

Information Sequencing, Financial Intermediation and Firms' Financing Choices

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Abstract

This paper proposes a model to analyze a firm's optimal financing choices in a structure with imperfect information on both the firm's quality and the industry's prospect. We find a non-monotonic relationship between the firm's quality and its financing choices in sharp contrast to the simple separating outcomes in former literature. A firm accesses commercial bank lending when the industry's prospect is very optimistic or pessimistic relative to its inherent quality. Moreover, as a firm's quality improves, the market share secured by commercial banks expands (shrinks) when the firm's initial quality is low (high). Finally, we also find that how intermediaries determine their information sequencing has great influence on their competitive advantages to meet the firm's financing needs.

JEL classification: G20, G21, G32

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1. Introduction

The nineties witnessed radical evolution in financial institutions and aroused keen interest and heated debate in both academic research and real world practices. Among various financial reforms proposed, the structure design of the financial system, or so-called financial system architecture, appears to be most conspicuous and important. This study is intended to shed some light on the architecture of the financial system from a business financing viewpoint when each financial institution confronts double uncertainties about the firm's quality and the industry's prospect.

Most of the literature on financial system architecture emphasizes the different roles that banks and capital markets play in the allocation of capital. Allen (1993,1995) provides a qualitative and preliminary framework for analysis. Boot and Thakor(1997a, 1997b) shows that bank lending which specializes in monitoring alleviates the moral hazard problem, whereas capital markets generate more public information valuable to firms. As a result, firms facing serious moral hazard problem should access commercial banks and those with modest moral hazard problem should choose capital markets for project funding. This result is consistent with the findings of Rajan(1992). Boot and Thakor(2000) further considers intra- and inter-bank competition in the financing market and comes to the conclusion that low and middle quality firms resort to commercial banks for their project funding(including relationship and transaction loans) while high quality firms choose capital market financing. On the contrary, Yosha(1995) and Bhattacharya and Chiesa(1995) show that bank lending is more attractive to better quality firms, whereas poorer quality firms prefer multilateral lending (capital markets financing) after taking into account the preservation of proprietary information.

The above studies derive simple separating outcomes between commercial bank lending and capital market financing primarily because they assume only one kind of hidden information, i.e., the firm's specific information.¹ In this paper we introduce two kinds of imperfect information, the firm's specific information (firm's quality) and the market information (industry's prospect). Financial institutions have to acquire both information before lending or underwriting decisions. We distinguish bank lending from investment bank underwriting according to their relative

¹ In fact Boot and Thakor(1997a, 1997b) consider two kinds of hidden information. The first one is about the firm's moral hazard problem (i.e. the probability of choosing a bad project) that can be resolved only by the monitoring of commercial banks. The other one is about the possibility of improvement in the return of the good project that can be revealed only through the trading in capital markets. Therefore, commercial banks and investment banks specialize in the area of the firm's and market information respectively. Obviously in their model intermediaries don't have to deal with both information in financing their clients. There is extreme demarcation between commercial banks and investment banks as regards the treatment of information. In our model the hidden information about firms and market is defined differently and intermediaries must process both information in financing their clients. Moreover, each intermediary has its distinct advantage in one of the firm's or market information.

advantages in the specific information: commercial banks are good at producing the firm's information while investment banks are more skillful in the production of the market information. These relative advantages are manifested in the comparative low variable cost of information production in their advantageous sector.

In addition, financial institutions also differ in their production sequence of information. In the first part of the analysis, it is assumed that each financial institution starts with the information research or production in its advantageous sector. The advantageous sector presumably has higher control and behaves like a leader over the whole production process of both information. Depending on the outcome of their research in that specific sector, they then consider whether it is worthwhile to venture into the production of the other sector's information. Therefore, the sequencing of information acquisition can save each institution from unnecessary cost and effort in extracting the subsequent information when the information about its client's quality or the industry's prospect in the initial stage indicates that the project is unacceptable.

In our model, the degree of reliability in these two kinds of information is a function of the intermediary's effort which will be endogenously determined in the framework of subgame perfect equilibrium. Our study shows that each financial intermediary does not necessarily produce more accurate information in its advantageous sector. As for the overall accuracy of combined information, commercial banks will surpass investment banks when the firm's quality is deemed not as optimistic as the industry's prospect.²

To evaluate the competitiveness of a financial intermediary in different market conditions, we need to contrast the benefit of improved information accuracy with its accompanying increase in information cost. When the industry's prospect is very optimistic relative to the firm's quality, the need for the firm's information is more necessary than the industry's information. Since commercial banks have an advantage in the firm's information, the net benefit realized by commercial bank lending will exceed the one by investment bank underwriting. As the industry's prospect becomes lower relative to the firm's quality, the need for the industry's information becomes stronger. Thus, investment banks that excel in generating the industry's information emerge to be the better financing source. However, once the industry's prospect is too pessimistic compared with the firm's quality level, the increasing marginal cost principle dictates that the substantial increase in the marginal cost of upgrading

² Here we define the firm's quality to be the probability that it is of a good type (instead of a bad type) and the industry's prospect is defined to be the probability that the expected project return is high (instead of low).

information precision for the investment bank will overwhelm the little increase in its marginal benefit of accuracy improvement. We will thereby witness the dominance of commercial banks over investment banks again. To sum up, given its quality level a firm should choose commercial bank lending when the industry's prospect is deemed to be very optimistic or pessimistic. Our study also shows that the middle range of the industry's prospect in which investment banks outpace commercial banks could expand or shrink by the improvement of the firm's quality depending on whether the initial firm's quality is greater or lower than some threshold.

Finally, we relax our exogenous sequencing assumption and let intermediaries choose their information sequencing endogenously. Interestingly, it is found that the aforementioned result about financing choices would be reversed once the intermediaries can optimally decide the sequencing of their information services. This shows that how intermediaries choose their information sequencing has crucial influence on their competitive advantages to meet a firm's financing needs.

This paper is organized as follows. Section 2 describes the basic model and assumptions. Section 3 examines intermediaries' information generating strategies and compares their relative information accuracy. The firm's financing choice and the relative importance of commercial banks financing and investment banks financing are analyzed in section 4. Section 5 discusses how our previous result is affected when intermediaries endogenously determine their information sequencing. Some concluding remarks are made in section 6.

2. The Model

2.1 The payoff structure of the project

We consider an economy consisting of firms each with a project that needs a \$1 investment. All firms are short of funds and must ask for external financing. The financier is limited to commercial bank lending or capital market debt underwriting. Universal risk neutrality with zero riskless rate of interest is assumed. As shown in figure 1, whether the project succeeds depends on two factors. The first one is related to the firm's specific characteristics. We assume that there are two types of firms, "good" and "bad". Only good type firms have chances to successfully undertake the project. The proportion of good type firms is p and $1-p$ is the proportion of bad type. At first, a firm's type is unknown to anyone, including itself. The second factor is about the prospect of the whole market or industry. We assume that the industry may turn out to be in the "high state" or "low state". With probability ϕ , firms find themselves in the "high state", and good type firms can successfully undertake the project and produce certain return $R > 1$. Instead, in the "low state" even good type firms can only produce expected return $\rho R < 1$.

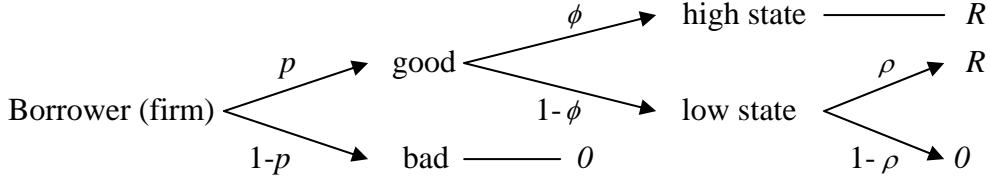


Figure 1. The project's payoff structure

The following two assumptions are made to assure that the project be socially unprofitable unless the firm is of a good type and the industry is in the high state:

Assumption 1: $\phi R + (1-\phi)\rho R < 1$.

