Information diversification prior to an IPO

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June 2002

Diversification of Investor's Expertise in IPOs*

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June 2002
This version: December 2007

*Thanks for helpful comments to Bruno Jullien, as well as Bruno Biais, Antoni Calvó-Armengol, Jacques Crémer, François Derrien, Antoine Faure-Grimaud, Edith Ginglinger, Denis Gromb, Anastasia Kartacheva, Didier Laussel, Inés Macho-Stadler, David Pérez-Castrillo, David Stolin and Jean Tirole. I have also benefited from comments by participants at the Jamboree 2003 conference, the VIIIth SMYE 2003, the ETAPE Paris seminar and the 1st PhD Presentation Meeting at the LSE. I am responsible for any error. An earlier version of this paper was circulated under the title "Information Diversification Prior to an IPO".

Abstract

In most Initial Public Offerings (IPO) in the world, the underwriter selects syndicate members and uses the information of their investors' clientele to set the offering price. The objective of this paper is to develop a model of the "book building" process in which the formation of the syndicate is an endogenous decision variable. More specifically, I will examine in which cases the lead underwriter will benefit from selecting syndicate members with different investors clientele characterized by a specific line of expertise. I model the fact that different investors have different lines of expertise in assuming that the uncertainty about the value of the shares has two dimensions. One may think about those two dimensions as information elicited from retail and institutional investors. Another interpretation may be that the first dimension is an industry-specific information and the second one, information from a local underwriter. A lead underwriter may also value both particular information about the issuer and indications of interest from key institutional investors coming from previous relationships of a syndicate member. In previous IPO's models with one dimensional uncertainty about the value of the shares, the underwriter must underprice shares to extract information from investors. Informational rents are therefore concealed to these investors in order to induce them to reveal their information and this results in underpricing. In this multi-dimensional context, I prove that it is not always optimal for the decision-maker to acquire all available information about the value of the shares. When deciding which syndicate's organization she wants to implement, the underwriter faces a trade off between the cost of extracting information and the informational efficiency. I show that it is optimal for the lead underwriter to select syndicate members having investors' clienteles with different lines of expertise when she faces a great informational problem, when she values more price accuracy, when the firm going public is more transparent, riskier, and when the capacity of the retail investors increases, which is consistent with the empirical evidence.

Keywords: Initial Public Offerings, Expertise, Asymmetric Information, Value of Information.

JEL Classification: D82, G2

Diversification of Investor's Expertise in IPOs

1 Introduction

Despite the diversity of selling mechanisms[1], most of the Initial Public Offerings (IPOs) in the world, and particularly in the US, are marketed through the "book building" method. In this issuing procedure, the lead underwriter first selects the syndicate members who share with her the underwriting functions. Then, during the road show, she meets institutional investors who are invited by the syndicate members, from which she elicits some indications of interest about the firm. Finally, the offering price and quantities are chosen by the lead underwriter, using these indications of interest. Forming the syndicate is thus a fundamental step to make a successful IPO. Moreover, as each member of the syndicate has a specific investors' clientele, the lead underwriter should form the syndicate according to her objective in terms of information production.

The objective of this paper is to study the optimal design of the syndicate in IPOs. More specifically, I analyze when it is beneficial for the lead underwriter to choose syndicate members with different clienteles of investors, each of them having a specific line of expertise. This should explain the emergence of different IPO syndicate structures.

There is strong empirical evidence that lead underwriters take into account the specificity of each member of the syndicate. Ljungqvist, Jenkinson and Wilhelm (2003) show that the integration of U.S. banks in IPOs conducted outside the United States may reduce significantly underpricing. Indeed, U.S. banks have a longer experience of the book building method. They also have access to an investors' clientele helpful in providing a more accurate demand for the shares. This gives them an advantage compared to local banks. However, local banks are needed because of their knowledge of the issuer. Song (2004b) notes that commercial banks and investment banks have different comparative advantages as underwriters. Commercial banks possess a better certification ability while investment banks have a better distribution ability[2]. Song (2004b) proves that those advantages are each valued by different issuers. She provides empirical evidence that, compared to pure investment bank syndicates, hybrid syndicates with commercial banks as co-managers tend to underwrite issues facing a greater information problem[3]. Narayanan *et al.* (2004) find that when lending banks and non-lending investment banks co-managed an issue, the total issuance costs are reduced. Such a syndicate structure benefits from the reputation of investment banks and the lower spreads of lending banks. Cooney *et al.* (2004) note that the criteria used to form an IPO underwriting syndicate might include (1) financial strength,

[1] See Biais and Faugeron Crouzet (2002), Derrien and Womack (2003), Sherman (2001), among others, for an extensive description of these mechanisms.

[2] Puri (1996) also investigates those differences between commercial and investment banks.

[3] Such issues are for instance smaller firms with lower stock ranking and less prior access to the capital markets.

(2) ability to distribute the security to a particular type of buyer and/or geographic area, (3) research capability, (4) market making strength, and (5) geographic location of the issuing firm. Palmer & Dodge, the famous U.S. law firm, corroborate this view. According to their website[4], "*an issuer should consider the institutional and retail sales capacity of each investment bank. Some underwriters cater almost exclusively to institutional investors, while others have a broad "retail" business directed to individual shareholders. Many believe that it is advantageous to make sales to both types of investors... The strength of this syndicate is quite important. For example, even if the managing underwriters exclusively target institutional investors, they can ensure distribution to individuals through their choice of the other underwriters to be included in the syndicate.*" They also note that "*Certain underwriters may have a strong reputation in one industry but not in others, so in evaluating reputation a company should focus on the appropriate types of deals. Technology company IPOs often involve a lead manager from a large investment bank with a smaller co-manager with industry expertise.*"

In this paper, I develop a model of the "book building" process, in the line of Benveniste and Spindt (1989) and Benveniste and Wilhelm (1990), in which the formation of the syndicate is an endogenous decision variable. A lead underwriter forms a syndicate to underwrite and distribute the issue. Each member of the syndicate has a particular investors' clientele with a specific line of expertise. When selecting the syndicate members, the lead underwriter perfectly knows the line of expertise of their investors' clientele. Designing the organization of the syndicate is therefore equivalent to directly selecting the institutional investors who will participate to the IPO.

