Essays on Corporate Disclosure and
Organizational Structure

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CHAPTER 1
Conceptual Framework: Corporate Disclosure and Organizational Structure

1.1 Introduction

Corporate disclosure is the study of the way firms make disclosure decisions. Thus, the way we understand about firms’ organizational structure, for example, may affect our understanding about firms’ disclosure behavior, and this insight is at the heart of Sunder’s (1997) argument: “to understand accounting, firm itself must be understood.” (p. 13). For example, two firms may have the same set of assets, yet their respective organizational structures can lead to widely varied levels of performance, which could also result in two firms exhibiting different disclosure behaviors. In fact, this has been shown empirically. For example, a multi-segment firm (i.e., conglomerate or diversified firm) and a group of single-segment firms exhibit different levels of performance with respect to investment efficiency (e.g., Rajan et al., 2000). Besides, a group of single-segment firms exhibit 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 of 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, and one of the key factors is information problems. The 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. With its tendency towards overstatement, the firms cannot credibly communicate their private information to the investors. As a result, investors will undervalue good projects and overvalue bad projects. This can potentially make it difficult for the firms to raise capital from the investors, and this is an example of the “lemons problem” (Akerlof, 1970). The accounting literature has investigated firms’ incentives of disclosing information in the context of the lemons problem (See Beyer et al. 2010; Stocken, 2012 for 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 the 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. The agency problems arise because, once capital has been raised, the 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 the research has shown that organizational structure plays an important role (See Stein, 2003; Gertner and Scharfstein, 2012 for review). Specifically, papers have shown that 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, 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 investment projects under the same roof.

In the next section, I discuss policy-related issues regarding segment reporting. The discussion shows that practitioners consider the allocation of capital as one of the most important tasks of the CEO, and academic literature has paid a lot of attention to the interaction between internal capital allocation and segment reporting. Section 1.3 discusses related academic literatures that consider some of key factors affecting
internal capital allocation and disclosure behavior (i.e., information and agency problems). Section 1.4 proposes an analytical framework that enables us to jointly consider firms’ disclosure behavior and internal capital allocation.

1.2. Policy-related Issues

1.2.1 Basics of Segment Reporting

Accounting standards on segment reporting (e.g., SFAS 131 and IFRS 8) were introduced to better align the identification and reporting of operating segments with internal management reporting, and this approach is often called a ‘management approach.’ Segment reporting with the management approach intends to identify information used internally by management to make key decisions such as capital allocation. The key principle according to a practical guide to segment reporting by Price Waterhouse Coopers (2008) is that “users are able to evaluate the nature and financial effects of the business activities in which it engages and the economic environment in which it operates.”

An identification of an operating segment is a key issue in segment reporting. According to, an operating segment is a component of an entity:

1) that engages in business activities from which it may earn revenues and incur expenses;
2) whose operating results are regularly reviewed by the entity’s Chief Operating Decision Maker (CODM) to make decisions about resources to be allocated to the segment and assess its performance; and

3) for which discrete financial information is available.

Identifying CODM is also important to find operating segments. The CODM oversees the allocation of resources to and the evaluation of the performance of the operating segments. Examples include the CEO, the chief operating officer, or the board of directors.

1.2.2 Literature on Segment Reporting

As can be seen from the description of the segment reporting principles, the allocation of resources within organizations is an important factor that affects the quality of segment reporting. The academic literature on segment reporting has indeed paid attention to the interaction between segment reporting and internal capital allocation. For example, Berger and Hann (2003) finds that, by increasing information disaggregation, the new standard (i.e., SFAS 131) induced firms to reveal previously “hidden” information about their capital allocation strategies. The firms that revealed inefficient allocation of capital negatively affected market valuations consistent with improved monitoring following adoption of SFAS 131. Bens and Monahan (2004) documents a positive association between the efficiency of internal capital allocation and security analyst ratings of voluntary disclosure. Bens Berger Monahan (2011) utilizes confidential, U.S. Census Bureau, plant-level data to investigate aggregation in external reporting. They show that firms that engage in inefficient capital allocation
tend to disclose less information. Cho (2015) shows that multi-segment firms that improved segment disclosure transparency by adopting the management approach mandated by SFAS 131 experienced an improvement in capital allocation efficiency in internal capital markets. D’Mello et al (2017) shows that Internal Control Weaknesses (ICWs) are associated with distortionary internal capital allocations. They further show that firms with weak existing governance mechanisms benefit more from maintaining effective internal control.

1.3. Related Literature

1.3.1 Voluntary Disclosure

Figure 1.2: Financial and information flow in a capital market

There is a vast literature in accounting that investigates firms’ incentive of 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 review). An important result in this literature is that, if external disclosure is truthful, firms voluntarily disclose much of their private information (e.g., Grossman, 1981; Milgrom, 1981). This is widely known as the “unraveling argument”,

6
and it is the result of both a rational investor who undervalues the project with no disclosed information and the firm that strategically discloses its information given the investor’s valuation of the project.

However, the unraveling argument that firms fully reveal their private information does not seem to be well supported empirically. For example, Kothari, Shu, and Wysocki (2009) shows that firms often withhold bad news, rather than fully revealing 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. For example, Verrecchia (1983) 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 the 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 full information to the investors.

The archival literature on voluntary disclosure suggests that, on average, voluntary disclosure can be a useful way for firms to mitigate the information asymmetry with the investors. For example, Amihud and Mendelson (1986) shows that firms with more public disclosure can mitigate the lemons problem. Shroff et al (2013) shows 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 an 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 provide key policy implications. In
the next subsection, I discuss the literature in corporate finance on internal capital
allocation and the related agency problems.

1.3.2 Internal Capital Allocation

![Figure 1.3: Financial and information flow in a diversified firm](image)

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

The bright side of internal capital allocation shows that firms with multiple projects (i.e., diversified firms) are better than outside investors in allocating capital across multiple projects. This perspective has been discussed by Alchian (1969), Williamson (1975) and Stein (1997). This is based on the two assumptions. First, firms knows more about their projects than investors. Second, the firms use their information when reallocating capital across their projects. With more information, the firms can allocate capital to the best project more efficiently than the investors who may have less information about the projects, and 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 the investors, and this is often called the dark side of internal capital markets. Papers such as Rajan et al. (2000) and Scharfstein and Stein (2000) show potential mechanisms through which firms allocate capital inefficiently, and these papers are based on multi-layered agency conflicts between divisional managers and the headquarters. That is, the divisional managers exert rent-seeking behavior, which leads to the distortion of capital allocation by the headquarters away from the first-best benchmark, which lowers the return for the investors.
1.3.3 Discussion

The multi-layered process of capital allocation implies that the investors are concerned with the efficiency of the allocation of the 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) shows 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) shows that firms with the 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, and this approach also helps us interpret the empirical evidence in the literature.

This dissertation intends to jointly understand firms’ disclosure behavior and organizational structure, by building a simple analytical model (chapter 2) and exploring robustness check and a possible extension (chapter 3). In chapter 1, I will focus on a variation of the existing models on internal capital allocation and voluntary disclosure to highlight the main economic forces, which are the focus of the analysis in chapter 2.
1.4 Analytical Framework

I propose an analytical framework to jointly investigate organizational structure and voluntary disclosure. Specifically, 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 there exist no such conditions, no firms will choose to have multiple projects under the same roof and, as a result, there will be no such thing as disclosure strategy of diversified firms.

I first investigate two models: one regarding internal capital allocation and the other about 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 the analysis of the two models, I combine the two models 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.
1.4.1 Analytical Framework – Internal Capital Allocation

Stand-alone firm benchmark

Consider the following variation of Stein (1997). I first consider a firm that has a single project that requires a fixed investment of capital $1 to be implemented. At $t = 1$, the investors decide whether to invest capital. The firm implements the project if capital is raised. That is, the raised capital is always invested in the projects, which is a common assumption in the literature on internal capital markets (e.g., Scharfstein and Stein, 2000). If implemented, at $t = 2$ the project generates cash flows $2$ with probability $p \in \{0.5, 0\}$, where $\Pr(p = 0.5) = \frac{1}{2}$, and $0$ with probability $1 - p$. If the project generates $2$, the investors obtain $R_\ell \in [0, 2]$ and the firm obtains $2 - R_\ell$. If the project generates $0$, both get zero.