Assumption 2: $pR < 1$

2.2 The information technology of financial intermediaries

There are two kinds of financial intermediaries, commercial banks and investment banks (underwriters) in our model. All financial intermediaries are subject to perfect competition. According to assumption 1 and 2, they have to collect two kinds of information before financing the project. One is about the firm's type and the other about the industry's prospect. Lacking either kind of information will render the project to be socially undesirable.

As to the information of the firm's type, we assume that after exerting an effort level e^f (the superscript "f" stands for "firms") the intermediary can generate his own private information which is an observable and verifiable signal $\sigma \in \{1,0\}$ (1 stands for favorable signal, 0 for unfavorable signal) about the firm's type, *good* or *bad*. The degree of informativeness of the signal depends on the effort e^f as follows³

$$Pr(\sigma=1 | \text{good type}) = q(e^f) \quad \text{and}$$

$$Pr(\sigma=0 | \text{bad type}) = 1.$$

Similarly, after exerting an effort level e^m (the superscript "m" stands for "market") the intermediary can derive another signal $\sigma \in \{1,0\}$ about the industry's prospect, *high* or *low*. The informativeness of the signal depends on the effort e^m as follows

$$Pr(\sigma=1 | \text{high state}) = q(e^m) \quad \text{and}$$

$$Pr(\sigma=0 | \text{low state}) = 1.$$

For simplicity, we have assumed the same functional form $q(\cdot)$ for both signals which satisfies $q'(\cdot) > 0$ and $q''(\cdot) \leq 0$.

With these signal structures, the posterior probability of being a good type firm after receiving a favorable signal "1", $Pr(\text{good type} | \sigma=1)$, is equal to one. Likewise, the posterior probability of the industry's being in the high state after receiving a favorable signal "1", $Pr(\text{high state} | \sigma=1)$, is also equal to one. In contrast, the posterior probability will become $p(1-q(e^f))/(1-pq(e^f)) < p$ for the good type and $\phi(1-q(e^m))/(1-\phi q(e^m)) < \phi$ for the high state after receiving an unfavorable signal "0".

³ We offer an asymmetric signal structure since we only care the situation that the firm is of a good type and the industry is in the high state. This structure form can greatly simplify our analysis.

According to assumption 1 and 2, the intermediary will finance the firm only when it receives two favorable signals “1”. The project’s expected net present value is $p \phi q(e^f)q(e^m) \times (R-1)$.

Next we specify the costs for intermediaries in acquiring information. The cost function for acquiring the firm’s information is assumed to be $C(e^f) = f^0 + f \times (e^f)^2$ and $C(e^m) = m^0 + m \times (e^m)^2$ for the industry’s information, where f^0 and m^0 represent the fixed costs and f and m represent the unit(effort) variable cost for the firm’s and industry’s information respectively. The advantage of commercial banks lies in the production of the firm’s information, while investment banks excel in the production of the industry’s information. This concept is widely assumed in literature. For example, Boot and Thakor(1997) points out that the advantage of bank lending roots in controlling the firm’s moral hazard problem, and capital market financing may provide more market information. Kanatas and Jianping(2003) assumes that investment banks(underwriters) differ from bank lenders in that while banks learn firms’ types without error, underwriters may be incorrect in their references.

In our model, we assume that these two financial intermediaries face the same information structure as described above. Their respective advantages lie in the cost functions, more specifically in the cost parameters. Let f_i^0 and f_i , $i= B$ and I , be commercial and investment banks’ fixed cost and unit variable cost for acquiring the firm’s information. Similarly, m_i^0 and m_i are the fixed cost and unit variable cost for acquiring the industry’s (market) information. For simplicity, it is assumed that both intermediaries have the same total fixed costs, i.e., $F_B \equiv f_B^0 + m_B^0 = F_I \equiv f_I^0 + m_I^0$. Most importantly, we assume that $f_B < f_I$ and $m_I < m_B$. Commercial banks are more efficient in generating marginal information about firms while investment banks are more skillful at producing marginal information about the market or industry.⁴

In addition to cost differences, another important element in this model is the sequence of information production. In the first part of the analysis, we assume that commercial banks and investment banks differ in their sequence of information production: commercial banks acquire the firm’s information in advance while investment banks acquire the industry’s information first. Only after receiving a favorable signal “1 ” in the first information-production stage will intermediaries proceed into the second stage.

This sequencing assumption necessitates some sort of coordination in procuring the firm’s and industry’s information. In our model, this coordination is beneficial in

⁴ This relative advantage may stem from the specific amount of fixed investment in different information. For example, commercial banks may incur higher fixed cost in acquiring the firm’s information as compared to investment banks. Therefore they would be more capable of generating marginal firm’s information.

nature because the intermediary can save its subsequent information procuring cost.⁵ As for which information should be procured first by any intermediary, we assume it depends much on what area of information this intermediary obtains its relative advantage. In other words, we hypothesize that there were two information sectors in any intermediary, the sector with relative cost advantage has higher control over the whole production process. This higher control leads to a leader-follower relationship between those two sectors. Thus, the optimal exertion of an intermediary's effort in procuring both areas of information can be solved as a subgame perfect equilibrium with the advantageous sector acting as the leader. In section 5, we will relax this sequencing assumption and endogenously determine the production sequence for both intermediaries.

3. The Information Accuracy of Financial Intermediaries

3.1 Information-Generating Strategies

In this section, we discuss how intermediaries determine their optimal effort level in generating information. We take commercial banks for example. The case of investment banks can be analogically derived. By way of backward induction, we first analyze a commercial bank's strategy in stage 2. Given any lending rate r_B , the commercial bank chooses e^m to maximize $\phi q(e^m)(r_B - 1) - m_B \times (e^m)^2$. Thus the optimal effort e^m must satisfy the following first order condition

$$\frac{2 m_B e^m}{q'(e^m)} = \phi (r_B - 1). \quad (1)$$

In the first stage, the commercial bank chooses e^f to maximize its expected profit $p q(e^f)[\phi q(e^m) \times (r_B - 1) - m_B \times (e^m)^2] - [F_B + f_B \times (e^f)^2]$ where e^m satisfies (1). So, the optimal effort level for acquiring the firm's information, denoted by e_B^f , is characterized by $p q'(e^f)[\phi q(e^m) \times (r_B - 1) - m_B \times (e^m)^2] - 2 f_B e^f = 0$, or

$$\frac{2 f_B e_B^f}{q'(e_B^f)} = p[\phi q(e^m)(r_B - 1) - m_B \times (e^m)^2]. \quad (2)$$

The lending rate r_B is determined by competition among commercial banks. In other words, r_B should satisfy the following zero profit condition: $p q(e^f)[\phi q(e^m) \times (r_B - 1) - m_B \times (e^m)^2] - [F_B + f_B \times (e^f)^2] = 0$. By substituting the zero profit condition into (2), the optimal effort level e_B^f can be ultimately solved by the following equation

$$\frac{2 f_B e_B^f}{q'(e_B^f)} = \frac{F_B + f_B \times (e_B^f)^2}{q(e_B^f)}. \quad (3)$$

⁵ It is noted from our assumption 1 and 2 that any project is profitable if and only if the firm is of a good type and the industry is in a high state. Therefore the intermediary would consider any further information exploration in the second stage only when the firm is of a good type or the industry is in a high state in the first stage.