To study such an environment, I make two assumptions. First, to model the fact that different investors have different lines of expertise, it is assumed that the uncertainty about the value of the shares has two dimensions. One may think about those two dimensions as information elicited from retail and institutional investors. Another interpretation may be that the first dimension is an industry-specific information and the second one, information from a local underwriter. A lead underwriter may also value both particular information about the issuer and indications of interest from key institutional investors coming from previous relationships of a syndicate member. Second, the lead underwriter is assumed to benefit from the information elicited from investors because it enhances pricing accuracy. Accurate pricing might be valued by both the lead underwriter and the owners of a firm for many reasons. When a firm goes public, owners often keep shares for their own account and foresee coming back to the market later. If the value of the shares is close to its real value, the owners will get some benefits in the future. Loughran and Ritter (2002) state that, for agency reasons, managers may think that their future job performance will be more valued if the initial shares are priced more accurately. There are many other reasons for which the lead underwriter would value more accurate pricing, such as better investment choices,

[4] Their website is www.palmerdodge.com

underwriter reputation, issuer signaling (see Sherman, 2001), but also lawsuit avoidance (see Sherman and Titman, 2002).

The participants in the IPO are the seller, the lead underwriter who acts in the best interest of the seller, and the investors. The investors can be divided in two distinct groups. The first group is composed of large, institutional, investors who each can costlessly gather information about only one dimension of the value of the shares. The second group is formed by small, retail investors who cannot absorb the whole issue. These retail investors cannot gather any information about the value of the firm. Institutional investors can only gather information in one dimension of the value of the shares because of the short period of time during which an IPO takes place. Due to this time constraint, institutional investors cannot collect information along another dimension than their line of expertise.

The lead underwriter may choose two different organizations for the syndicate. Within the first organization, called a specialized syndicate, the syndicate members have investors' clienteles with the same line of expertise, whereas within the second one, labelled as a diversified syndicate, their investors' clientele have different lines of expertise.

In this context, I first study the optimal direct mechanism and its implementation when the lead underwriter forms a specialized syndicate. Within a specialized syndicate, selected institutional investors have the same line of expertise. When they are informed, they observe the same signal about the value of the shares. I show that the lead underwriter can relatively cheaply induce them to tell the truth as she can compare their reports. This allows her to underprice the shares only in good states of the nature. Institutional investors observing a good signal get a positive informational rent in order to induce them to reveal the truth. However, shares are not underpriced in other states of the nature. This results in no rents for investors with a bad signal and uninformed ones. The retail, uninformed, investors face a kind of "winner's curse" problem, since they only get some shares when their value is low.

When the lead underwriter forms a diversified syndicate, the members of the syndicate have investors' clientele with different lines of expertise. Once again, institutional investors with a good signal get positive rents. However, I show that due to the independence of investors' signals, positive rents must be granted to uninformed investors in order to induce truthful revelation of their information. It turns out that the shares are now underpriced when at least a good or an uninformative signal is reported. The "winner's curse" problem faced by the retail, uninformed, investors is less severe than in the previous case as they also receive positive rents. Indeed, the lead underwriter allocates them a positive quantity when she receives at least an uninformative signal. Intuitively, if retail investors get the maximum quantity they can absorb in those states of the nature, the quantity allocated to institutional investors with an uninformative signal is lowered. This reduces the incentives of an institutional investor with a good signal to misreport. The lead underwriter may therefore capture a part of their informational rent. This results by a positive rent for retail

investors.

There are two main differences between those two organizations. First, as the signals are independent under a diversified syndicate, each investors' clientele has a kind of monopoly power on the information it has gathered, whereas by forming a specialized syndicate, the lead underwriter may use the correlation between investors' signals. This allows her to concede lower informational rents to the investors. This implies that underpricing is needed in less states of the nature to extract information about the value of the shares. Second, if the lead underwriter forms a diversified syndicate instead of a specialized one, information about both dimensions of the value of the firm is now available to set the offering price. This improves the expected revenues as there are economic benefits associated with pricing accuracy.

I then analyze the trade-off between those two effects to which the seller is facing. I show that the region of the parameter space in which designing a diversified syndicate is more profitable than designing a specialized one is extended when the lead underwriter values more price accuracy, when the firm going public is more transparent, riskier, and when the capacity of the retail investors increases.

Benveniste and Spindt (1989) and Benveniste and Wilhelm (1990)[5] have been the first to study the underpricing phenomenon in IPOs underwrited with the "book building" method. They argue that financial intermediaries must underprice shares to extract information from institutional investors. Informational rents are therefore conceded to these investors in order to induce them to reveal their information and this results in underpricing. My analysis extends their work in considering a two-dimensional uncertainty about the firm's value. This allows me to enhance the understanding of the relationship between the repartition of informational rents among institutional investors and the formation of the syndicate structure.