The capital market is competitive in that the investors break even in expectation. That is, $R_\ell$ is determined so that $E_\ell[p] \times R_\ell - 0.7 = 0$, where $I$ represents the information set of the investors. The following table depicts the timeline of the model:
At $t = 1$, the investors decide whether to invest $1 in the firm. The investors know that $p = 0.5$ with probability $\frac{1}{2}$. Thus, the expected payoff for the investors is $\frac{1}{2} \times 0.5 \times R_\ell$. Then, even if $R_\ell$ 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 in expectation and choose not to invest capital in the firm. This implies that, even if the firm has a profitable project with $p = 1$, 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

Consider a firm that has project 1 and 2. Project $i \in \{1, 2\}$ requires a fixed investment of $1 and has success probability $p_i \in \{0.5, 0\}$. $p_1$ and $p_2$ are independent, and $p_i = 0.5$ with probability $1/2$. At $t = 3$, if project $i \in \{1, 2\}$ generates $2$, and the cash flows are distributed according to the financial contract signed at $t = 1$. At $t = 2$,
the firm decides which project to implement. 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 $t = 1$, the investors decide whether to invest $1.4$, $0.7$, or $0$ in the firm. The following table summarizes the timeline:

<table>
<thead>
<tr>
<th>$t = 1$</th>
<th>$t = 2$</th>
<th>$t = 3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investors decide to invest capital.</td>
<td>The firm decides which project to implement.</td>
<td>Cash flows from each project realized and distributed according to the signed contract.</td>
</tr>
<tr>
<td>Financial contract signed.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1.7: Timeline – a two-project firm model

At $t = 2$, the firm decides which project to implement. If $1.4$ has been raised from the investors, the two projects are implemented; if $0$ has been raised, no projects are implemented. If $0.7$ has been raised, the firm decides which project to implement. The firm is well-informed about the projects compared to investors, because she knows $p_1$ and $p_2$. Let $R_\ell$ be the repayment amount the investors receives upon cash flow $R$ from either project. Then, 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. To maximize her expected payoff, the firm chooses to implement project 1 if $p_1 \geq p_2$. That is, the firm allocate $0.7$ to the best project, and this process is 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. Note that 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 at $t = 2$ by the firm to a project that has higher success probability. Given that two projects are independent, the likelihood of the firm having at least one project with $p = 0.5$ is $1 - \left(\frac{1}{2}\right)^2 = \frac{3}{4}$. That is, the likelihood that the raised capital $0.7$ is allocated to a project with $p = 0.5$ is $\frac{3}{4}$. Then, the expected net present value of the investment of $0.7$ in the firm becomes

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

This implies that the firm that has two projects under the same roof can raise $0.7$, thereby mitigating the under-investment problem, whereas the stand-alone firm that has a single project cannot raise capital at all. The firm can raise capital even if $p_1 = p_2 = 0$, and this is an over-investment problem. However, the benefit of mitigating the under-investment problem is greater than the cost of over-investment problem, because the over-investment problem happens with lower probability, that is, $(1/2)^2 = 1/4$. Then, $R_\ell$ is determined so that

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

The discussion of the two models show that firms that have multiple projects can partially overcome the underinvestment problem, because the investors are more
confident that the capital that they provide to the two-project firm is more likely to be allocated to a profitable project. In the next subsection, I investigate the implications of voluntary disclosure in the context of capital investment.

### 1.4.2 Analytical Framework – Voluntary Disclosure

Consider again a firm that has a single investment project. Now, suppose that the firm can credibly disclose information about success probability before raising capital. Specifically, the firm chooses \( d \in \{D, ND\} \). If \( d = D \) is chosen, \( p \in \{0.5, 0\} \) is disclosed to the investors. If \( d = ND \) is chosen, \( p \) is withheld, and \( p \in \{0.5, 0\} \) is not observed by the investors. The new timeline is as follows.

<table>
<thead>
<tr>
<th>( t = 1 )</th>
<th>( t = 2 )</th>
<th>( t = 3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>The firm chooses ( d \in {D, ND} )</td>
<td>Investors decide to invest capital.</td>
<td>If the project generates $2,</td>
</tr>
<tr>
<td>( R_{\ell} ) is determined so that ( E[\ell</td>
<td>p] \times )</td>
<td>( R_{\ell} = 0.7 ).</td>
</tr>
</tbody>
</table>

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

At \( t = 2 \), the investors calculate expected success probability conditional upon the firm’s disclosure strategy, \( E[p|d \in \{D, ND\}] \). Then, \( R_{\ell} \) that goes to the investors upon the success of the project is determined by \( E[p|d \in \{D, ND\}] \times R_{\ell} = 0.7 \) or

\[
R_{\ell} = \frac{0.7}{E[p|d \in \{D, ND\}]}. 
\]
Note that $R_\ell$ decreases in $E[p|d \in \{D, ND\}]$. With lower $R_\ell$, the firm can enjoy higher payoff $2 - R_\ell$ upon the success of the project. Thus, the firm has an incentive to choose its disclosure strategy $d \in \{D, ND\}$ to increase the conditional expected success probability calculated by the investors. This implies that, if the firm is informed that $p = 0.5$, she has an incentive to choose $d = D$. This is because the highest value of the conditional expected success probability is 0.5. This also implies that, if the firm chooses $d = ND$, the investors infer that the firm is informed of $p = 0$. The discussion implies that the firm’s private information about success probability $p$ is effectively revealed to the investors: if $d = D$, the investors know that $p = 0.5$; if $d = ND$, the investors know that $p = 0$. This is an example of the unraveling argument.

In the presence of credible communication between the firm and the investors, the firm that has a single project can implement its project if $p = 0.5$, whereas the firm without credible communication cannot. Thus, even with a single project, the firm can completely overcome the under-investment problem, and the benefit of having multiple projects under the same roof disappears. Intuitively, the investors are as informed as the firm due to the unraveling argument, which makes diversified firms irrelevant in increasing firm value.

This example shows that credible communication can potentially destroy any benefit that firms can enjoy from having multiple projects under the same roof. However, 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 subsection, I show that, in the presence of disclosure friction, there still are benefits to having multiple projects under the same roof.
1.4.3 Analytical Framework – Internal Capital Allocation and Voluntary Disclosure

Consider an investment project with three possible success probabilities. Specifically, 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**

Let me describe the timeline of the stand-alone firm model. At $t = 1$, the firm chooses its disclosure strategy $d \in \{D, ND\}$. I assume that, for some exogenous reason, the firm chooses $d = D$ if $p = 1$ so that $p = 1$ is revealed to the investors. However, the firm chooses $d = ND$ if either $p = 0$ or $p = 0.5$ and the investors do not observe the success probability. The voluntary disclosure literature has identified several conditions under which firms withhold bad news (See Beyer et al., 2010; Stocken, 2012 for 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 as long as they can break even in expectation. At $t = 3$, if $R = 2$ is realized, the investors enjoy $R_\ell \in [0,2]$ and the firm enjoys $2 - R_\ell$. If $R = 0$ is realized, both parties obtain zero.
Figure 1.9: An investment project and firm’s disclosure strategy

Let me consider two cases: $p = 1$ and $p \neq 1$. If $p = 1$, the firm chooses $d = D$ at $t = 1$ by the assumption about exogenous disclosure strategy and $p = 1$ is revealed to the investors. Then, the investors know that they can break even with the investment of $0.7$. Thus, $R_0 = 0.7$ 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 $d = ND$ at $t = 1$. Then, 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:

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

Thus, 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.
The example shows that, upon \( d = ND \), the firm suffers from the under-investment problem and no project is implemented. However, upon \( d = D \), the profitable project is implemented. From the ex-ante perspective, \( p = 1 \) (i.e., \( d = D \)) occurs with probability \( \frac{1}{3} \), and the conditional expected net present value upon \( d = D \) 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**

Consider a firm that has two independent project 1 and 2. Project \( i \in \{1, 2\} \) requires a fixed investment $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 \( p_i \in \{0, 0.5, 1\} \). I assume that \( p_1 \) and \( p_2 \) are independent, and the probability distribution of the success probability of project \( i \) is as follows: \( \Pr(p_i = 0) = \Pr(p_i = 0.5) = \Pr(p_i = 1) = \frac{1}{3} \). 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 \( d_i = ND \). The following table summarizes the timeline:

<table>
<thead>
<tr>
<th>( t = 1 )</th>
<th>( t = 2 )</th>
<th>( t = 3 )</th>
<th>( t = 4 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>The firm chooses ( d_i \in {D, ND} )</td>
<td>Investors decide to invest capital.</td>
<td>The firm decides which project to implement.</td>
<td>Cash flows are realized and distributed according to the contract.</td>
</tr>
<tr>
<td>Financial contract signed.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1.10: Timeline – a two-project firm model with voluntary disclosure
If $p_1 = p_2 = 1$, the firm chooses to disclose $p_1$ and $p_2$ by choosing $d_1 = d_2 = D$. Conditional upon $d_1 = d_2 = D$, the investors calculate the expected net present value of the two projects, which is $2 \times (2 - 0.7) = 2.6$. Since 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 the project $j$ is $E[p_j]R - K = (\frac{1}{2} \times 0.5 + \frac{1}{2} \times 0) \times 2 - 0.7 = -0.2$. 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 $d_1 = d_2 = ND$. Then, 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 can be maximized. Then, 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 allocate $0.7$ to the project with higher success probability. The following table summarizes the conditional expected values of the firm:

<table>
<thead>
<tr>
<th>$p_2$</th>
<th>$p_1 = 0$</th>
<th>$p_1 = 0.5$</th>
<th>$p_1 = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p_2 = 1$</td>
<td>$2 - 0.7 = 1.3$</td>
<td>$2 \times (2 - 0.7) = 2.6$</td>
<td>$d_1 = ND; d_2 = D$</td>
</tr>
<tr>
<td></td>
<td>$d_1 = ND; d_2 = D$</td>
<td>$d_1 = D; d_2 = D$</td>
<td></td>
</tr>
<tr>
<td>$p_2 = 0.5$</td>
<td>$\frac{3}{4} \times 0.5 \times 2 - 0.7 = 0.05$</td>
<td>$2 - 0.7 = 1.3$</td>
<td>$d_1 = D; d_2 = ND$</td>
</tr>
<tr>
<td>$p_2 = 0$</td>
<td>$d_1 = ND; d_2 = ND$</td>
<td>$d_1 = D; d_2 = ND$</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1.11: Conditional expected firm values

Remember that a 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 only raise capital for one project. The firm can also raise capital $0.7$ even if $p_1 = p_2 = 0$, and this is an over-investment problem. The benefit of mitigating under-investment problem is greater than the cost of over-investment problem, because the firm suffers the over-investment problem with lower probability, that is, $1/4$. 
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 \( \left( \frac{2}{3} \right)^2 = \frac{4}{9} \). Then, 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, that is, 0.86. This implies that there exists value to having multiple projects under the same roof, if firms face disclosure frictions that prevent them from fully revealing their private information to the investors.

### 1.4.4 Discussion

The analysis in this section shows 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 investigate internal capital allocation in the context of voluntary disclosure, there must be some form of limitation on the communication between the two parties so that firms find it valuable to have multiple projects under the same roof. With exogenous friction in disclosure, 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. In chapter 2, I consider the investors’ uncertainty about the firm’s information endowment (i.e., Dye, 1985;
Jung and Kwon, 1988). In chapter 3, I consider disclosure cost (i.e., Verrecchia, 1983). In addition, I consider the case of success probability $p$ being continuous in chapter 2.

1.4 Conclusion

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.

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

Chapter 2 and 3 are based on the framework I discussed in chapter 1. Chapter 2 consists of my job-market paper “Organization Structure, Voluntary Disclosure, and Investment Efficiency”. This chapter analytically investigates how external accounting
disclosure can affect the optimal approach to organizing investment projects within firms. I show that stand-alone firms exhibit higher disclosure quality than firms with multiple projects or diversified firms. Since more information can lead to a more efficient investment decision by capital markets, stand-alone firms appear to be the optimal organizational structure. However, I show that there exist various conditions under which diversified firms enjoy higher investment efficiency than stand-alone firms. A diversified firm can internally allocate capital across the divisions, which increase 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 different organizational structures (either stand-alone or diversified). This chosen structure will then have implications on productivity at the firm level and subsequently on overall productivity in an economy.

Chapter 3 discusses both a possible extension of the model and the robustness of the mechanism discussed in chapter 2. This chapter serves as a bridge between chapter 2 and future research opportunities. In the first part of chapter 3, I consider a possible extension of the model in chapter 2. Specifically, I investigate the incentive of managers at the divisional level to exert effort to generate valuable information given that the firm can credibly disclose the information to the investors. I show that external disclosure helps the firm to encourage more information acquisition on the part of divisional managers. This is largely due to the partial unraveling argument in the spirit of Dye (1985) and Jung and Kwon (1988). The divisional managers prefer more to less capital
investment (i.e., empire builder). They try to minimize the likelihood of the firm withholding information by increasing the likelihood of generating information. This is because no disclosure by the firm due to no information will be negatively viewed by the investors who then choose not to invest capital in the firm. The perspective that external disclosure can affect the behavior of stakeholders other than investors is relatively new in corporate disclosure literature, and this perspective can potentially broaden our understanding of corporate disclosure in a much broader sense. 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.
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) investigates 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.
Cheynel (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

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 $\frac{1}{2} > p_{BE}$. 

Figure 2.1: A Stand-alone Firm
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 \( \gamma \). 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 \( R_{\ell} \) upon cash flows \( R \) to break even in expectation. Repayment \( R_{\ell} \) 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 \( R_\ell \) 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.

<table>
<thead>
<tr>
<th>( t = 1 )</th>
<th>( t = 2 )</th>
<th>( t = 3 )</th>
<th>( t = 4 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nature selects ( p )</strong> from ( U[0,1] ).</td>
<td><strong>If ( s = p ), she makes disclosure decision</strong></td>
<td><strong>Investors make investment</strong></td>
<td><strong>Cash flows ( R ) generated with probability ( p ). ( R_\ell ) and ( R - R_\ell ) distributed to investors and entrepreneur,</strong> respectively.</td>
</tr>
<tr>
<td><strong>Entrepreneur observes signal</strong> ( s = \emptyset, d = ND ). If ( s = p ) with probability ( \gamma ).</td>
<td><strong>Investors observe ( s = p ) if ( d = D ).</strong></td>
<td><strong>Repayment ( R_\ell ) to investors is determined.</strong></td>
<td><strong>No cash flows generated with probability ( 1 - p ).</strong></td>
</tr>
</tbody>
</table>

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 \( R_\ell \) 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 $\gamma$ 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 $R_\ell$ 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, $R_\ell$ 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. $p^*(y)$ is defined in Lemma A1 in the appendix.

(i) Suppose that $p^*(y) \geq p_{BE}$. The investors’ belief is as follows: $E[p|d = D] = p$ and $E[p|d = ND] = p^*(y)$. At date 3, the investors choose $k = 1$. The entrepreneur chooses $d = D$ for $s \geq p^*(y)$ and $d = ND$ for $s < p^*(y)$ at date 2.

(ii) Suppose that $p^*(y) < p_{BE}$. 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 $R_\ell$ 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 $\gamma$) 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 $\gamma$ 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 $\gamma$ 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 \( \gamma \). 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 \( \gamma \) of Observing \( s = p \).** Part (ii) of proposition 1 shows that, with a low \( \gamma \), 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 \( \gamma \) leads to an increase in the ex-ante firm value. Upon \( d = ND \), the investors believe that the firm with a higher \( \gamma \) 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 $\gamma$ or a lower profit margin (i.e., lower cash flows $R$ or higher investment costs $K$).

**Empirical Implications of Proposition 1.** High cash flows $R$ upon success can be interpreted as good economic or industry conditions. It may also reflect a project with high productivity. Likelihood $\gamma$ of observing signal $s = p$ can be interpreted as either overall quality of internal information system or overall knowledge of the firm about projects.

Suppose the entrepreneur cannot disclose signal $s$ (i.e., $d = ND$ for any $s \in \{p, \emptyset\}$). Suppose also that she decides to incur some fixed costs so that she can credibly disclose $s = p$, as in Proposition 1. The results suggest that firms may exhibit more
voluntary disclosure if they (i) suffer from adverse market conditions or lower productivity (i.e., low cash flows $R$ or high investment costs $K$), or (ii) have access to better project knowledge or higher quality of internal information system (i.e., a high $\gamma$). This is because the relative benefit of making disclosure decision outweighs the fixed costs for these firms. In contrast, firms may exhibit less voluntary disclosure if they enjoy (i) favorable market conditions or high productivity (i.e., a high $R$ or a low $K$), or (ii) poor internal information system or knowledge about projects (i.e., a low $\gamma$).

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 $\gamma$ 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 $R_\ell$ 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.

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 $\gamma^2$. 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:
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 $R_\ell$ 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 $R_\ell$ 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.
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 the same as $p_{BE}$ 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,

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

(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 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 $p^* \geq p_{BE}$. 

53
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.

Empirical Implications of Lemma 4 and Corollary 1. The result suggests that the entrepreneur with two projects withholds more bad news than the two entrepreneurs with a single project, if $V_{ND} > 0$. Empirical papers have shown that the withholding of information by diversified firms can be an indicative of unresolved agency conflicts (e.g., Berger and Hann, 2007; Bens et al., 2011). My analysis suggests that there is another side of the story. 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. Thus, less disclosure alone may not be an indicative of too much agency conflict; organizational structure plays an important role in mitigating the information asymmetry problem.

The result also 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 (e.g., Berger et al., 1999). The analysis suggests that this can happen if each project has a moderate level of NPV. The following proposition derives the condition under which the entrepreneur can engage in internal capital allocation.
Proposition 2. Let $\gamma^{**}(R, K) \equiv \sqrt{\frac{3(R-2K)}{3(R-2K)+\frac{2K^2}{R^2}}}$

(i) $\gamma^*(R, K) < \gamma^{**}(R, K)$ for $R > 2K$ and $\gamma^*(R, K) = \gamma^{**}(R, K)$ for $R = 2K$.