With the resulting e_B^f above, the bank's lending rate r_B becomes $1 + \frac{F_B + f_B \times (e_B^f)^2 + p q(e_B^f) \times m_B \times (e^m)^2}{p \phi q(e_B^f) q(e^m)}$ as a result of the zero profit condition. Finally,

this r_B is substituted into (1) to derive the optimal effort level for acquiring the industry's information, denoted by e_B^m , from the following equation

$$\frac{2 m_B e_B^m}{q'(e_B^m)} = \frac{F_B + f_B \times (e_B^f)^2}{p q(e_B^f) q(e_B^m)} + \frac{m_B \times (e_B^m)^2}{q(e_B^m)}. \quad (4)$$

And, the equilibrium lending rate is equal to $1 + \frac{F_B + f_B \times (e_B^f)^2 + p q(e_B^f) \times m_B \times (e_B^m)^2}{p \phi q(e_B^f) q(e_B^m)}$.

In the analysis below, we assume that $q(e^f) = (1 + e^f)/2$ and $q(e^m) = (1 + e^m)/2$,⁶ $e^f, e^m \in [0, 1]$. From (3), e_B^f can be solved by $2 f_B e_B^f = \frac{F_B + f_B \times (e_B^f)^2}{1 + e_B^f}$. That is

$$e_B^f = \frac{\sqrt{f_B^2 + f_B F_B}}{f_B} - 1. \quad (5)$$

By substituting (5) into (4), e_B^m is derived as

$$e_B^m = \frac{\sqrt{m_B^2 + m_B S_B}}{m_B} - 1, \quad (6)$$

where $S_B = \frac{4}{p} [\sqrt{f_B^2 + f_B F_B} - f_B]$. Similarly, we can solve the investment bank's optimal effort level as⁷

$$e_I^m = \frac{\sqrt{m_I^2 + m_I F_I}}{m_I} - 1, \quad (7)$$

$$e_I^f = \frac{\sqrt{f_I^2 + f_I S_I}}{f_I} - 1, \quad (8)$$

where $S_I = \frac{4}{\phi} [\sqrt{m_I^2 + m_I F_I} - m_I]$.

Lemma 1: *The optimal effort level of any intermediaries in procuring both area of information is determined by the corresponding exogenous parameters as follows.*

- (1) *For the information produced in the first stage, the optimal effort decreases as the corresponding unit variable cost increases and increases as the original fixed cost F increases.*
- (2) *For the information produced in the second stage, the optimal effort decreases as the corresponding unit variable cost increases and increases as the composite term S increases. This composite term comes from the sequential effect and the*

⁶ Under this specification, $q(0) > 0$ which implies it is still informative even with zero effort. We can interpret the fixed cost F_B (F_I) as the cost required to be minimally informed at zero effort. Any positive effort will bring additional firm's and (or) industry's information to the intermediaries.

⁷ For details please refer to appendix 1.

zero profit condition. It is an increasing function of the first stage's cost and most important the decreasing function of the success probability of the first stage.

These results are quite intuitive. The determination of the optimal effort in acquiring information depends on its impact on the marginal revenue and marginal cost respectively. For stage 1, the marginal cost of effort is increasing in the effort owing to the convexity of the cost function, and the marginal revenue of effort is first decreasing then increasing in the effort mainly due to the zero profit condition.⁸ Furthermore, the marginal revenue curve will shift upward by an increase in the fixed cost or unit variable cost due to the zero profit condition, and the marginal cost curve will shift upward if unit variable cost increases. Therefore, higher fixed cost (F_B and F_I) will lead to a greater effort indirectly through the zero profit condition. As for the unit variable cost (f_B and m_I), we find that an increase in unit variable cost will discourage the intermediary's effort since its impact on the marginal cost (direct effect) is much stronger than that on the marginal benefit (indirect effect through zero profit condition).

For stage 2, the effect of unit variable cost (m_B and f_I) is analogous to stage 1. A new impact, manifested in S_B and S_I , will now be created as a result of sequencing and the zero profit condition. Before choosing stage 2's effort level, intermediaries have already incurred stage 1's information cost. This creates an effect akin to what the fixed cost F_B (F_I) has done on the first stage's effort level. Thereby we could call S_B and S_I as "pseudo fixed cost".⁹ It is shown that the information costs in stage 1, fixed as well as unit variable ones, have positive effect on these pseudo fixed costs and thus on stage 2's desired effort level. Moreover and most importantly, the prior success probability of stage 1's information has negative effect on these pseudo fixed costs. Therefore, as the probability of good type firms (high industry state) becomes lower, commercial banks (investment banks) will exert more

⁸ For commercial banks the marginal revenue of effort in stage 1 is $q'(e^f) \frac{F_B + f_B \times (e^f)^2}{q(e^f)}$ from (3), where

$q'(e^f)$ is the marginal improvement of information accuracy from additional effort and $\frac{F_B + f_B \times (e^f)^2}{q(e^f)}$

is the expected revenue as a result of the zero profit condition. The marginal revenue first decreases and then increases in the effort as a result of the interaction of two forces, one is the linearity of q function which induces a decreasing marginal revenue and the other is zero profit condition which induces an increasing marginal revenue. At the beginning the former force is stronger but the latter one will gradually predominate as e becomes larger due to the convexity of cost function. Besides the slope of the marginal revenue in the positive range is always smaller than that of the marginal cost.

⁹ In fact it can be proved that S_B equals $\frac{F_B + f_B \times (e_B^f)^2}{p q(e_B^f)}$ in (4), or (4) can be rewritten as $\frac{2 m_B e^m}{q'(e^m)} = \frac{S_B + m_B (e^m)^2}{q(e^m)}$. Therefore when deciding the optimal effort in the second stage, S_B plays a role similar to F_B in the first stage.

effort in producing additional industry's (firm's) information in the second stage. Later we will see that this sequential effect plays an essential role in our analysis.

One final remark. The optimal effort in (5)~(8) could possibly be greater than 1, in which case we will simply let the optimal effort be 1 as a corner solution.¹⁰

3.2 The Comparison of Information Accuracy Between Intermediaries

Next we examine the eventual information accuracy in this economy. To pinpoint the meaningful comparison of information accuracy between the two intermediaries, we assume that $f_B = m_I$ and $m_B = f_I$.¹¹ With this simplification, the primary source of advantage on either firm's or industry's information for each intermediary will stem from the intermediary's sequence of gathering the specific information (i.e. the comparison between S_I and F_B , or S_B and F_I) and the relative size of unit variable costs between the two information acquisition (i.e. f_B v.s. f_I or m_B v.s. m_I).

Let's define $f_B = m_I \equiv a$ to denote the unit variable cost for the advantageous information sector, $m_B = f_I \equiv d$ to denote the unit variable cost for the disadvantageous information sector, and $F_B = F_I \equiv F$ to denote the fixed cost. Then we can rewrite (5)~(8) as follows

$$\begin{aligned} e_B^f &= \frac{\sqrt{a^2 + aF}}{a} - 1 \quad \text{and} \quad e_B^m = \frac{\sqrt{d^2 + dS_B}}{d} - 1, \\ e_I^m &= \frac{\sqrt{a^2 + aF}}{a} - 1 \quad \text{and} \quad e_I^f = \frac{\sqrt{d^2 + dS_I}}{d} - 1, \end{aligned}$$

where $S_B = \frac{4}{p}[\sqrt{a^2 + aF} - a]$ and $S_I = \frac{4}{\phi}[\sqrt{a^2 + aF} - a]$.

From these equations, it is clear that stage 1's efforts (e_B^f for commercial banks and e_I^m for investment banks) are the same. Therefore the accuracy of the advantageous information for these two intermediaries is the same. The comparison of efforts in the sector with disadvantages (e_B^m for commercial banks and e_I^f for investment banks) hinges on the relative size of S_B and S_I . Since $S_I = (p/\phi) S_B$, commercial banks will provide more accurate information than investment banks in the second stage when $p < \phi$ and vice versa.