While underpricing is well studied in the IPO literature, less attention has been devoted to the selection of the syndicate members. Notable exceptions are Corwin and Schultz (2005) and Song (2004a). Corwin and Schultz (2005) analyze the structure of IPO syndicates and find evidence that syndicate members have a crucial role in enhancing information production[6]. Song (2004a) examines the entry of commercial banks into a syndicate. The main result of this paper is that the organization of the syndicate crucially depends on the characteristics of the firms going public. The empirical findings of those papers are consistent with my results. The lead underwriter must take into account the expertise of the syndicate members or their investors' clientele when designing the structure of the

[5] More recent papers about the book building process include Sherman (2001), Biais and Faugeron Crouzet (2002), Loughran and Ritter (2002), Derrien and Womack (2003), Jenkinson, Ljungqvist, and Wilhelm (2003), and Maksimovic and Pichler (2004).

[6] They also find that previous relationships among syndicate members serve an important role in future syndicate organizations. See also Pichler and Wilhelm (2001) for a theoretical analysis of such an argument.

syndicate.[7]

Another related paper is Sherman and Titman (2002). They analyze why lead underwriters limit the number of investors participating in the IPO process. Their model is based on premises that gathering of information is costly, but generating information allows pricing more accurately the shares in the secondary market. They show that the lead underwriter faces a trade off when she selects the number of investors: the greater is the number of investors, the most accurately the shares are priced, but, the greater is the underpricing. Maksimovic and Pichler (2004) also study how a lead underwriter determines the number of syndicate participants. In both models, institutional investors are not differentiated with respect to their line of expertise[8]. When selecting the investors, the lead underwriter is only interested in their number and not in their intrinsic qualities. Instead my model considers the selection of investors with respect to their line of expertise. This allows me to describe another choice of the lead underwriter and to characterize the relationship between the multidimensional structure of information about the issuer and the features of the syndicate.

From a purely theoretical perspective, my article may be viewed as studying the design of expertise with multiple experts. The nearest theoretical paper from mine is Gromb and Martimort (2004). Gromb and Martimort (2004) study the optimal design of incentive contracts for experts and the implications for the organization of delegated expertise. When contracts are report-based, they show that the principal prefers to rely on two experts rather than relying on one expert who has to collect two signals. However, in Gromb and Martimort (2004), the experts only gather signals about the same information while in my model, experts (investors) may observe signals about different dimensions of the information. This adds a new dimension to the analysis that allows me to endogenize in a different way the structure of the organization of delegated expertise.

Laffont and Martimort (1999) prove that separating the available information between several regulators improves social welfare. However, in their model, the benefits from separation come from the fact that it makes collusion less sustainable whereas in my paper, the lead underwriter forms a diversified syndicate in order to improve the information elicited from investors. Moreover, in the framework that I analyze, different organizations may emerge while in Laffont and Martimort (1999) separation is always optimal.

Cremer and McLean (1988) and Laffont and Martimort (2000) show that correlation between agent's signals allows the principal to elicit this information costlessly compared to the case of independent signals. My paper deviates from theirs in several respects. First, the informed investors may gather uninformative signals in my model. This makes

[7] This result is also shared by the literature on syndication in venture capital or loans. See for instance, Casamatta and Haritchabalet (2004) or Sufi (2005).

[8] Even though uncertainty about the value of the shares has two dimensions in Maksimovic and Pichler (2004), investors randomly gather information about only one of both dimensions.

extraction of rents more costly even in the case of perfectly correlated information. Second, the presence of retail investors changes the allocation of rents. Indeed, they receive a part of the rent previously allocated to "good types" investors in Laffont and Martimort's (2000) analysis. Finally, I study the optimal organization structure when the lead underwriter can determine the informational features of the group of buyers.

My work is also related to the literature on share auctions[9]. The mainstream of this literature mainly focuses on uniform versus discriminatory auctions. In a complete information framework, Back and Zender (1993) show that the revenue generated is never less in a discriminatory auction than in a uniform price auction. However, Wang and Zender (2002) prove that, once incomplete information is assumed, a ranking of those two auctioning mechanisms is not possible as there exists cases in which uniform price auctions dominate discriminatory auctions and *vice versa*. Instead, I study the optimal mechanism when the uncertainty about the value of the good is two-dimensional and when the seller may select the pool of bidders he will face[10].

The rest of the paper is organized as follows. Section 2 presents the model. In section 3, I study the optimal direct mechanism and its implementation when the lead underwriter forms a specialized syndicate. Section 4 describes the case of a diversified syndicate. The fifth section examines when the lead underwriter is better off with one of the previous organizations. I also analyze in this section the comparative statics and highlight the empirical implications of my results. Finally, section 6 concludes and all proofs are in section 7.

2 The Model

A seller needs capital in order to invest in a project, and decides to sell S shares of his firm using an underwriter. This lead underwriter needs information to price the shares. This information may be elicited from other underwriters. The lead underwriter therefore forms a syndicate to underwrite and distribute the issue. Each member of the syndicate has a specific investors' clientele with a specific line of expertise. I assume that when the lead underwriter selects syndicate members she takes into account the line of expertise of her investors' clientele. Designing the organization of the syndicate is therefore equivalent to directly selecting the investors who will participate to the IPO. The participants in the IPO are therefore the seller, the lead underwriter who acts in the best interest of the seller, and the investors. The market is formed by two types of rational and risk neutral investors. Large institutional investors can costlessly gather information about the valuation of the

[9] This literature begun with Wilson's (1979) seminal paper. Those results have been generalized by Back and Zender (1993), Biais and Faugeron-Crouzet (2002) and Wang and Zender (2002) among others.

[10] She may select either bidders with correlated signals (specialized syndicate) either bidders with independent signals (diversified syndicate).

firm on the market and have large bidding capacity. Small uninformed retail investors cannot gather any information, and cannot collectively absorb the whole issue. To simplify the analysis, I assume that there are only two institutional investors[11], each being client from a different syndicate member, and two dimensions of information. Those two dimensions may represent the syndicate members' characteristics[12].