(ii) $p^{**} \in \left[p_{BE}, \frac{1}{2}\right]$ exists if $\gamma \geq \gamma^*(R, K)$ and $\gamma \leq \gamma^{**}(R, K)$.

(iii) $p^{**}(\gamma)$ decreases in $\gamma$.

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 $\gamma$ 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

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

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

> 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.

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

**Empirical Implications of Proposition 3.** 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 $\gamma_i$ 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. 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 $\gamma_i$ 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.

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

**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 $R \in (R^{**}, R^*)$. 

59
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, $\gamma$ 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.

Figure 2.7: The graph of $\gamma^{**}(R, K)$ and $\gamma^*(R, K)$ with $K = 1$
Empirical Implications of Corollary 2. If cash flows $R$ can be interpreted as indicative of productivity and $R$ is bounded above by a reasonable number, my analysis implies that diversified firms can be more productive than stand-alone firms. With higher productivity, the diversified firms can easily attract capital from the investors upon no disclosure, and these firms can enjoy internal capital allocation. This can potentially explain that diversified firms are, on average, more productive (i.e., Schoar, 2002).

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.

Overall, the analysis suggests that disclosure environment plays an important
role in determining the boundary of the firm. As Coase (1990) argues, “the theory of the
accounting system is part of the theory of the firm.”
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 \( \gamma \) 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 \( E[p|d = ND] = \frac{p_{BE}}{2} \leq p_{BE} \) 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 \( [0, p_{BE}] \subseteq A \). 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:

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

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

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

$$2\sqrt{1 - \gamma} < 2 - \gamma \iff 4(1 - \gamma) < (2 - \gamma)^2 = 4 - 4\gamma + \gamma^2 \iff 0 < \gamma^2,$$
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 $k = 1$. 

65
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 $s^* \in A$. 

66
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

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

(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

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

which is increasing in $\gamma$. 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) $\frac{\partial}{\partial R} \left(\frac{R(R-2K)}{(R-K)^2}\right) = \frac{2R^2}{(R-K)^3} > 0$ 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 $\gamma$. 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

\[
B(p^{**}) = (p_{BE})^2 + 2 \times p_{BE}(p^{**} - p_{BE}) + \frac{(p^{**} - p_{BE})^2}{2} = \frac{(p^{**})^2 + 2p^{**}p_{BE} - (p_{BE})^2}{2}.
\]

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:

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

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

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 \( s_iR - K \geq V_{ND} \) 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 
\[
\gamma^*(R,K) - \gamma^* (R,K) = \sqrt{\frac{3(R-2K)}{3(R-2K)+\frac{2K^3}{R^2}}} - \frac{R(R-2K)}{(R-K)^2} > 0 \text{ for } R > 2K.
\]

(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 \( R \geq 2K \): 
\[
\frac{\partial}{\partial R} \left( \frac{R(R-2K)}{(R-K)^2} \right) = \frac{2K^2}{(R-K)^2} > 0 \text{ and } \frac{\partial}{\partial R} \left( \frac{3(R-2K)}{3(R-2K)+\frac{2K^3}{R^2}} \right) > 0.
\]
\[ (c) \frac{\partial}{\partial R} \left( \frac{R(R-2K)}{(R-K)^2} \right) = \frac{2K^2}{(R-K)^2} = \frac{2}{K} \text{ at } R = 2K, \text{ and } \frac{\partial}{\partial R} \left( \frac{3(R-2K)}{(R-2K)^2} \right) = \frac{2K^3}{(R-2K)^3} \text{ at } R = 2K \text{ is infinity.} \]

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

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

Thus, (a), (b), and (c) together imply that \( \gamma^\ast\ast(R,K) \) for \( R > 2K \) and \( \gamma^\ast(R,K) = \gamma^\ast\ast(R,K) \) 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, \( V_n(p^{**}) \). Recall \( B(p^{**}) \), the probability of \( d_1 = d_2 = ND \) upon \( s_1 = p_1 \) and \( s_2 = p_2 \),

\[ B(p^{**}) = \frac{(p^{**})^2 + 2p^{**}p_{BE} - (p_{BE})^2}{2}. \]

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, \(l_i = 0, l_j = 1\) and

\[E\left[ p_j \mid s_j \in (p_{BE}, p^*) \right] = \frac{p_{BE} + p^*}{2} .\]

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,

\[E\left[ \max\{s_1, s_2\} \mid s_1, s_2 \in \left[p_{BE}, \frac{p_{BE} + p^*}{2}\right] \right] = \frac{p_{BE} + p^*}{2} + \frac{1}{3}p_{BE} = \frac{1}{3}[2p_{BE} + p^*].\]

With probability \(1/4\), \(s_1 \in \left[p_{BE}, \frac{p_{BE} + p^*}{2}\right]\) and \(s_2 \in \left[p_{BE}, \frac{p_{BE} + p^*}{2}\right]\) and the entrepreneur chooses \(l_1 = 1\) and \(l_2 = 0\). The same calculation is performed for \(s_2 \in \left[p_{BE}, \frac{p_{BE} + p^*}{2}\right]\) and \(s_1 \in \left[p_{BE}, \frac{p_{BE} + p^*}{2}\right]\) Then, we have

\[2 \times E\left[ p_l \mid s_l \in \left[p_{BE}, \frac{p_{BE} + p^*}{2}\right] \right] = \frac{p_{BE} + 3p^*}{2}.\]

Then, the expected cash flows upon \(s_1, s_2 \geq p_{BE}\) such that \(s_1 + s_2 \leq p_{BE} + p^*\) is

\[\frac{1}{2} \left[ \frac{2p_{BE} + p^*}{3} + \frac{p_{BE} + 3p^*}{2} \right] = \frac{7p_{BE} + 11p^*}{12}.\]

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

\[A(p^*) = \frac{1}{B(p^*)} \left[ \left(p_{BE}\right)^2 \frac{2}{3} p_{BE} + 2p_{BE}(p^* - p_{BE}) \frac{p_{BE} + p^*}{2} \right. \]
\[\left. + \frac{(p^* - p_{BE})^2}{2} \frac{7p_{BE} + 11p^*}{12} \right].\]

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

\[
\frac{1 - \gamma^2}{1 - \gamma^2 + \gamma^2 B(p^{**})} \frac{1}{2} + \frac{\gamma^2 B(p^{**})}{1 - \gamma^2 + \gamma^2 B(p^{**})} A(p^{**}) = p^{**}. \tag{AA.1}
\]

Note that at \( p^{**} = 1/2 \), the left-hand side of the equation in (AA.1) becomes

\[
\frac{(85 - 18p_{BE} + 12(p_{BE})^2 + 8(p_{BE})^3)\gamma^2 - 96}{24((7 - 4p_{BE} + 4(p_{BE})^2)\gamma^2 - 8)},
\]

which is less than \( 1/2 \), since

\[
\frac{1}{2} - \frac{(85 - 18p_{BE} + 12(p_{BE})^2 + 8(p_{BE})^3)\gamma^2 - 96}{24((7 - 4p_{BE} + 4(p_{BE})^2)\gamma^2 - 8)}
= \frac{(1 + 6p_{BE}(5 - 6p_{BE}) + 8(p_{BE})^3)\gamma^2}{24(8 - (7 - 4p_{BE}(1 - p_{BE}))\gamma^2)} > 0.
\]

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

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

I identify the value of \( \gamma \) that makes the left-hand side of the equation in (AA.1) greater than \( p_{BE} \), and, with the help of the intermediate value theorem, this allows us to show the existence of the real solution to the equation in (AA.1).
Note that \( \frac{\partial \gamma}{\partial y} \left( \frac{3-(3-4p_{BE}^3)y^2}{6-6(1-p_{BE}^2)y^2} \right) = \frac{p^2(4p_{BE}-3)\gamma}{3(1+(p_{BE})^2-1)y^2} < 0 \) since \( p_{BE} \leq \frac{1}{2} \) and \( 4p_{BE} - 3 \leq 0. \) Then, \( \gamma \) needs to be low enough so that \( \frac{3-(3-4p_{BE}^3)y^2}{6-6(1-p_{BE}^2)y^2} > p_{BE}. \) By solving

\[
\frac{3-(3-4p_{BE}^3)y^2}{6-6(1-p_{BE}^2)y^2} = p_{BE},
\]

we get

\[
\gamma^*(R,K) = \sqrt{\frac{3(R - 2K)}{3(R - 2K) + \frac{2K^3}{R^2}}}
\]

(AA.2)