Proposition 1: *Assume that intermediaries first produce the advantageous information. In addition, the information production costs of intermediaries have the following relationship: $f_B = m_I \equiv a$, $m_B = f_I \equiv d$, $a < d$ and $F_B = F_I \equiv F$. The information accuracy in this economy can then be characterized as follows.*

¹⁰ This is due to our specification of q as a linear function of effort. Theoretically we can specify $q(e)$ satisfying $q'(0) = \infty$ and $q'(\infty) = 0$ to deter the corner solution. However, though this more general specification can prevent us from the discussion of corner solutions, the optimal effort solved will become more complicated causing the following analysis difficult. Therefore we choose the simple linear form and believe that the basic quality won't be affected.

¹¹ Under this assumption, the inherent difficulty in generating different information is the same. Besides we can simplify the four unit variable costs to two.

1. For specific information, the relative accuracy hinges on the relative strength of cost advantages and sequential effect.

(1) If $d > \max \left(\frac{4a(\sqrt{a^2 + aF} - a)}{pF}, \frac{4a(\sqrt{a^2 + aF} - a)}{\phi F} \right)$, then commercial banks provide more accurate firm's information and investment banks provide more accurate industry's information.

(2) If $d < \min \left(\frac{4a(\sqrt{a^2 + aF} - a)}{pF}, \frac{4a(\sqrt{a^2 + aF} - a)}{\phi F} \right)$, then commercial banks provide more accurate industry's information and investment banks provide more accurate firm's information.

(3) If $p < \phi$ and $\frac{4a(\sqrt{a^2 + aF} - a)}{pF} > d > \frac{4a(\sqrt{a^2 + aF} - a)}{\phi F}$ then commercial banks provide more accurate firm's as well as industry's information. If $p > \phi$ and $\frac{4a(\sqrt{a^2 + aF} - a)}{\phi F} > d > \frac{4a(\sqrt{a^2 + aF} - a)}{pF}$ then investment banks provide more accurate industry's as well as firm's information.

2. As far as the total information accuracy is concerned, commercial banks dominate if and only if $p < \phi$ and investment banks dominate if and only if $p > \phi$.

This proposition states that an intermediary does not necessarily create more accurate information in its advantageous information sector. Despite its inherent cost disadvantage, in the disadvantageous sector the pseudo fixed cost derived from information sequencing may be so large that it induces such a high effort exceeding the one in the advantageous sector. The pseudo fixed cost is determined by the parameters in stage 1, including the fixed cost F , unit variable cost a and the prior probability p (or ϕ) as mentioned before. When a is small relative to d , there are two effects favoring the information's superiority in the advantageous sector: one is directly from the cost advantage and the other results from the decreasing pseudo fixed cost. Thus we conclude that the larger the cost difference between d and a , other things being equal, the less likely the information accuracy in the disadvantageous sector would exceed the one in the advantageous sector. Accordingly, proposition 1 illustrates three possible scenarios: (1) no reverse information accuracy, (2) reverse information accuracy in both areas of information, and (3) reverse information accuracy in one area of information.

Although the relative accuracy for specific information seems intricate with the consideration of exogenous sequential impact, the comparison of total accuracy is quite clear-cut. We define total accuracy as $q(e^f)q(e^m)$. Since the information accuracy is the same in the first stage, the comparison of overall information accuracy hinges on the relative size of S_B and S_I in the second stage (or equivalently on the

relative size of p and ϕ).

4. The Firm's Financing Choices

We now turn to the problem of the firm's financing choice between different financing sources. Let π^B and π^I denote the firm's expected profits if it seeks bank lending and bank underwriting respectively. Since intermediaries earn zero profit under the perfect competition assumption, the firm's expected profit is the expected net present value of the project subtracted by the expected information costs, or

$$\begin{aligned}\pi^B &= p\phi q(e_B^f)q(e_B^m)(R-1) - [F + a \times (e_B^f)^2 + p q(e_B^f) \times d \times (e_B^m)^2] \\ &= \frac{p\phi}{4} \times \frac{\sqrt{a^2 + aF}}{a} \times \frac{\sqrt{d^2 + dS_B}}{d} \times (R-1) \\ &\quad - [(2a+2F - 2\sqrt{a^2 + aF}) + \frac{p}{2} \times \frac{\sqrt{a^2 + aF}}{a} \times (2d+S_B - 2\sqrt{d^2 + dS_B})]. \quad (9)\end{aligned}$$

$$\begin{aligned}\pi^I &= p\phi q(e_I^f)q(e_I^m)(R-1) - [F + a \times (e_I^m)^2 + \phi q(e_I^m) \times d \times (e_I^f)^2] \\ &= \frac{p\phi}{4} \times \frac{\sqrt{a^2 + aF}}{a} \times \frac{\sqrt{d^2 + dS_I}}{d} \times (R-1) \\ &\quad - [(2a+2F - 2\sqrt{a^2 + aF}) + \frac{\phi}{2} \times \frac{\sqrt{a^2 + aF}}{a} \times (2d+S_I - 2\sqrt{d^2 + dS_I})]. \quad (10)\end{aligned}$$

The first term in (9) and (10), $p\phi q(e^f)q(e^m) \times (R-1)$, is the expected net present value of the project where $q(e^f)q(e^m)$ denotes total information accuracy. According to proposition 1, commercial banks generate superior total information accuracy as well as larger expected net present value if $p < \phi$ and vice versa. The terms in the bracket [.] stand for expected information cost. $2a+2F - 2(a^2 + aF)^{0.5}$ is the fixed cost plus stage 1's variable information cost which is the same for both intermediaries. The information cost differs only in the second stage. By comparing stage 2's variable information cost $\frac{p\sqrt{a^2 + aF}}{2a} (2d+S_B - 2\sqrt{d^2 + dS_B})$ with $\frac{\phi\sqrt{a^2 + aF}}{2a} (2d+S_I - 2\sqrt{d^2 + dS_I})$, it is found that commercial (investment) banks' expected information cost in stage 2 (as well as total information cost) is higher when $p < (>) \phi$.¹² Since higher expected net present value is accompanied by higher total information cost, the relative size of π^B and π^I needs further investigation.

Let's define V as the difference between π^B and π^I divided by ϕ . After substituting S_I as $(p/\phi)S_B$, we get

¹² Specifically when $p < \phi$ commercial banks will incur stage 2's cost less likely than investment banks. Meanwhile their cost in stage 2 is higher since they exert more effort (for $S_B > S_I$). Overall the latter effect dominates due to the convexity of cost function.

$$V \equiv \frac{\pi^B - \pi^I}{\phi} = \frac{\sqrt{a^2 + aF}}{a} \times \left\{ \frac{p(R-1)}{4d} \times [\sqrt{d^2 + dS_B} - \sqrt{d^2 + dS_B\theta}] - [\theta(d - \sqrt{d^2 + dS_B}) - (d - \sqrt{d^2 + dS_B\theta})] \right\}, \quad (11)$$

where $\theta = p/\phi$. Consider a firm with quality p , we can solve the critical θ such that $V=0$. There exists two such θ satisfying $V=0$, one equals 1 trivially and the other is $\hat{\theta}$,

$$\hat{\theta} = \frac{W^2 S_B + 2W(\sqrt{d^2 + dS_B} - d)}{S_B - 2(\sqrt{d^2 + dS_B} - d)},$$

where $W = p(R-1)/4d$. Therefore, for firms with quality p , $\pi^B = \pi^I$ when $\theta=1$ or $\theta = \hat{\theta}$ (equivalently when $\phi = p$ or $\phi = p/\hat{\theta} \equiv \hat{\phi}$).¹³ Because V first decreases then increases with θ and $\partial^2 V / \partial \theta^2 > 0$,¹⁴ π^B will be smaller than π^I when θ is between 1 and $\hat{\theta}$ (or equivalently when ϕ is between p and $\hat{\phi}$). Furthermore, the critical point $\hat{\theta}$ would be larger (smaller) than 1 (i.e. $\hat{\phi}$ less (greater) than p) if $2[(d^2 + dS_B)^{0.5} - d] + (W-1)S_B > (<) 0$ holds.