The available information has two components, each representing a direction in which an institutional investor can specialize in gathering information. Each institutional investor has a line of expertise and can only gather information in the direction of his line of expertise. I model information gathering by a private signal s_i, $i = 1, 2$, which can be either good (g), or bad (b), or uninformative (u).

When institutional investors receive an uninformative signal (u), they stay as uninformed as when they do not gather information along this dimension of information. Thus, receiving signal (u), or receiving no signal is informationally equivalent. Then, I also use (u) when no information has been gathered in one dimension of the information.

Gathering of information is not observable by the lead underwriter, institutional investors can therefore claim that they have received a private signal even when they did not gather any information.

The signal received by each institutional investor may be uninformative, (u) with probability $(1 - \pi)$, or informative with probability (π), in this case, the signal could be good (g) with probability (α), or bad (b) with probability $(1 - \alpha)$.

The expected value of the shares is the sum of the expected values in each dimension. When investor 1 (resp. 2) received a private signal s_1 (resp. s_2), the value of the shares in dimension i is $V_i(s_1, s_2)$. $V_i(s_1, s_2)$ is symmetric in (s_1, s_2) and:

$$\begin{aligned} V_i(g, g) = V_i(g, u) &= \theta_u + \theta_g, \\ V_i(b, b) = V_i(b, u) &= \theta_u - \theta_b, \\ V_i(u, u) &= \theta_u, \end{aligned}$$

with $\theta_u = \alpha V_i(g, g) + (1 - \alpha) V_i(b, b)$.

The lead underwriter may form two different organization structures, the first one, called specialized syndicate is such that the selected institutional investors have the same line of expertise; the second one which is labeled diversified syndicate is such that institutional investors have different lines of expertise. Within a specialized organization, there is perfect correlation between informative signals meaning that when both investors receive an informative signal, (g or b), they receive the same signal. However, it could be the case

[11] Having only two institutional investors in the mechanism may be a restriction for the underwriter (see Sherman and Titman, 2002), but this could be explained by regulatory requirements. Another explanation may be that having many investors is too costly for the underwriter. She may have to pay the costs for gathering information to the investors.

[12] Interpretations of those different characteristics are presented in the Introduction.

that one of them receives an informative signal while the other receives an uninformative signal (signal u). Within a diversified organization, the signals that investors receive are independently distributed.

Retail investors may be considered as a fringe, and cannot purchase more than $S(1-k)$ shares, with $k \in (0,1)$. In this model, k is exogenous and $(1-k)$ reflects the degree of participation (or the capacity) of retail investors.

The lead underwriter acts in the best interest of the seller. Moreover, she can differentiate the institutional from the retail investors, and also observe the line of expertise of an institutional investor. She is risk neutral and her objective is to maximize the expected proceeds minus a term which reflects her valuation for a more accurate valuation, $\lambda f(\rho)$[13]. In other words, the lead underwriter is not only interested in high expected proceeds, but also in the accuracy of the information elicited from investors. ρ is the probability that the true state is not discovered in both directions. All throughout the paper, I assume that $f(\rho) > 0$ for all $\rho \in (0,1)$, $f'(.) > 0$, $f''(.) \leq 0$ and $\lambda > 0$[14].

Consider a setting with three periods. First, at date 1, the strategic lead underwriter selects the syndicate members depending on the lines of expertise of their investors' clientele. She also announces price and quantities schedule. Institutional investors then decide whether or not to gather information and also to reveal it or not to the lead underwriter. Finally, the lead underwriter sets the offering price based on the information she has elicited from the institutional investors and the previously announced schedules. At date 2, the shares are traded, and finally, at date 3, the state of nature is publicly revealed. The timing of the game is described in Figure 1.

The lead underwriter proposes the following direct mechanism G to the investors[15]. Each institutional investor send a message m_i announcing his private information, good, bad, or uninformative. The mechanism maps these messages into a price $p(m_1, m_2)$ and quantities $q_i(m_1, m_2)$ for institutional investor i and $q_u(m_1, m_2)$ for retail investors.

I denote $G = \{p(.,.), q_1(.,.), q_2(.,.), q_u(.,.)\}$ this mechanism.

One could remark that this mechanism doesn't allow price discrimination[16], but only quantity discrimination (which is needed to induce institutional investors to reveal their information). This is in line with what is observed in practice for IPOs.

[13] Benefits of pricing accuracy for the lead underwriter or the issuer are discussed in the introduction.

[14] Those assumptions are the same as in Sherman (2001).

[15] From the Revelation Principle, there is no loss of generality in considering only direct mechanisms.

[16] Benveniste and Wilhem (1990) show that the underwriter could raise the expected profits of the firm in using price discrimination. However, Biais, Bossaerts and Rochet (2002) show that uniform pricing is optimal under collusion between institutional investors and the underwriter.