Note that with \( p_{BE} = 0 \) or \( K = 0, \) we have \( \gamma^*(R,K) = 1. \) This implies that if \( p_{BE} \) is low, there exists probability \( \gamma < 1 \) that ensures the existence of solution \( p^* \) in (AA.1);

with \( p_{BE} = 1/2 \) or \( R = 2K, \) \( \gamma^*(R,K) = 0. \) This implies that, with \( p_{BE} \) close to \( 1/2, \)

probability \( \gamma \) needs to be close to zero to ensure the existence of \( p^* \). Thus, \( p^* \in [p_{BE}, 1/2]. \) Then, if \( \gamma < \gamma^*(R,K), \) we have

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

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

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

\[
\frac{(1 - \gamma)(1 + \gamma)}{(1 - \gamma)(1 + \gamma) + \gamma^2B(p^*)} \frac{1}{2} + \frac{\gamma^2B(p^*)}{(1 - \gamma)(1 + \gamma) + \gamma^2B(p^*)} A(p^*) = p^*.
\]

\( p^* \) that satisfies the cubic equation in (AA.1) is the unique real solution such that

\[
p^* = \frac{22^{2/3} \left( (2 + 7(p_{BE})^2) \gamma^2 - 2 \right)}{A} + \frac{2^{1/3} A}{\gamma^2} - 5p_{BE}, \text{ where}
\]
\[ A = \left( 3(1 + 10p_{BE})\gamma^4(1 - \gamma^2) - 74(p_{BE})^3\gamma^6 
+ \gamma^3\sqrt{16(2 - (2 + 7(p_{BE})^2)\gamma^2)^3 + \gamma^2(74(p_{BE})^3\gamma^2 - 3(1 - \gamma^2)(1 + 10p_{BE}))^2} \right)^{1/3}. \]

The other two solutions are complex numbers.

(iii) Using the implicit function theorem, we have

\[ p^{**}(\gamma) = \frac{2\gamma(12(1 - 2p^{**}(\gamma)) + (p_{BE})^3 + 15p_{BE}(p^{**}(\gamma))^2 - 9(p_{BE})^2p^{**}(\gamma) + (p^{**}(\gamma))^3)}{3(-8(1 - \gamma^2) + 3(p_{BE})^2\gamma^2 - 10p_{BE}p^{**}(\gamma)\gamma^2 - \gamma^2(p^{**}(\gamma))^2)} < 0, \]

since the denominator is negative due to \( 3(p_{BE})^2\gamma^2 - 10p_{BE}p^{**}(\gamma)\gamma^2 < 3(p_{BE})^2\gamma^2 - 3p_{BE}p^{**}(\gamma)\gamma^2 = 3p_{BE}\gamma^2(p_{BE} - p^{**}(\gamma)) < 0 \); the numerator is positive due to

\[ 12(1 - 2p^{**}(\gamma)) > 0 \text{ with } p^{**}(\gamma) < 1/2 \text{ and } 15p_{BE}(p^{**}(\gamma))^2 - 9(p_{BE})^2p^{**}(\gamma) > 9p_{BE}(p^{**}(\gamma)(p^{**}(\gamma) - p_{BE}) > 0 \text{ with } p^{**}(\gamma) > p_{BE}. \]
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

\[
(1 - p^{**}(\gamma))(E[p_i|s_i \geq p^{**}(\gamma)]R - K) + p^{**}V_{ND}
\]

\[
= (1 - p^{**})\left(\frac{1 + p^{**}}{2}X - K\right) + p^{**}V_{ND}.
\]

With probability \(\gamma^2\), 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:

\[
\gamma^2 \left[ 2(1 - p^*)^2 \left( \frac{1}{2} + p^* \right) R - K \right] + 2p_{BE}(1 - p^*) \left( \frac{1}{2} + p^* \right) R - K)
\]
\[
+ 2(1 - p^*)(p^* - p_{BE}) \left( \frac{1}{2} + \frac{p^* + p_{BE}}{2} \right) R - 2K
\]
\[
+ \frac{(p^* - p_{BE})^2}{2} \times \left( \frac{p_{BE} + 2p^*}{3} R - K \right) + \left( p^* \right)^2 - \frac{(p^* - p_{BE})^2}{2} V_{ND}
\]
\[
+ 2\gamma(1 - \gamma) \left( 1 - p^* \right) \left( \frac{1}{2} + p^* \right) K - K \right) + p^* V_{ND} \right) + (1 - \gamma)^2 V_{ND}.
\]

By rearranging, we have

\[
80
\]
\[
2\gamma (1 - p^{**}) \left( \frac{1 + p^{**}}{2} R - K \right)
\]
\[
+ \left[ [1 - \gamma (1 - p^{**})]^2 + \gamma^2 (p^{**} - p_{BE})(1 - p^{**}) \right.
\]
\[
+ \frac{\gamma^2 (p^{**} - p_{BE})^2}{6} \right] V_{ND}.
\]

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

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

Thus, the ex-ante value of the diversified firm is higher than the ex-ante value of the two stand-alone firms for \(\gamma \leq \frac{\sqrt{\frac{3(R-2K)}{3(R-2K)+\frac{8K^3}{R^2}}}}{\sqrt{\frac{3(R-2K)}{3(R-2K)+\frac{8K^3}{R^2}}}} = p_{BE}\) 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

\[
2 \times \left( \frac{1}{2} R - K \right), \text{ as in section 4.1.} \]

\(\gamma > \gamma^{**}(R, K)\), 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 $\lim_{R \to \infty} \gamma^*(R, K) = \lim_{R \to \infty} \gamma^{**}(R, K) = 1$ 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 a multi-layered agency conflicts which have received much attention in the literature on internal capital markets. Specifically, I investigate a simple model in which external disclosure and internal information production interact with each other. I show that, under certain conditions, external disclosure encourages more production of information 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), instead of Dye (1985)’s disclosure friction, 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 cost, 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 voluntary disclosure, I consider a contractual approach to mitigating the information asymmetry between firms and investors. I show that, under certain conditions, the first-best ex-ante outcome can be achieved with the contractual approach. I also discuss possible limitations on the proposed contract.

3.2 Information Acquisition and Disclosure

3.2.1 Introduction

Chapter 2 investigates the disclosure strategy of a multi-divisional firm in the context of investment efficiency, and the focus of the analysis is the communication between the firm and the investors. However, other stakeholders may also be affected by corporate disclosure, and one important group of the stakeholders is a group of people who work within the firm. For example, Ferreira and Rezende (2007) develops 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 investment. However, Healy and Palepu (2001) argues that “there has been relatively little research on these types of voluntary disclosures.” (p. 406). One reason that this perspective has not received much attention can be attributable to the lack of theoretical framework, and the research opportunities in this direction are potentially abundant.
The perspective that external disclosure can affect the incentives of internal employees can be helpful in understanding the agency conflicts within organizations in a more holistic way. For instance, the literature on internal capital allocation has mostly emphasized the agency conflicts within the firm. Specifically, the literature has investigated the agency conflict between the headquarters of the firm and the divisional managers in explaining 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 free-riding problem by division managers (e.g., Rotemberg and Saloner 1994; De Motta 2003; Brusco and Panunzi 2005). However, the literature has not considered external governance 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 example, 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 with each other under certain conditions. This is 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). Since 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 so as to lower the likelihood of no disclosure and
credit rationing. In this model, voluntary disclosure effectively acts as a commitment device for the firm not to implement the project upon no information. This is a credible threat toward the divisional managers who prefer more to less investment, and this encourages more information production on the part of the divisional managers.

The remainder of the section is organized as follows. Section 3.2.2 describes the modeling setup. Section 3.2.3 conducts the analysis of the model. Section 3.2.4 concludes the section.

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 $c'(a) > 0 > c''(a)$, and $\gamma \in (0, 1)$. In addition, $c(0) = 0$ and $\lim_{a \to 1-\gamma} c(a) = \infty$. 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 $\gamma > 0$. $\gamma$ can be interpreted as the quality of 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, $R_\ell$ 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 $R_\ell$, 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 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. $d^* = \arg \max_{d \in \{D, ND\}} E[R - R_\ell; d]$ 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 $R_\ell$ satisfies 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 $a$ is consistent with Bayes rule, if possible.

### 3.2.3 Analysis

Consider an entrepreneur with a single investment project. I use backward induction to derive the ex-ante value of the project. I start the analysis of the first-best model. Then, I analyze the models under no disclosure and disclosure regimes. I finish this section with the comparison of the two regimes.
First-Best Case: Full Disclosure and Information Production by Entrepreneur

Suppose that signal $s \in \{p, \emptyset\}$ is always disclosed to the investors whenever generated. 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, and the entrepreneur’s job is to fulfill her obligations to deliver repayment $R_\ell$ to the investors upon positive cash flow and choose $a$. 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 in that repayment amount $R_\ell$ is set so that the investors
break even: \( pR_\ell = K \). Then, 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, repayment \( R_\ell \) satisfies \( \frac{1}{2}R_\ell = K \), 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 has capital \( K \).