This result is derived directly from the features of π^B and π^I . From (9) and (10) we see that π^B is a positive and linear function of ϕ , and π^I is a positive and concave function of ϕ .¹⁵ Starting from $\phi = p$, where $\pi^B = \pi^I$, the comparison of π^B and π^I in fact centers on how much they would change with respect to ϕ . When p is high enough such that $2[(d^2 + dS_B)^{0.5} - d] + (W-1)S_B > 0$ holds,¹⁶ ϕ will also be high around p with its impact on π^I less than on π^B , i.e., $\partial \pi^B / \partial \phi > \partial \pi^I / \partial \phi$ around $\phi = p$. For $\phi > p$, the above effect (i.e. $\partial \pi^B / \partial \phi > \partial \pi^I / \partial \phi$) persists since π^I is concave in ϕ . For $\phi < p$, investment banks take the helm of the market until ϕ falls below the critical $\hat{\phi}$. Then the net profit loss from the decrease in ϕ becomes

¹³ Here we take the firm's quality p as fixed, and then make the comparison by changing the industry's prospect parameter ϕ . We can also fix the industry's prospect ϕ and compare π^B and π^I by looking into the changes of the firm's quality p .

¹⁴ $\frac{\partial^2 V}{\partial \theta^2} = \frac{\sqrt{a^2 + aF}}{a} \times \frac{(W+1)(dS_B)^2}{4} \times (d^2 + dS_B\theta)^{-3/2} > 0$.

¹⁵ From (9) by fixing the firm's quality p , the expected information cost in π^B is independent of ϕ and the expected net present value is a positive linear function of ϕ . This is due to the fact that the two optimal efforts of commercial banks are independent of ϕ . From (10) the expected net present value is a positive and concave function of ϕ while the expected information cost is a negative and convex function of ϕ . The concavity of π^I in ϕ is primarily attributed to the convexity of cost function and the declining of investment banks' optimal effort in stage 2 as ϕ increases. So π^I increases at a decreasing rate as ϕ increase.

¹⁶ Given parameters a, d, F and R , $2[(d^2 + dS_B)^{0.5} - d] + (W-1)S_B$ is increasing in p . Therefore it's possible to find the threshold \hat{p} satisfying $2[(d^2 + dS_B)^{0.5} - d] + (W-1)S_B > 0$ for $p > \hat{p}$.

so large that investment banks lose their financing market when $\phi < \hat{\phi}$. As a result, commercial bank financing dominates capital market financing when $\phi > p$ or $\phi < \hat{\phi}$ if $2[(d^2 + dS_B)^{0.5} - d] + (W - 1)S_B > 0$. The case where the firm's quality p is so low that $2[(d^2 + dS_B)^{0.5} - d] + (W - 1)S_B < 0$ can be deduced analogically.

Therefore, we classify the firm's quality p into two categories. If p is rather large such that $2[(d^2 + dS_B)^{0.5} - d] + (W - 1)S_B > 0$ holds, commercial bank lending turns up the better choice for the firm when $\phi > p$ or $\phi < \hat{\phi}$ and capital market financing is the better choice when $\hat{\phi} < \phi < p$. On the other side, if p is rather small such that $2[(d^2 + dS_B)^{0.5} - d] + (W - 1)S_B < 0$ holds, firms choose commercial bank lending when $\phi > \hat{\phi}$ or $\phi < p$. Whether p is large or small, commercial bank lending dominates capital market financing when the probability of good states in the industry is rather high or low. We exhibit these results in figure 2.

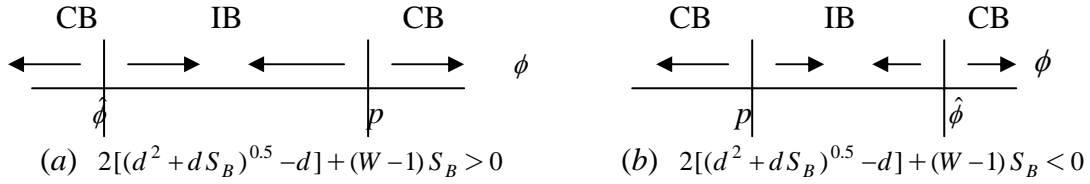


Figure 2. The firm's optimal financing choices

The analysis so far implicitly assumes that the optimal effort in both stages has interior solution. For stage 1, this treatment is harmless since we can easily assume that $F < 3a$ to deter the corner solution. However, the optimal effort in stage 2 depends on p (or ϕ). If p (ϕ) is too small, then stage 2's optimal effort of commercial banks (investment banks) will encounter a corner solution, in which case equation (9) and (10) become inappropriate. We analyze these situations in appendix 3. Proposition 2 below is focused on the scenario of having interior solutions.

Proposition 2: *Given a firm's quality p , the firm's financing choice hinges on how good the industry's prospect ϕ becomes as compared to its quality p . Commercial banks will be the better choice for the firm's financing when the industry's prospect ϕ is rather high or low, and investment banks will be the better choice when ϕ is in the middle level. Specifically,*

1. For those firms whose quality p satisfies

$$2[(d^2 + \frac{4d}{p}(\sqrt{a^2 + aF} - a))^{0.5} - d] + (\frac{p(R-1)}{4d} - 1)(\frac{4}{p}(\sqrt{a^2 + aF} - a)) > 0, \text{ they will choose}$$

commercial bank lending when $\phi > p$ or $\phi < \hat{\phi}$, and choose capital market financing otherwise.

2. For those firms whose quality p satisfies

$2[(d^2 + \frac{4d}{p}(\sqrt{a^2 + aF} - a))^{0.5} - d] + (\frac{p(R-1)}{4d} - 1)(\frac{4}{p}(\sqrt{a^2 + aF} - a)) < 0$, they will choose commercial bank lending when $\phi < p$ or $\phi > \hat{\phi}$ and choose capital market financing otherwise.

$$\text{where } \hat{\phi} = p \times \left(\frac{(p(R-1)/4d)^2 S_B + (p(R-1)/2d)(\sqrt{d^2 + dS_B} - d)}{S_B - 2(\sqrt{d^2 + dS_B} - d)} \right)^{-1}$$

Proof: See appendix 2.

In contrast to existing literature, proposition 2 establishes a non-monotonic relationship about the firm's financing choice. In general, the need for the firm's information is more eager (than the industry's information) when the industry's prospect is more optimistic (than the firm's quality) and vice versa. When $\phi > p$, an increase in ϕ will benefit commercial banks from an enlarged demand for their privileged information but worsen their cost disadvantage because it now reduces investment banks' information cost at a decreasing rate (owing to the convexity of cost function). If p exceeds some threshold such that $2[(d^2 + dS_B)^{0.5} - d] + (W-1)S_B > 0$ holds, then for those ϕ greater than p the benefit from increased demand for commercial banks' privileged information overwhelms their cost disadvantage since ϕ is so high that the decrease in investment banks' information cost becomes nominal. On the contrary, if p is so small that $2[(d^2 + dS_B)^{0.5} - d] + (W-1)S_B < 0$ holds, then for those ϕ greater than p the benefit from the privileged market demand will overwhelm the deterioration of their relatively high information cost only when ϕ is significantly larger than p (i.e. when $\phi > \hat{\phi}$). In the range of $[p, \hat{\phi}]$, ϕ is not high enough to diminish investment banks' marginal cost improvement and therefore worsens commercial banks' cost disadvantage to an extent to transcend the benefit accrued to commercial banks. As a result, when $\phi > p$ a commercial bank which excels in the firm's information gathering is deemed a better financing source than investment banks under the scenario of $2[(d^2 + dS_B)^{0.5} - d] + (W-1)S_B > 0$, and loses the market share to investment banks when ϕ is located in the range of $[p, \hat{\phi}]$ under the other scenario.