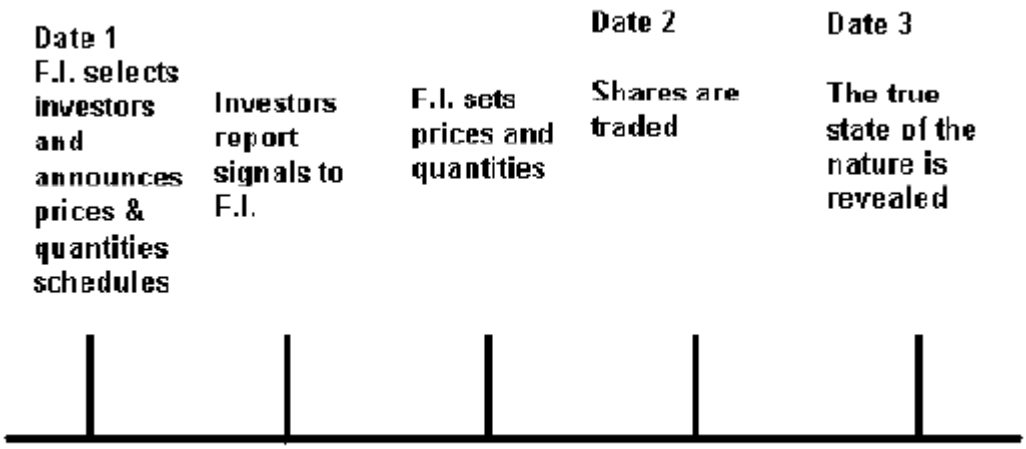

Figure 1: Timing of the game

3 Specialized syndicate

In this section, I analyze the case in which the lead underwriter wants to form a specialized syndicate and selects two investors who have the same line of expertise.

Let's consider Nash equilibria implementation, so that an institutional investor has incentives to gather information and to reveal his true signal, provided that the other one truly reveals information.

To set ideas, it is assumed that both institutional investors gather information in the first direction. This is without loss of generality, because both directions are symmetric.

Since institutional investors do not receive signals in the second direction, the expected value of shares is $V = V_1(s_1, s_2) + \theta_u$ when the received signals are (s_1, s_2).

To simplify the notation, let, $V(s_1, s_2), p(m_1, m_2), q_i(m_1, m_2)$, $i = 1, 2, u$, respectively be the expected value of the shares, the offering price and the quantity allocated to investor i, if the signals received by the institutional investors are (s_1, s_2) , and the messages sent are (m_1, m_2).

3.1 The program of the lead underwriter

In this subsection, I describe the program of the lead underwriter who maximizes her objective under the constraints that all the investors participate to the mechanism and that institutional investors gather information and truthfully reveal it[17].

[17] As we assume there is no cost of gathering information, this last constraint is always satisfied, due to the participation constraint, so we will omit it throughout the paper.

The incentive constraints of the problem are the following:

An institutional investor with an informative signal s should not report that he is uninformed:

$$U_1(s) \geq (1-\pi)q(u,u)\left[V(s) - p(u,u)\right] + \pi q(u,s)\left[V(s) - p(s,u)\right] \tag{1}$$

where $U_1(s) = (1-\pi)q(s,u)\left[V(s) - p(s,u)\right] + \pi q(s,s)\left[V(s) - p(s,s)\right]$, for $s \in \{g,b\}$.

An uninformed institutional investor should not report he has received an informative signal s:

$$U_1(u) \geq (1-\pi)q(s,u)\left[V(u) - p(s,u)\right] + \alpha\pi q(s,s)\left[V(s) - p(s,s)\right] \tag{2}$$

where

$$\begin{aligned} U_1(u) = (1-\pi)q(u,u)\left[V(u) - p(u,u)\right] + \alpha\pi q(u,g)\left[V(g) - p(g,u)\right] \\ +(1-\alpha)\pi q(u,b)\left[V(b) - p(b,u)\right], \end{aligned} \quad \text{for } s \in \{g,b\}.$$

Finally, the global incentive constraints, i.e. an institutional investor with a good signal should not report he has received a bad signal, or conversely:

$$U_1(s) \geq (1-\pi)q(s',u)\left[V(s) - p(s',u)\right] + \pi q(s',s)\left[V(s) - p(s',s)\right] \tag{3}$$

for $s \in \{g,b\}$ and $s' \in \{g,b\}$, $s \neq s'$.

All investors (informed and uninformed one) have to be induced to participate to the mechanism, which give the following ex post[18] participation constraints:

$$V(s) \geq p(s,s), \text{ for } s \in \{g,b,u\}. \tag{4}$$

$$V(s) \geq p(s,u), \text{ for } s \in \{g,b\}. \tag{5}$$

One must add to these constraints that all shares must be sold, i.e.:

$$q_1(m_1,m_2) + q_2(m_1,m_2) + q_u(m_1,m_2) = S \tag{6}$$

As already mentioned, the lead underwriter maximizes the expected proceeds from the IPO minus $\lambda f(\rho)$, a term which reflects her valuation for a more accurate valuation under the previous constraints. This gives the following program of the lead underwriter:

$$\begin{aligned} &Max\left\{SE(p) - \lambda f(\rho)\right\} \\ &q(.,.), p(.,.) \\ &s.t. (1), (2), (3), (4), (5), (6). \end{aligned}$$

with:

$$\begin{aligned} E(p) = (1-\pi)^2 p(u,u) + \pi^2(\alpha p(g,g) + (1-\alpha)p(b,b)) \\ +2\pi(1-\pi)(\alpha p(g,u) + (1-\alpha)p(b,u)). \end{aligned}$$

Let's remark that in this case, $\rho = 1$. Indeed, as no experts gather information in the second dimension, the true state is never discovered in both dimensions.

[18] They still want to participate to the mechanism when all the information about the value of the shares is common knowledge.

3.2 The equilibrium

The following proposition characterizes the unique Nash equilibrium which is solution of the program of the lead underwriter when she forms a specialized syndicate.

Proposition 1 *The optimal policy for a lead underwriter who wants to form a specialized syndicate is to concede:*

- *a positive informational rent of an institutional investor with a good signal:*

$$U_g = \theta_g(1-\pi)\frac{kS}{2}, \tag{7}$$

- *no informational rent of an institutional investor with an uninformative or bad signal:* $U_u = 0$ *and* $U_b = 0$,
- *no rent for retail investors.*

Proof. The proof of this proposition, as well as those of the propositions and the lemmas of the following sections are in the appendix. ■

In the optimal mechanism, only institutional investors with a good signal get an informational rent. In order to induce institutional investors with a good signal to truthfully reveal their information, the lead underwriter must underprice the shares in some states of nature.