At date 1, the entrepreneur chooses probability \( a \). With \( a \), signal \( s = p \) is observed with probability \( \gamma + a \), and the entrepreneur invests capital \( K \) if \( p \geq p_{BE} \). Signal \( s = \emptyset \) is observed with probability \( 1 - \gamma - a \), and the entrepreneur always invests capital \( K \). Then, the objective function of the entrepreneur at date 1 becomes
\[
(y + a) \Pr(s \geq p_{BE}) (E[p]s \geq p_{BE})R - K) + (1 - \gamma - a)(E[p]R - K)
\]
\[
= (1 - p_{BE}) \left( \frac{1 + p_{BE}}{2} R - K \right) + (1 - \gamma - a) \left( \frac{1}{2}R - K \right) - c(a)
\]

By rearranging, we have
\[
\frac{R}{2} - K + (y + a)p_{BE} \left[ K - p_{BE} \frac{R}{2} \right] - c(a).
\]

Since \( K - p_{BE} \frac{R}{2} > K - p_{BE}R = 0 \), 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 chooses $a$ at private cost $c(a)$. Then, the investors cannot make their investment decisions contingent on the disclosed information. I show that, without external disclosure, signal $s$ has no productive use, because investment decisions are made independent of signal $s$.

At date 3, the investors decide whether to invest capital $K$ in the project. They conjecture that the entrepreneur chooses $a = a^*$. Then, the investors 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 $E[p] = \frac{1}{2}$. Then, the expected cash flow becomes

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

and repayment $R_\ell$ 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
\((\gamma + a)E[E[p|s = p]](R - R_\ell) + (1 - \gamma - a)E[p](R - R_\ell) - c(a)\)

\[= \frac{1}{2} R - K - c(a).\]

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 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 the firm cannot disclose signal \(s\) and the entrepreneur can choose \(a\) at private cost \(c(a)\).

**Date 3 – Investment.** The investors do not observe signal \(s\) under no disclosure regime, and they decide whether to invest capital \(K\) in the project in return for repayment \(R_\ell\). Since the investors require zero expected profit, the expected repayment amount must be equal to the investors’ initial outlay. Let \(a^*\) denote the investors’ conjecture about the agent’s choice of probability \(a\). Then, the expected pledgeable income is

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

The expected pledgeable income is greater than the cost of investment \(K\), so the investors decide to invest capital \(K\) in the project. Because the capital market is competitive, the investors break even in expectation, and repayment \(R_\ell\) satisfies
\[(\gamma + a^*)E[E[p|s = p]]R_\ell + (1 - \gamma - a^*)E[p]R_\ell = \frac{1}{2}R_\ell = K.\]

Then, we have \(R_\ell = 2K\) and the entrepreneur obtains \(R - R_\ell = R - 2K\) upon cash flow \(R\).

Note that the project is always implemented, since the entrepreneur enjoys positive expected cash flow and the investors break even. In addition, 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 private cost of increasing \(a\). Since 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 rational expectation equilibrium. Then, the date-1 expected value of the project becomes
\[
\gamma E[E[p|s = p]](R - R_\ell) + (1 - \gamma)E[p](R - R_\ell) = \frac{1}{2}(R - 2K) = \frac{1}{2}R - K > 0.
\]

The following proposition summarizes the analysis of a stand-alone firm with no external disclosure.

**Proposition 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 \(R_\ell\) 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. Since 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 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 the 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

\[
s^*(\gamma, a^*) \equiv \sqrt{1-\gamma-a^*-(1-\gamma-a^*)} / (\gamma + a^*) .
\]

(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 \( \gamma \) and \( a^* \).

Part (i) of lemma 3.2 confirms the standard result in disclosure literature. The entrepreneur always has an incentive to disclose good signal \( s = p \geq s^* \) so that her project can be evaluated at a higher expected value and 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 $\gamma$. Intuitively, with higher $\gamma$, 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 $\gamma$ 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 $a$. The key difference from the previous section happens when signal $s = p$ is withheld by the entrepreneur. Lemma 3.2 shows that, if $\gamma$ is high enough, the investors refuse to invest in the project. This has a direct implication on the incentive of the agent to generate signal $s = p$. The following proposition shows that the agent has an incentive to generate information if $\gamma$ 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 $K$. 

96
Proposition 3.3 shows that firms with external disclosure can induce their agents to generate information, whereas firms without external disclosure cannot induce information generation. The reason comes from the possibility of credit rationing upon no disclosure of signal $s$. Since firms without external disclosure always raise capital from the 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 happens 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 proposition 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 $\gamma$ is low enough. Thus, if $\gamma$ is low, voluntary disclosure does not add value to the project. However, part (ii) of proposition 3.3 shows that, if $\gamma$ is high enough, the expected value of the project with external disclosure becomes $(\gamma + a^*)(1 - p_{BE})\left(\frac{1 + p_{BE}}{2}R - K\right)$. Then, firms that have both high $\gamma$ 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 no-disclosure benchmark.

**Corollary 3.4.**

(i) The expected values of the project under no disclosure and external discourse are the same for \( \gamma \leq \frac{R(R-2K)}{(R-K)^2} \).

(ii) Firms with either higher \( \gamma \) or higher \( K \) or lower \( R \) may prefer adopting external disclosure.

The corollary shows that firms with lower \( \gamma \) are indifferent between disclosure and no disclosure regimes in terms of the expected value of the project. If the firm needs to incur cost to be able to disclose information in the sense of Dye (1985), the result suggests that firms with lower \( \gamma \) may choose not to incur cost at all.

Part (ii) of the corollary shows that firms with higher \( \gamma \) may choose to incur cost to be able to disclose information in the sense of Dye (1985), because these firms are more likely to fine-tune their capital raising based on disclosed and non-disclosed information. In addition, firms with higher profit margin (higher \( R \) and lower \( K \)) are not likely to incur cost to install Dye’s (1985) disclosure technology. The intuition is as follows. With external disclosure, firms that have either higher \( \gamma \) 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 disclose more information voluntarily.

3.2.4 Discussion

This section discusses a possible extension of the model in chapter 2. Specifically, I 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.

I discuss two topics that may worth exploring. First, although I consider the communication between the entrepreneur and the investors, I abstract away from possible communication game between divisional managers and the entrepreneur and focus only on the incentive of information production. Stein (2002), for example, considers information production by the divisional manager and the related communication game between the divisional managers and the entrepreneur and abstracts away from the disclosure game between the entrepreneur and the investors. It would be interesting to consider how external disclosure affects internal communication, and this approach may help us to understand how managerial and financial accounting reporting interact with each other.

Second, the analysis of the model shows that external disclosure can help not only lower the information asymmetry between firms and investors, but also encourage more information production by internal employees. The result is based on the
assumption that there are multiple group of audience for corporate disclosure: investors and employees. More interesting tradeoffs about external disclosure may emerge in the presence of multiple numbers of audience with different characteristics.

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). Specifically, the firm is randomly informed of the success probability of each project, but the disclosure friction is that the firm cannot credibly reveal its information endowment. Thus, upon no disclosure from the firm, the investors cannot tell whether the firm is informed or uninformed. This raises the question of whether the main results in chapter 2 hold true with other kinds of disclosure friction.

Another well-known disclosure friction in corporate disclosure literature is disclosure cost in the spirit of 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 or Stocken, 2012 for review).

In this section, I discuss an example to show that, in the presence of 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. Specifically, each project requires a fixed investment of $K = 1.25$. If implemented, project $i \in \{1,2\}$ generates either $R_i = 2$ or $R_i = 0$. For each project $i \in \{1,2\}$, $R_i = 2$ is realized with success probability $p_i \in \left\{\frac{1}{2}, \frac{3}{4}, 1\right\}$, and I assume that $\Pr\left(p_i = \frac{1}{2}\right) = \Pr\left(p_i = \frac{3}{4}\right) = \Pr(p_i = 1) = \frac{1}{3}$. I assume that $p_1$ and $p_2$ are independent. As in the previous models, the investors invest capital in the firm as long as they can break even in expectation. That is, the capital market is competitive.

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 $c = 0.2$. 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 $c$. Disclosure cost is in the spirit of Verrecchia (1983). 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, and the investors break even in expectation. At $t = 3$, if implemented, project $i$ generates $R_i = 2$ with probability $p_i$ and $R_i = 0$ with probability $1 - p_i$. Each party obtains the cash flows according to the financial contract. The following table summarizes the timeline:
3.3.3 Analysis

Stand-alone firm benchmark

Let me first consider a firm that has a single project. Consider the firm’s disclosure strategy and the investors’ investment strategy. I show the following observation of the model, and the proof is in the appendix.

**Observation 3.5.** The firm chooses $d = ND$ if $p = \frac{1}{2}$ and $d = D$ if $p \in \left\{ \frac{3}{4}, 1 \right\}$. The investors choose not to invest capital $K$ upon $d = ND$ and to invest capital $K$ if $d = D$.