Similarly, when $\phi < p$ a decrease in ϕ will benefit investment banks from an enlarged demand for their privileged information but worsen their cost disadvantage because it now enhances investment banks' information cost at an increasing rate (owing to the convexity of cost function). If p is so small that $2[(d^2 + dS_B)^{0.5} - d] + (W-1)S_B < 0$ holds, then for those ϕ less than p the increased demand for investment banks' privileged information is definitely overwhelmed by their cost disadvantages since ϕ is too low that the increase in investment banks' information cost becomes substantial. On the contrary, if p is rather large that

$2[(d^2 + dS_B)^{0.5} - d] + (W - 1)S_B > 0$ holds, then for those ϕ less than p the benefit from the privileged information accuracy will overwhelm the deterioration of their relatively high information cost when ϕ is above some threshold (i.e. when $\phi > \hat{\phi}$). The cost disadvantage dominates only when ϕ is significantly less than p (i.e. when $\phi < \hat{\phi}$). As a result, when $\phi < p$ an investment bank which excels in the industry's information gathering is deemed as a better financing source than commercial banks in the range of $[\hat{\phi}, p]$ under the scenario of $2[(d^2 + dS_B)^{0.5} - d] + (W - 1)S_B > 0$, and lose the whole market share to commercial banks under the other scenario.

Corollary 1: *For those firms whose quality p satisfies $2[(d^2 + \frac{4d}{p}(\sqrt{a^2 + aF} - a))^{0.5} - d] + (\frac{p(R-1)}{4d} - 1)(\frac{4}{p}(\sqrt{a^2 + aF} - a)) > 0$, the range of ϕ in which they choose investment bank financing, i.e. the interval $(\hat{\phi}, p)$, expands as p becomes larger. The improvement of firms' quality will extend the market share of investment banks if firms' quality has initially reached a high level. On the contrary, if firms' quality is initially at a low level such that $2[(d^2 + \frac{4d}{p}(\sqrt{a^2 + aF} - a))^{0.5} - d] + (\frac{p(R-1)}{4d} - 1)(\frac{4}{p}(\sqrt{a^2 + aF} - a)) < 0$, the improvement of firms' quality will cause the investment banks' market share to shrink.*

Proof: See appendix 2.

The impact of the firm's quality p on investment banks' dominance range is two-fold: when p is rather large, by lowering ϕ the net benefit of investment banks from its superior information accuracy is very conspicuous. An increase in p at this moment will substantially enhance the information advantage for investment banks despite some minor erosion of their competitiveness from the reduction of information cost for commercial banks¹⁷, resulting in an expansion of investment banks' dominance range. On the other hand, when p is small, the net benefit of investment banks from its superior information accuracy becomes less prominent from the further decrease in ϕ . At this moment an increase in p , though it continues improving investment banks' information advantage, will now substantially reduce commercial banks' information cost (according the increasing marginal cost) and greatly erode investment banks' competitiveness. Therefore the dominance range for investment banks is contracted.

Before the end of this section, we construct a numerical example to demonstrate our theoretical result. We choose parameters $a=0.03$, $d=0.08$, $F=0.02$ and $R=1.2$. Given these parameters, the cutoff point of p (or) ϕ below which the corner solution

¹⁷ It is noted that investment banks' information cost is decreasing in ϕ but independent of p , while commercial banks' information cost is decreasing in p at a decreasing rate but independent of ϕ .

is encountered is around 0.145.¹⁸ We show the outcome in table 1.

Table 1 The Firm's Financing Choices

p	$\hat{\phi}$	Interior solution (for $\phi > 0.145$)		Corner solution (for $\phi < 0.145$)
		CB	IB	
0.1	×	$\phi > 0.145$	×	$\phi < 0.1$ IB $0.1 < \phi < 0.145$ CB
0.2	0.534	$0.145 < \phi < 0.2, \phi > 0.534$	(0.2, 0.534)	$\phi < 0.13$ IB $0.13 < \phi < 0.145$ CB
0.3	0.365	$0.145 < \phi < 0.3, \phi > 0.365$	(0.3, 0.365)	$\phi < 0.115$ IB $0.115 < \phi < 0.145$ CB
0.4	0.273	$0.145 < \phi < 0.273, \phi > 0.4$	(0.273, 0.4)	$\phi < 0.110$ IB $0.110 < \phi < 0.145$ CB
0.5	0.215	$0.145 < \phi < 0.215, \phi > 0.5$	(0.215, 0.5)	$\phi < 0.112$ IB $0.112 < \phi < 0.145$ CB
0.6	0.175	$0.145 < \phi < 0.175, \phi > 0.6$	(0.175, 0.6)	$\phi < 0.122$ IB $0.122 < \phi < 0.145$ CB
0.7	0.146	$0.145 < \phi < 0.146, \phi > 0.7$	(0.146, 0.7)	$\phi < 0.144$ IB $0.144 < \phi < 0.145$ CB
0.8	0.125	$\phi > 0.8$	(0.145, 0.8)	$\phi < 0.145$ IB

In this table, when p is not less than 0.4 the parameters satisfy $2[(d^2 + dS_B)^{0.5} - d] + (W-1)S_B > 0$, so π^B is greater than π^I when $\phi > p$ or $\phi < \hat{\phi}$.¹⁹ For those p less than 0.4 the parameters satisfy $2[(d^2 + dS_B)^{0.5} - d] + (W-1)S_B < 0$, so π^B is greater than π^I when $\phi < p$ or $\phi > \hat{\phi}$. When p is so small (such as 0.1 in this case) as to encounter the corner solution, we find that commercial banks dominate for all $\phi > 0.145$. When p and ϕ are both less than 0.145, commercial banks dominate when $\phi > p$, otherwise investment banks dominates. To sum, under the assumption that intermediaries produce the advantageous information in the first stage, commercial banks outweigh investment banks when the industry's prospect is rather high or low relative to the firm's quality. Investment banks outperform when the industry's prospect is in the middle level relative to the firm's quality or when the prospect ϕ is sufficiently low.

5. The endogenous determination of information sequencing

The main result in section 3 and 4 (proposition 1, 2 and corollary 1) builds on our earlier assumption that intermediaries produce their advantageous information in

¹⁸ Please refer to appendix 3.

¹⁹ If the critical point $\hat{\phi}$ is less than the corner point 0.145, investment banks dominate for all $\phi < p$.

advance. If the intermediary has an additional option of endogenously determining its information sequencing by looking at the relative size of p and ϕ , our previous result would be significantly affected.

The determination of information sequencing is complicated with the interaction of the cost difference (a and d) and the difference of the prior probability p and ϕ . Thus, we conjecture a hypothetical situation in which the unit variable cost is the same for both kinds of information and then discuss the impact of the difference of the prior probability p and ϕ on the choice of sequencing. Let m be the unit variable cost for producing both kinds of information, and $\pi(f)$ ($\pi(m)$) be the firm's expected profit if the intermediary produces the firm's (market's) information first (called "firm-market order" ("market-firm order") thereafter). It is explained in appendix 4 that given a firm's quality $\pi(f)$ equals $\pi(m)$ when $\phi = p$ or $\phi = \tilde{\phi}$. The derivation of $\tilde{\phi}$ is very similar to $\hat{\phi}$,

$$\tilde{\phi} = p \times \left(\frac{(p(R-1)/4m)^2 S_p + (p(R-1)/2m) (\sqrt{m^2 + mS_p} - m)}{S_p - 2(\sqrt{m^2 + mS_p} - m)} \right)^{-1},$$

where $S_p = \frac{4}{p} [\sqrt{m^2 + mF} - m]$.