Shares do not need to be underpriced when at least one institutional investor announces a bad signal, or both institutional investors announce uninformative signals. Indeed, when institutional investors gather information in the same direction, signals are perfectly correlated if they are informative. This allows the lead underwriter not to give any rent to institutional investors observing a bad signal and uninformed ones. However, despite the perfect correlation of the two institutional investors' signals, the lead underwriter cannot extract all the investors' surplus, as in Cremer and McLean (1988), in giving no share to the institutional investors when they announce different signals. This is due to two premises. First, there exists a non zero probability not to obtain an informative signal. Second, the retail investors cannot absorb the whole issue.

When at least one good signal is sent, prices are indeterminate as long as the incentive compatibility conditions are satisfied. This means that the optimal mechanism can be implemented in various ways. The only restriction is that the incentive compatibility constraint (1) for an institutional investor with an informative signal g is satisfied. This gives rise to informational rents for the institutional investors with a good signal. For instance, the lead underwriter could only underprice when both institutional investors announce good signals as in Biais and Faugeron Crouzet (2002).

Moreover, the lead underwriter, in order to reduce the incentives to lie, does not give any shares to the investors, if they announce two contradictory informative signals, $((g,b),(b,g))$. So, the quantity allocated to each investor is zero if one of them announces a good signal while the other one announces a bad signal.

In the cases in which at least one institutional investor announces a bad signal, or both announce uninformative signals, the quantities allocated to the informed investors are the lowest possible given that uninformed investors cannot absorb the whole issue.

The loss in the expected proceeds from the IPO is proportional to the quantity of shares which cannot be absorbed by the retail investors (kS). This implies that if the retail investors could absorb the whole issue, the lead underwriter could completely eliminate underpricing[19].

Let's note that the retail investors face a kind of "winner's curse" problem, since they only receive shares if the value of the firm is low or uncertain. Thus, they only get shares when they are not underpriced and do not get any rent.

Finally one can remark that the quantities allocated to each institutional investor are increasing in the signal he sends, and decreasing in the signal the other one sends.

4 Diversified syndicate

This section studies the case in which the lead underwriter wants to form a diversified syndicate, and thus, selects two institutional investors who have two different lines of expertise. Contrary to the previous section, their signals are now independently distributed. They could now receive different signals even though they are informative.

This assumption changes radically the problem. Indeed, when an institutional investor receives an informative signal, the lead underwriter cannot guess what the signal of the other one is. Hence, she is not able to use this comparison to induce institutional investors to reveal the truth.

In this case, the institutional investors have a kind of local monopoly power on the private information they have gathered, and so could aspire to higher informational rents. However, the loss in the lead underwriter's benefits (compared to the previous section), due to this increase of the rents, could be compensated by an improvement of the informational efficiency of the market.

Again, let's consider Nash equilibria in which institutional investors have incentives to gather information and to reveal their true signal, provided that the other one truly reveals his information.

[19] This is because there is no cost to acquire information. Otherwise, there would be a minimal k that ensures information acquisition.

For simplicity, it is assumed that institutional investor 1 (resp. 2) gather information in the first (resp. second) direction[20].

Since institutional investors receive only one signal, but in opposite directions, the expected value of the shares is $V = V_1(s_1, u) + V_2(s_2, u)$ when the received signals are (s_1, s_2).

Likewise the previous section, let, $V(s_1, s_2), p(m_1, m_2), q_i(m_1, m_2)$, $i = 1, 2, u$, respectively be the expected value of the shares, the offering price and the quantity allocated to investor i, if the signals received by the investors are (s_1, s_2) , and the messages send are (m_1, m_2).

4.1 The program of the lead underwriter

The program of the lead underwriter is again to maximize her objective function under the participation and incentive constraints.

However, the incentive constraints of the problem are now different. They are given by the following conditions:

An institutional investor with an informative signal s prefers to report truthfully his signal instead of reporting that he is uninformed:

$$\begin{array}{c} U_2(s) \geq (1-\pi)q(u,u)\left[V(s,u) - p(u,u)\right] \\ +\alpha\pi q(u,g)\left[V(s,g) - p(g,u)\right] + (1-\alpha)\pi q(u,b)\left[V(s,b) - p(b,u)\right], \end{array} \tag{8}$$

where:

$$\begin{array}{l} U_2(s) = (1-\pi)q(s,u)\left[V(s,u) - p(s,u)\right] + \alpha\pi q(s,g)\left[V(s,g) - p(s,g)\right] \\ +(1-\alpha)\pi q(s,b)\left[V(s,b) - p(s,b)\right]. \end{array}$$

An uninformed institutional investor should not report an informative signal:

$$\begin{array}{c} U_2(u) \geq (1-\pi)q(s,u)\left[V(u,u) - p(s,u)\right] \\ +\alpha\pi q(s,g)\left[V(g,u) - p(s,g)\right] + (1-\alpha)\pi q(s,b)\left[V(b,u) - p(s,b)\right], \end{array} \tag{9}$$

where:

$$\begin{array}{l} U_2(u) = (1-\pi)q(u,u)\left[V(u,u) - p(u,u)\right] + \alpha\pi q(u,g)\left[V(g,u) - p(g,u)\right] \\ +(1-\alpha)\pi q(u,b)\left[V(b,u) - p(b,u)\right]. \end{array}$$

Finally, the global incentive constraints, i.e. an institutional investor with an informative signal s, should not report informative signal $s^{'}$:

$$\begin{array}{c} U_2(s) \geq (1-\pi)q(s',u)\left[V(s,u) - p(s',u)\right] \\ +\alpha\pi q(s',g)\left[V(g,s) - p(s',g)\right] + (1-\alpha)\pi q(s',b)\left[V(b,s) - p(s',b)\right], \end{array} \tag{10}$$

for $s, s' \in \{g, b\}^2$, $s \neq s'$.