Thus, with $p = \frac{1}{2}$, the firm chooses $d = ND$ and there is no investment. The reasons for no disclosure include low success probability and disclosure cost $c$. With $p = \frac{3}{4}$, the firm chooses $d = D$ and the expected firm value becomes...
\[ \frac{3}{4} \times R - K - c = 0.05. \]

With \( p = 1 \), the firm chooses \( d = D \) and the expected firm value becomes

\[ 1 \times R - K - c = 0.55. \]

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

\[ \frac{1}{3} \times (0 + 0.05 + 0.55) = 0.2, \]

and the ex-ante value of the two stand-alone firm becomes 0.4.

**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 \( p_2 \):

<table>
<thead>
<tr>
<th>( p_2 )</th>
<th>( p_1 = 0.5 )</th>
<th>( p_1 = 0.75 )</th>
<th>( p_1 = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( d_1 = ND ) and ( d_2 = D ); Expected NPV: 0.55</td>
<td>( d_1 = D ) and ( d_2 = D ); 0.55 + 0.05 = 0.6</td>
<td>( d_1 = D ) and ( d_2 = D ); 0.55 + 0.55 = 1.1</td>
</tr>
<tr>
<td>0.75</td>
<td>( d_1 = d_2 = ND )</td>
<td>( d_1 = D ) and ( d_2 = D ); 0.55 + 0.05 = 0.6</td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>( d_1 = d_2 = ND )</td>
<td>( d_1 = D ) and ( d_2 = ND ); 0.55</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.3: Conditional expected firm values
i) \( p_i = 1 \) for \( i \in \{1, 2\} \). 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, 
\[ d_j = ND \text{ if } p_j = \frac{1}{2} \text{ and } p_j = D \text{ if } p_j \in \left\{ \frac{3}{4}, 1 \right\}. \]
In these cases, the disclosure strategies of the two projects are independent.

iii) \( p_i \in \left\{ \frac{1}{2}, \frac{3}{4} \right\} \) 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 \( p_i \in \left\{ \frac{1}{2}, \frac{3}{4} \right\} \) and \( d_i = D \) if \( p_i = 1 \) for \( i \in \{1, 2\} \). Then, upon \( d_1 = d_2 = ND \), the investors know that \( p_i \in \left\{ \frac{1}{2}, \frac{3}{4} \right\} \) for \( i \in \{1, 2\} \). In addition, the investors know that, if they were to provide $1.25 to the firm, it would allocate $1.25 to the project \( i \) with \( p_i \geq p_j \) so that its expected payoff can be maximized. Then, the likelihood of capital $1.25 being allocated to a project with \( p_i = \frac{3}{4} \) is \( 1 - \left( \frac{1}{2} \right)^2 \), and the likelihood of capital $1.25 being allocated a project with \( p_i = \frac{1}{2} \) is \( \left( \frac{1}{2} \right)^2 \). This implies that the expected net present value of the firm conditional upon \( d_1 = d_2 = ND \) is

\[
\left( \left( 1 - \left( \frac{1}{2} \right)^2 \right) \frac{3}{4} + \left( \frac{1}{2} \right)^2 \frac{1}{2} \right) R - K = 1.375 - 1.25 = 0.125.
\]
Note that even if the firm discloses \( p_1 = p_2 = \frac{3}{4} \), the expected net present value of the firm is

\[
2 \times \left( \frac{3}{4} \times R - K - c \right) = 0.1,
\]

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 \( p_i = \frac{3}{4} \) whereas the two-project firm chooses \( d_i = ND \) if \( p_1, p_2 \in \left\{ \frac{1}{2}, \frac{3}{4} \right\} \). This result shows that the firm with two projects under the same roof discloses less information. This is due to the two reasons. First, the firm can save disclosure cost. Second, even without disclosure, the investors are relatively confident that capital that they provide will be allocated to a better project.

Note that \( p_i \in \left\{ \frac{1}{2}, \frac{3}{4} \right\} \) for \( i \in \{1, 2\} \) occurs with probability \( \frac{4}{9} \), and \( p_i = 1 \) and \( p_j = 0.5 \) occurs with probability \( \frac{2}{9} \), \( p_i = 1 \) and \( p_j = \frac{3}{4} \) occurs with probability \( \frac{2}{9} \) and \( p_1 = p_2 = 1 \) occurs with probability \( \frac{1}{9} \). Then, the ex-ante value of the firm becomes

\[
\frac{4}{9} \times 0.125 + \frac{2}{9} \times (0.55 + 0.6) + \frac{1}{9} \times 1.1 = 0.433.
\]

This is greater than 0.4, 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 with the help of an example that much of the main results in chapter 2 holds true with an alternative assumption about disclosure friction. Specifically, this section considers a standard disclosure friction, which is disclosure cost 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

So far, I have assumed that the entrepreneur of a firm always invests raised capital in her projects even if the projects are negative-NPV. This is consistent with the assumption that managers prefer more to less investment (i.e., empire builder), and this is a standard assumption in the literature on internal capital allocation (e.g., Scharfstein and Stein 2000; Stein 2002; See Gertner and Scharfstein, 2012 for review). Under this framework, Stein (1997) shows that there exists the benefit of having multiple projects under the same roof. This is because, even if firms may be empire builders, the firms prefer to invest capital in better projects. This is often called “winner picking and loser sticking”. This is the main source of benefit of being multi-divisional in the framework in chapter 1 and the model in chapter 2.
In this section, I consider an alternative approach in that the firm signs a refined financial contract so that the firm is induced not to invest capital in a negative-NPV project. This discussion is based on Maskin and Tirole (1992) and Tirole (2006), and it shows that, under certain conditions, the firm may achieve the first-best outcome with the help of the refined financial contract. The analysis can potentially help us identify conditions under which firms can rely on internal capital allocation to mitigate the information asymmetry between firms and investors.

3.4.2 Model

Consider a firm consisting of an entrepreneur who possesses an investment project but no capital. Thus, the entrepreneur needs to borrow capital from the investors to implement the project. As in chapter 2, the capital market is assumed to be competitive in that 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 $1 - p$. Success probability $p$ can be either $p_1$ or $p_2$, where $1 > p_1 > p_2 > 0$. I assume that $\Pr(p = p_1) = \beta$ 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 while the project with $p = p_2$ is not profitable. That is,

$$p_1R - K > 0 \text{ and } p_2R - K < 0.$$  (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. If the investors do not accept the contract, no capital will be provided to the entrepreneur and no project is to be implemented.

Date 4 – Outcome. The project generates cash flows, which are then distributed to the entrepreneur and the investors according to the financial contract. The following table summarizes the timeline of the model:

<table>
<thead>
<tr>
<th>$t = 1$</th>
<th>$t = 2$</th>
<th>$t = 3$</th>
<th>$t = 4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Nature selects $p \in {p_1, p_2}$.</td>
<td>▪ The entrepreneur offers a financial contract to the investors.</td>
<td>▪ Investors decide whether to accept the contract.</td>
<td>▪ Cash flows $R$ generated with probability $p$.</td>
</tr>
<tr>
<td>▪ Entrepreneur observes $p$.</td>
<td></td>
<td></td>
<td>▪ No cash flows generated with probability $1 - p$.</td>
</tr>
<tr>
<td></td>
<td>▪ The entrepreneur takes an action.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.4: Timeline
3.4.3 Analysis

3.4.3.1 Benchmark

In this section, I discuss the two benchmark settings: No information asymmetry between the entrepreneur and the investors and information asymmetry with a “simple” financial contract in which the raised capital is always invested in the project.

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). Then, the entrepreneur can write a financial contract such that the investors break even in expectation at \( t = 3 \). That is, if the investors are paid \( R_\ell \in [0, R] \) upon cash flow \( R \) at \( t = 4 \) such that \( p_1 R_\ell - K = 0 \), the investors are willing to accept the contract and provide capital \( K \) at \( t = 3 \). Then, 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. Since \( p = p_1 \) with probability \( \beta \), the ex-ante expected value of the project becomes \( \beta(p_1R - K) \).
“Simple” contract

At date 1, success probability $p \in \{p_1, p_2\}$ is determined and observed by the entrepreneur, but the investors do not observe the success probability. If the unconditional expected net present value of the project is negative, the investors cannot break even in expectation and there will be no implementation of the project. If, on the other hand, the unconditional NPV of the project is positive, or

$$\{\beta p_1 + (1 - \beta)p_2\}R - K > 0,$$

the investors can break even in expectation if $R_\ell \in [0, R]$ is paid such that

$$\{\beta p_1 + (1 - \beta)p_2\}R_\ell = K.$$ The ex-ante value of the project becomes

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

This is less than the ex-ante value of the project with symmetric information, because

$$\beta(p_1R - K) - [\{\beta p_1 + (1 - \beta)p_2\}R - K] = (K - p_2R)(1 - \beta) > 0.$$ 

In the next section, I consider a financial contract that can deliver higher ex-ante value of the project than that with the simple contract.