Lemma2: Let m be the unit variable cost for producing both kinds of information. Given a firm's quality p , the intermediary's sequencing choice hinges on how good the industry's prospect ϕ becomes as compared to its quality p . It will generate the firm's information in advance when the industry's prospect ϕ is rather high or low, and the industry's information at first when ϕ is in the middle level. Specifically,

1. For those firms whose quality p satisfies

$$2[(m^2 + \frac{4m}{p}(\sqrt{m^2 + mF} - m))^{0.5} - m] + (\frac{p(R-1)}{4m} - 1)(\frac{4}{p}(\sqrt{m^2 + mF} - m)) > 0,$$

the intermediary will generate the firm's information in advance when $\phi > p$ or $\phi < \tilde{\phi}$, and generate the industry's information in advance otherwise.

2. For those firms whose quality p satisfies

$$2[(m^2 + \frac{4m}{p}(\sqrt{m^2 + mF} - m))^{0.5} - m] + (\frac{p(R-1)}{4m} - 1)(\frac{4}{p}(\sqrt{m^2 + mF} - m)) < 0,$$

the intermediary will generate the firm's information in advance when $\phi < p$ or $\phi > \tilde{\phi}$ and generate the industry's information in advance otherwise.

Proof: See appendix 4.

Since the unit variable cost is the same for both kinds of information, "firm-market order" will create more accurate information as well as higher expected information cost than "market-firm order" when $\phi > p$, owing to the sequential effect. Although the convexity of the cost function obscures the overall comparison, the

fundamental feature is that the intermediary tends to choose “firm-market order” when the industry’s prospect is rather high or low. This basic attribute is still sustained even after consideration of cost differences. Therefore, both intermediaries tend to choose “firm-market order” when the industry’s prospect is rather high or low. In other words, they tend to compete under the same order of information sequencing.

This insight from the comparison of p and ϕ indicates that we need to find out the competitive advantages of both intermediaries when they face the same order of information sequencing. Interestingly, we discover that commercial banks (investment banks) excel investment banks (commercial banks) under the “market-firm order”(“firm-market” order). This means that when facing the same ordering, intermediaries have competitive advantages in the kind of order when their disadvantageous information is produced in advance. Intuitively, producing disadvantageous information in advance will downgrade the first stage’s information accuracy but largely upgrade the second stage’s information accuracy since the latter increase not only comes from the advantageous unit variable cost, but also from the preferable sequential effect S .²⁰ This double effect confirms that one intermediary producing disadvantageous information in advance will create more accurate information than another intermediary under the same ordering. On the cost side, producing disadvantageous information in advance will reduce the first stage’s information cost, but largely enhance the second stage’s information cost due to the above double effect. However, the second stage’s information cost is incurred only with a probability, so the positive total cost difference is small relative to the positive information accuracy difference. Thus, we conclude that under the “firm-market order” investment banks surpass commercial banks and vice versa.

Taking the possibility of endogenously determining the information sequencing into account, the appropriate comparison is between commercial banks under the “market-firm order” and investment banks under the “firm-market order”. This ordering is just the opposite of our earlier assumption. Therefore, we recognize that whether intermediaries can endogenously determine their information sequencing or not has great influence on their competitive advantages. For comparison, we represent a similar numerical example to the one in section 4. We still choose parameters $a=0.03$, $d=0.08$, $F=0.02$ and $R=1.2$. Given these parameters, the cutoff point of p (or) ϕ below which the corner solution is encountered now becomes around 0.42.²¹ We show the outcome in table 2.

²⁰ According to lemma 1, sequential term S is an increasing function of the first stage’s unit variable cost.

²¹ This cutoff point is now calculated as $4(\sqrt{d^2 + dF} - d)/(3a)$.

Table 2. The Firm's Financing Choices

p	$\bar{\phi}^*$	Interior solution (for $\phi > 0.42$)		Corner solution (for $\phi < 0.42$)
		CB	IB	
0.1	×	×	$\phi > 0.42$	$\phi < 0.1$ CB $0.1 < \phi < 0.42$ IB
0.2	×	×	$\phi > 0.42$	$\phi < 0.2$ CB $0.2 < \phi < 0.42$ IB
0.3	×	×	$\phi > 0.42$	$\phi < 0.3$ CB $0.3 < \phi < 0.42$ IB
0.4	×	×	$\phi > 0.42$	$\phi < 0.4$ CB $0.4 < \phi < 0.42$ IB
0.5	0.119	$0.42 < \phi < 0.5$	$\phi > 0.5$	CB
0.6	0.096	$0.42 < \phi < 0.6$	$\phi > 0.6$	CB
0.7	0.079	$0.42 < \phi < 0.7$	$\phi > 0.7$	CB
0.8	0.066	$0.42 < \phi < 0.8$	$\phi > 0.8$	CB

* $\bar{\phi}$ is the critical point (similar to $\hat{\phi}$) when interior solutions happen.²²

From table 2, we see that with the same parameters as those used in table 1 the outcome now is totally different and becomes quite clear-cut: given a firm's quality p commercial banks dominate when $\phi < p$.

6. Conclusion

This paper examines the merits of different financial intermediaries from the viewpoint of relative information precision in their processing a business financing. By explicitly modeling the information content about the industry's prospect and the firm's genuine quality, and endogenously determining the desirable level of information accuracy, we derive a non-monotonic result of financing choices with respect to the level of the firm's quality and the industry's condition, which is in sharp contrast to previous simple separating outcomes. Each firm must thus make its financing choice based on the comparison of its quality level with the industry's prospect rather than solely on the quality. Under the assumption that intermediaries generate their advantageous information first, we find out that commercial banks will be the better choice than investment banks especially when the prospect for the specific industry is either very optimistic or pessimistic.

We derive that as the firm's quality improves, the relative importance of

²² $\bar{\phi} = p \times \left(\frac{W^2 S_I + 2W(\sqrt{a^2 + a S_I - a})}{S_I - 2(\sqrt{a^2 + a S_I - a})} \right)^{-1}$, where $S_I = 4(\sqrt{d^2 + dF} - d) / p$ and $W = p(R-1)/(4a)$. If $\bar{\phi}$ is less than the corner point level commercial banks dominate for all $\phi < p$ (here p is above the corner point level).

commercial banks and capital market financing also changes. If firms are initially at a rather high quality level, the improvement of quality will contract banks' lending markets, yet capital market financing shrink if they are initially at a rather low quality level. This finding may explain how a financing market evolves from venture capitalists to commercial banks and then to capital market underwriting. When firms are at a low quality level, financing markets are dominated by commercial banks and venture capitalists. Here, venture capitalists that are supposedly knowledgeable in the capital market are considered as another channel of capital market financing. Commercial banks gradually expand their market shares while venture capitalists taper off as the firm's quality improves. When the quality upgrades to a certain threshold level, underwriting financing provided by investment banks will set foot in the market. Moreover, the underwriting business will be getting more prosperous with the decaying market shares of commercial banks as firms advance to a higher quality grid.

What is shocking is that the above conclusion would be reversed if intermediaries had the option of choosing information sequencing endogenously. We find that intermediaries tend to choose the same ordering by looking into the relative degree of the firm's quality and the industry's prospect. Furthermore, we discover that when facing the same ordering, intermediaries have competitive advantages in the kind of order that their disadvantageous information is produced in advance. Therefore, it is crucial how intermediaries determine their information sequencing. Our analysis offers this interesting phenomenon, which merits further research.