[20] This is without loss of generality because the two directions are symmetric.

The ex post participation constraints are:

$$V(s,s') \geq p(s,s'), \text{ for } s,s' \in \{g,b,u\}. \tag{11}$$

Again, all shares must be sold, i.e.:

$$q_1(m_1,m_2) + q_2(m_1,m_2) + q_u(m_1,m_2) = S \tag{6}$$

The lead underwriter is maximizing the expected proceeds, minus a term that reflects the possibility of price inaccuracy, under the incentive constraints, the participation constraints, and the gathering information constraints.

This gives the following program for the lead underwriter:

$$\begin{aligned} &Max\left\{SE(p) - \lambda Ef(\rho)\right\} \\ &q(.,.), p(.,.) \\ &s.t. (8), (9), (10), (11), (6). \end{aligned}$$

with:

$$\begin{aligned} E(p) = (1-\pi)^2 p(u,u) + \pi^2(\alpha^2 p(g,g) + (1-\alpha)^2 p(b,b)) + 2\pi^2\alpha(1-\alpha)p(g,b) \\ +2\pi(1-\pi)(\alpha p(g,u) + (1-\alpha)p(b,u)), \end{aligned}$$

Now, I have $\rho = 1 - \pi^2$. Indeed, as each expert gather an informative signal with probability π, the true state is discovered in both dimensions with probability π^2.

4.2 The equilibrium

There is a unique Nash equilibrium which is solution of this program of the lead underwriter. It is stated in the following proposition.

Proposition 2 *The optimal policy for a lead underwriter who wants to form a diversified syndicate is to concede:*

- *a positive informational rent of an institutional investor with a good signal:*

$$U_g = \theta_g \tfrac{kS}{2} \left[(1-\pi) + 2(1-\alpha)\pi + \alpha\pi\right], \tag{12}$$

- *a positive informational rent of an institutional investor with an uninformative signal:* $U_u = \alpha\pi\theta_g \tfrac{kS}{2}$,
- *no informational rent of an institutional investor with a bad signal:* $U_b = 0$,
- *a positive rent for retail investors:* $U_n = 2(1-\pi)\tfrac{(1-k)}{k} U_u$.

When institutional investors gather information in different directions, in the optimal mechanism, institutional investors with a good signal and also with an uninformative signal get an informational rent. Again, shares are underpriced in order to induce institutional investors not to misreport their signal. However, this underpricing corresponds not only to the informational rent of institutional investors with good signals as in the previous section, but also to the rent of those with uninformative signals. Institutional investors with an uninformative signal get an informational rent in order to induce them to reveal the truth and not to send a bad signal.

More underpricing in this section is due to the independence of the signals. The lead underwriter cannot use the information revealed by an institutional investor to force the other one to reveal his true signal. She must give positive quantities to institutional investors who announce different signals and cannot punish them as in the previous section. The institutional investors have a local monopoly on their private information. Thus, the lead underwriter must concede more rents to give them incentives to reveal the truth.

On the other hand, shares are not underpriced when both institutional investors announce a bad signal. In these cases, the quantities allocated to these informed investors are the lowest possible ($Sk/2$), but cannot be zero because retail investors cannot absorb the whole issue.

When at least one uninformative or one good signal is sent, prices are indeterminate as long as the incentive compatibility conditions are satisfied. Again, the optimal mechanism can be implemented in various ways. The only restriction is that the incentive compatibility constraints for an institutional investor with an informative signal g (8) and with an uninformative signal (9) are satisfied. This gives rise to informational rents for the institutional investors with a good or an uninformative signal. For instance, the lead underwriter could only underprice when both institutional investors announce good signals and both announce uninformative signals.

Retail investors face a "winner's curse" problem, since they only receive shares if the value of the firm is bad or uncertain. However, this winner's curse is less severe than previously, because they get a positive rent even if they are uninformed.

This is in contrast with previous IPO studies. In many of these studies, the retail investors have a quite passive role since they only get shares when shares are not underpriced as in the previous section. Knowing this, they should not bear the risk to participate to the IPO. However, when institutional investors gather information in different directions, retail investors get a positive rent. This gives them a reason to participate to the IPO[21].

[21] One can therefore reasonably think that forming a diversified syndicate will induce retail investors to participate to the IPO. Informational rents to institutional investors will therefore be reduced and the lead underwriter's willingness to form a diversified syndicate will be reinforced. However, this effect is not taken into account in my model.

In fact, due to the independence of the signals, eliciting information becomes more costly. The lead underwriter must concede informational rents to institutional investors with an uninformative signal. In order to ensure type's separation, the rent granted to institutional investors with a good signal must be raised. However, instead of conceding a much higher rent to those institutional investors, this is less costly to concede a part of it to retail investors. Intuitively, if the lead underwriter allocates to retail investors the maximum quantity they can absorb, the quantity allocated to institutional investors with an uninformative signal is reduced. This lowers the benefits from misreporting for an institutional investor with a good signal. This allows the lead underwriter to capture a part of the informational rent she must give him. This makes profitable the allocation of a rent to retail investors. Moreover, let's note that the greater is the rent given to institutional investors with an uninformative signal, the greater must be the rent given to retail investors.

