efficiency, whereas stand-alone firms do not have this ability. Under certain conditions, this increased investment efficiency from internal capital allocation outweighs the increased investment efficiency a stand-alone

firm receives from higher disclosure quality. Because of both the possibility of external disclosure and these certain conditions, firms may choose either stand-alone or multi-divisional structure.

Chapter 3 discusses an extension of the robustness of the model discussed in Chapter 2. In the first part of Chapter 3, I consider an extension of the model in Chapter 2. In particular, I show that external disclosure helps the firm to encourage more information production by divisional managers. The perspective that external disclosure can affect the behavior of stakeholders other than investors is relatively new in the corporate disclosure literature, and this perspective can potentially broaden our understanding of corporate disclosure. In the second part of Chapter 3, I consider another source of disclosure friction in the spirit of Verrecchia (1983) and show that the main results in Chapter 2 can also be held true in an alternative framework. The result confirms the discussion in Chapter 1 that disclosure friction is the crucial to understanding the disclosure behavior of firms that have multiple projects. Third, I consider a contractual approach to improve the efficiency of capital investment and possible limitations of applying the contractual approach in the real world.

Overall, the dissertation suggests that disclosure environment plays an important role in determining the boundary of the firm. Prominent scholars have called for more research in this direction. As Coase (1990) argued, “the theory of the accounting system is part of the theory of the firm.” Arrow (2015) argued that “the incentives around information sharing are a part of the reason for the superiority of intrafirm allocations.” I believe that this perspective is fundamental to our understanding of accounting, and future research opportunities are abundant.

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