3.4.3.2 Refined 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 with the information asymmetry between the entrepreneur and the investors. Before I conduct the analysis, let me introduce two concepts necessary for the analysis.
Let an allocation be a pair of type-contingent contract \((c_1, c_2)\), and \(c_1\) is the contractual terms for the entrepreneur with \(p = p_1\) and \(c_2\) is the contractual terms for the entrepreneur with \(p = p_2\).

After learning \(p \in \{p_1, p_2\}\) at date 1, the entrepreneur offers an option contract \((c_1, c_2)\) to the investors. 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 amount of cash flows that go to the entrepreneur in case of positive cash flow \(R_i\). \(R_i^F\) the amount of cash flows that go to the entrepreneur (paid by the investors) in case of zero cash flow. \(R_i^0\) the amount of cash flows that go to the entrepreneur in case of no investment. For example, if the
entrepreneur with \( p = p_i \) chooses contract \( c_i = \{ y_i, R_1^S, R_1^F, R_1^0 \} \), the expected payoff for the entrepreneur with \( p = p_i \), \( U_i(c_i) \), is

\[
U_i(c_i) = y_i \{ p_i R_1^S + (1 - p_i) R_1^F \} + (1 - y_i) R_1^0.
\]

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 \( p = p_1 \) maximizes the following maximization program:

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

\[
\begin{align*}
\text{IC (} p_1 \text{): } & U_1(c_1) \geq U_1(c_2) \text{ and IC (} p_2 \text{): } U_2(c_2) \geq U_2(c_1). \\
\text{IR for for the investors: } & \beta \{ y_1 (p_1 R - K) - U_1(c_1) \} + (1 - \beta) \{ y_2 (p_2 R - K) - U_2(c_2) \} \geq 0.
\end{align*}
\]

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.
3.4.4 Discussion

The analysis shows that the firm can achieve the first-best ex-ante value of the firm without the help of either internal capital allocation across multiple projects or credible communication between firms and investors.

The literature on the strategic accounting reports can be categorized based on whether Revelation Principle holds true, and the Revelation Principle is often used to investigate the contractual relation between firms and investors. One of the requirements for the Revelation Principle to hold true is that the firm must report truthfully which state has occurred. Thus, contractual framework may not be relevant in a situation in which a firm often misrepresents its information, and voluntary disclosure framework may be appropriate. (See Stocken, 2012 for further discussion)

One of the biggest challenges in the refined financial contract in this section is that entrepreneurs do not lie about whether they have their own projects. According to the contraction in proposition 3.5, the entrepreneur who has a bad project can obtain

\[ R^0_2 = p_2 \frac{\beta(p_1 R - \kappa)}{\beta p_1 + (1 - \beta) p_2} > 0. \]

For the contract in proposition 3.6 to hold, the investors must make sure that entrepreneurs who do not even have a project can collect \( R^0_2 \) by claiming that she has a bad project. Thus, as long as it is costly to identify whether entrepreneurs lie about their having projects, the Revelation Principle may not apply, and the voluntary disclosure framework may still continue to apply.
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

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

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 \( R \) satisfies \( pR = K \) and the entrepreneur’s expected payoff becomes
\( p(R - R_e) = pR - K > p_{BE}X - K = 0 \). 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 \( R_e \) satisfying \( s^*R_e = K \), and the entrepreneur’s expected payoff upon no disclosure of signal \( \sigma \) becomes \( s^*(R - R_e) = s^*R - K > p_{BE}R - K = 0 \).

(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 $\gamma$ 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

$$\gamma(1 - s^*)\left(\frac{1 + s^*}{2}R - K\right) + (1 - \gamma(1 - s^*))s^*$$

$$= \gamma(1 - s^*)\left(\frac{1 + s^*}{2}R - K\right)$$

$$+ (1 - \gamma(1 - s^*))\left(\frac{1 - \gamma}{1 - \gamma(1 - s^*)} \times \frac{R}{2} + \frac{\gamma s^*}{1 - \gamma(1 - s^*)} \times \frac{s^*}{2}R - K\right)$$

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

(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

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

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

117
\((\gamma + a)(1 - p_{BE})K - c(a)\),

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) \(\frac{\partial}{\partial x}\left(\frac{R(R-2K)}{(R-K)^2}\right) = \frac{2K^2}{(R-K)^3} > 0\) and \(\frac{\partial}{\partial K}\left(\frac{R(R-2K)}{(R-K)^2}\right) = -\frac{2KR}{(R-K)^3} < 0\) □

\textbf{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 \(\gamma\). In addition, we have

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

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

\textbf{Proof of Observation 3.5}

Suppose that \(d = ND\) for any \(p \in \left\{\frac{1}{2}, \frac{3}{4}, 1\right\}\). Then, the expected value of the firm becomes

\(\)
\[
\frac{1}{3} \left( \frac{1}{2} + \frac{3}{4} + 1 \right) \times R - K = 0.25. 
\]

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

\[
R - K - c = 0.55,
\]

which is greater than 0.25.

Suppose that the firm chooses \( d = ND \) for \( p \in \left\{ \frac{1}{2}, \frac{3}{4} \right\} \) and \( d = D \) for \( p = 1 \).

Upon \( d = ND \), the expected NPV of the firm becomes

\[
\left( \frac{1}{2} \times \frac{1}{2} + \frac{1}{2} \times \frac{3}{4} \right) \times R - K = 0.625 \times 2 - 1.25 = 0,
\]

However, if the firm chooses \( d = D \), the expected NPV of the firm becomes higher:

\[
\frac{3}{4} \times R - K - c = 1.5 - 1.25 - 0.2 = 0.05.
\]

Thus, the investors' belief that the firm chooses \( d = ND \) if \( p \in \left\{ \frac{1}{2}, \frac{3}{4} \right\} \) is not consistent with the firm's disclosure strategy.

Suppose that the firm \( d = ND \) if \( p = \frac{1}{2} \) and \( d = D \) if \( p \in \left\{ \frac{3}{4}, 1 \right\} \). Then, upon \( d = ND \), the expected net present value of the investment is

\[
E[p|d = ND] \times 2 - K = \frac{1}{2} \times 2 - 1.25 = -0.25.
\]
Since the expected NPV is negative, the investors choose not to invest capital and both parties obtain zero payoff. If \( p = \frac{1}{2} \) and \( d = D \), the expected net present value of the investment is

\[
\frac{1}{2} \times R - K - c = -0.45.
\]

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 \( p = \frac{3}{4} \) and \( d = D \), the expected net present value of the firm becomes

\[
\frac{3}{4} \times R - K - c = 1.5 - 1.25 - 0.2 = 0.05.
\]

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

\[
R - K - c = 0.55.
\]

Note that the expected values of the firm in both cases are greater than -0.25, 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

\[
U_2(c_1) = y_1\{p_2R_1 + (1 - p_2)R_1^S\} + (1 - y_1)R_1^0 = U_1(c_1) - (p_1 - p_2)(R_1^S - R_1^F).
\]
Then, IC \((p_2)\) constraint can be rewritten as

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

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

\[
\beta y_1(p_1 R - K) + (1 - \beta)y_2(p_2 R - K) - U_1(c_1) + (1 - \beta)y_1(p_1 - p_2)(R_1^S - R_1^F) = 0.
\]

By rearranging, we have

\[
U_1(c_1) = \beta y_1\left(\frac{p_1 R - K}{\text{positive}}\right) + (1 - \beta)y_2\left(\frac{p_2 R - K}{\text{negative}}\right) + (1 - \beta)y_1\left(\frac{p_1 - p_2}{\text{positive}}\right)(R_1^S - R_1^F).
\]

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 \(U_1(c_1) = p_1 R_1^S\) and IR constraint can be rewritten as

\[
\beta(p_1 R - K) - p_1 R_1^S + (1 - \beta)(p_1 - p_2)R_1^S = 0,
\]

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:

\[ y_2\{p_2R^S_2 + (1 - p_2)R^E_2\} + (1 - y_2)R^0_2 \geq y_1\{p_2R^S_1 + (1 - p_2)R^F_1\} + (1 - y_1)R^0_1. \]

With \(y_2 = 0, y_1 = 1,\) and \(R^F_1 = 0,\) and the constraint binding, we have

\[ R^0_2 = p_2R^S_1. \]

Thus, we have \(c_2 = \{y_2, R^0_2\}\) such that \(y_2 = 0\) and \(R^0_2 = p_2R^S_1 = p_2 \frac{\beta(p_1 R - K)}{\beta p_1 + (1 - \beta)p_2}.\) 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 \(\beta\) 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.\[\]

122
References