Appendix 1

In this appendix we analyze an investment bank's optimal effort level in generating information. By way of backward induction, given any underwriting fee u , the investment bank chooses e^f to maximize $p q(e^f) \times u - f_I \times (e^f)^2$ in the second stage. Thus the optimal e^f must satisfy the following first order condition

$$\frac{2 f_I e^f}{q'(e^f)} = p u . \quad (\text{A1})$$

In the first stage the investment bank chooses e^m to maximize its expected profit $\phi q(e^m) [p q(e^f) \times u - f_I \times (e^f)^2] - [F_I + m_I \times (e^m)^2]$ where e^f satisfies (A1). So the optimal effort level for acquiring the industry's information, denoted by e_I^m , is characterized by $\phi q'(e^m) [p q(e^f) \times u - f_I \times (e^f)^2] - 2 m_I e^m = 0$, or

$$\frac{2 m_I e^m}{q'(e^m)} = \phi [p q(e^f) \times u - f_I \times (e^f)^2] . \quad (\text{A2})$$

The underwriting fee u is determined by competition among investment banks. Then by zero profit condition $\phi q(e^m) [p q(e^f) \times u - f_I \times (e^f)^2] - [F_I + m_I \times (e^m)^2] = 0$ and (A2),

e_I^m is determined by the following equation

$$\frac{2 m_I e^m}{q'(e^m)} = \frac{F_I + m_I \times (e^m)^2}{q(e^m)}. \quad (A3)$$

We replace this e_I^m into the zero profit condition to find the underwriting fee u as $\frac{F_I + m_I \times (e_I^m)^2 + \phi q(e_I^m) \times f_I \times (e^f)^2}{p \phi q(e^f) q(e_I^m)}$. Finally this u is substituted into (A1) to

determine the optimal effort level for acquiring the firm's information, denoted by e_I^f , as follows

$$\frac{2 f_I e^f}{q'(e^f)} = \frac{F_I + m_I \times (e^m)^2}{\phi q(e^f) q(e_I^m)} + \frac{f_I \times (e^f)^2}{q(e^f)}. \quad (A4)$$

The firm's total cost of capital is then $1 + \frac{F_I + m_I \times (e_I^m)^2 + \phi q(e_I^m) \times f_I \times (e_I^f)^2}{p \phi q(e_I^f) q(e_I^m)}$. Capital

market investors require \$1 rates of return since they know the repayment is riskless.

Appendix 2

Proof of proposition 2: We derive the critical θ satisfying $V=0$. From (11), the term in $\{.\}$ is zero if and only if

$$[(\sqrt{d^2 + d S_B} - d)\theta] + W\sqrt{d^2 + d S_B} + d = (W+1)\sqrt{d^2 + d S_B} \theta,$$

where $W = p(R-1)/4d$. By squaring the terms on each side of the above equation, we get a quadratic equation

$$(2d + S_B - 2\sqrt{d^2 + d S_B})\theta^2 + 2[(1-W)(\sqrt{d^2 + d S_B} - d) - \frac{W^2 + 1}{2} S_B]\theta + W(W S_B + 2\sqrt{d^2 + d S_B} - 2d) = 0.$$

So the critical θ can be solved as

$$\hat{\theta} = \frac{[(W-1)(\sqrt{d^2 + d S_B} - d) + \frac{W^2 + 1}{2} S_B] \pm \sqrt{[(W+1)(\sqrt{d^2 + d S_B} - d) + \frac{(W+1)(W-1)}{2} S_B]^2}}{2d + S_B - 2\sqrt{d^2 + d S_B}}.$$

If $2[(d^2 + d S_B)^{0.5} - d] + (W-1)S_B > 0$,

$$\hat{\theta} = \frac{[(W-1)(\sqrt{d^2 + d S_B} - d) + \frac{W^2 + 1}{2} S_B] \pm [(W+1)(\sqrt{d^2 + d S_B} - d) + \frac{W^2 - 1}{2} S_B]}{2d + S_B - 2\sqrt{d^2 + d S_B}}.$$

The critical θ is thus equal to 1 and $\frac{2W(\sqrt{d^2 + d S_B} - d) + W^2 S_B}{2d + S_B - 2\sqrt{d^2 + d S_B}}$ which is greater

than 1. Therefore $V > 0$ if $\theta < 1$ or $\theta > \hat{\theta}$. In other words $\pi_B > \pi_I$ if $\phi > p$ or $\phi < \hat{\phi} (\equiv p/\hat{\theta})$. On the other hand, if $2[(d^2 + d S_B)^{0.5} - d] + (W-1)S_B < 0$ the critical $\hat{\theta}$

becomes smaller than 1. Therefore $V > 0$ if $\theta > 1$ or $\theta < \hat{\theta}$. In other words $\pi_B > \pi_I$ if $\phi < p$ or $\phi > \hat{\phi}$.

Proof of corollary 1: To find how changes of p affect the measures of $(\hat{\phi}, p)$, we first differentiate $\hat{\phi}$ with respect to p

$$\frac{\partial(\frac{p}{\hat{\phi}})}{\partial p} = \frac{4d}{R-1} \times \frac{-S_B}{p} \left[\frac{p(R-1)(\sqrt{d^2 + dS_B} - d)S_B + 4d^2(S_B + 2d - 2\sqrt{d^2 + dS_B})}{4d\sqrt{d^2 + dS_B}} \right] < 0.$$

It is clear measures of $(\hat{\phi}, p)$ increase as p becomes larger. Correspondingly, measures of $(p, \hat{\phi})$ decrease as p becomes larger.

Appendix 3 The cases of corner solutions

Corner solution happens when p and (or) ϕ are so small leading the sequential effect S so big that the optimal effort in the second stage $\frac{\sqrt{d^2 + dS}}{d} - 1$ exceeds 1. Thus we can calculate the corner solution point as $\frac{4(\sqrt{a^2 + aF} - a)}{3d}$. There are three possibilities

for corner solutions which we describe in this appendix.

Case 1: p is higher than the corner point but ϕ is less than the corner point.

In this situation investment banks encounter corner solution in the second stage. The firm's expected profit from investment banks financing (10) must be adapted to as

$$\pi^I = \frac{1}{2} p \phi (R-1) \frac{\sqrt{a^2 + aF}}{a} - \frac{1}{2} \frac{\sqrt{a^2 + aF}}{a} \phi d \quad (10')$$

Comparing it with π^B in (9), it is found that $\pi^B > \pi^I$ if $\phi > \frac{0.5 p \times (\sqrt{a^2 + aF} / a) [2d + S_B - 2\sqrt{d^2 + dS_B}]}{d(\sqrt{a^2 + aF} / 2a) + p(R-1)(\sqrt{a^2 + aF} / 2a)(\sqrt{d^2 + dS_B} / 2d - 1)} \equiv \phi'$. However if this ϕ' is greater than the corner point or is negative then π^B is always less than π^I in this case.

Case 2: p is less than the corner point but ϕ is higher than the corner point

In this situation commercial banks encounter corner solution in the second stage. The firm's expected profit from commercial banks financing (9) must be adapted to as

$$\pi^B = \frac{1}{2} p \phi (R-1) \frac{\sqrt{a^2 + aF}}{a} - \frac{1}{2} \frac{\sqrt{a^2 + aF}}{a} p d \quad (9')$$

Comparing it with π^I in (10), it is possible to find two critical ϕ such that π^I exceeds π^B when ϕ is between the two critical ϕ (for now again π^I is a concave function of ϕ). The two critical values are $p \times \left(\frac{2XY + Z^2 d S_B \pm \sqrt{(2XY + Z^2 d S_B)^2 - 4Y^2(X^2 - Z^2 d^2)}}{2Y^2} \right) - 1$

where $X = p(R-1) + d$, $Y = d - S_B$ and $Z = 2 + (p(R-1) / 2d)$. If the term in chi-square is

negative then π^B is always larger than π^I in this case.

Case3: p and ϕ are both less than the corner point

In this situation commercial banks and investment banks all encounter corner solution in the second stage. The appropriate comparison is between (9') and (10'). Now both intermediaries create the same information accuracy and the net benefit solely depends on the relative size of p and ϕ : commercial banks dominate when $\phi > p$.

Appendix 4

In deriving proposition 2 we compare π^B with π^I , the former assumed “firm-market order” and the latter “market-firm order”. Thus we can easily get lemma 2 from proposition 2 by substituting a and d with m .

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