Let' also remark that the total loss of expected proceeds from the IPO, L, is equal to:

$$L = \alpha\pi\theta_g \left[[(1-\pi) + 2(1-\alpha)\pi + \alpha\pi] \, kS + (1-\pi)S \right].$$

This total loss of expected proceeds from the IPO is an affine function of the quantity of shares which cannot be absorbed by the retail investors (kS). Thus, even though the retail investors could absorb the whole issue, the lead underwriter could not completely eliminate underpricing as she must give a positive rent to those retail investors. This is in contrast with the results of the previous section in which the lead underwriter could eliminate underpricing when retail investors could absorb the whole issue.

Finally, let's note that the quantities allocated to each informed investor are increasing in the signal he sends, and decreasing in the signal the other informed investor sends.

I must, also, point out that when the institutional investors have different lines of expertise, more shares are underpriced, which implies a fall in the benefits of the lead underwriter. However, the informational efficiency of the market has been improved, (because more information is available to the lead underwriter), which implies an increase in those same benefits.

Then, there is an ambiguous effect on the benefits of the lead underwriter. Intuitively, if the gain in informational efficiency compensates the loss in the proceeds of the IPO, (due to more underpricing), the benefits of the lead underwriter may be higher with the diversification of the lines of expertise than in the specialization in only one line of expertise. Determining when the lead underwriter selects institutional investors with different expertise is the objective of the next section.

5 The region of diversification

In the two previous sections, I have respectively computed the expected benefits of the lead underwriter when she selects a specialized organization and a diversified organization.

This section states conditions under which it is optimal for the lead underwriter to form a diversified syndicate, i.e. when the latter organization dominates the former.

The expected benefits in the case of diversification of information are higher than the one of specialization when the gain implied by a more accurate information on the value of the shares is higher than the loss of revenues due to the underpricing of shares in more states of the nature, necessary to give incentives to institutional investors to tell the truth.

This result is quite intuitive. Indeed, relying on different lines of expertise allows institutional investors to have a local monopoly on the information they have gathered, and thus, they obtain higher informational rents. This is never favorable for the lead underwriter, if she only maximizes the proceeds resulting from the IPO, since more information implies more rents and therefore fewer proceeds. However, now, more information improves the informational efficiency of the market, and hence increases the benefits of the lead underwriter. Then, there is a trade off between these two effects and diversification is more profitable than specialization, if the latter effect dominates the former.

5.1 Comparative statics

For purposes of notation, let's call "region of diversification", the region where it is in the interest of the lead underwriter to form a diversified syndicate rather than a specialized one. Let me also note that the ratio number of shares sold / gain in discovering that the value of the shares is high, $\frac{\lambda}{S\theta_g}$, is in fact a measure of the valuation for collecting information of the lead underwriter[22]. The higher is this ratio, the higher is the value of good information for her.

The following propositions explicitly state this intuition.

Proposition 3 *1. The lead underwriter prefers to form a diversified syndicate rather than a specialized one:*

(a) whatever the capacity of the retail investors, $(1-k)$, if the value of information, $\lambda/S\theta_g$, is high enough and,

(b) up to a certain capacity of the retail investors, if the value of information takes intermediary values.

2. The lead underwriter always forms a specialized syndicate, if information is not enough valuable.

3. The region of diversification is extended when the value of collecting information, $\lambda/S\theta_g$, increases and when the capacity of the retail investors, $(1-k)$, increases.

[22] There are other possible measures for the value of good information. Here, what I called the value of information, is the gain from gathering better information by share. We should also use the expected utility from becoming informed minus the utility of an uninformative type (because if he is uninformed an agent will announce he has received an uninformative signal).

The results I obtain are quite intuitive, more the information is valuable, more it is profitable for the lead underwriter to elicit this information. So, forming a diversified syndicate is more profitable than forming a specialized one. In addition, when the capacity of retail investors increases, the lead underwriter can use it to induce informed investors to reveal the truth. This reduces informational rents, and as informational efficiency is improved, the region of diversification is extended.

If the information gathered about the value of the firm is enough valuable for the lead underwriter, forming a diversified syndicate is always more profitable than forming a specialized one, no matter the degree of participation of the retail investors. This is quite intuitive. Indeed, when information is highly valuable, the lead underwriter is willing to elicit all the available information instead of relying on only one line of expertise and hence, being uninformed about the other line. In this case, the term reflecting the informational efficiency of the market is so high that it always compensates the loss of revenues due to underpricing.

If information is less valuable, but high enough, there exists a degree of participation of the retail investors from which forming a diversified syndicate is more profitable than forming a specialized one. Here, the gain from informational efficiency of the market compensates the loss of revenues due to underpricing, but only from a certain degree of participation of the retail investors. Indeed, a higher degree of participation of the retail investors in the mechanism lowers the informational rents allocated to institutional investors. This reduces the costs of inducing institutional investors to truthfully reveal their information. This makes diversification more profitable. In this case, one can remark that a higher retail investors' capacity reduces the institutional investors' local monopoly power along their line of expertise. This benefits to the lead underwriter when information is enough valuable for her.

On the other hand, if information is not enough valuable, it is never profitable for the lead underwriter to form a diversified syndicate, whatever the degree of participation of the retail investors. In this case, it is optimal for the lead underwriter to always select institutional investors with the same line of expertise.

Let's now explicitly state the role of α, the probability that the signal is good if it exists.

Corollary 4 *1. The lead underwriter prefers to form a diversified syndicate rather than a specialized one:*

(a) whatever α, if the valuation of the lead underwriter for information is high enough and,

(b) for α lower than α^*, otherwise.

2. The region of diversification is extended when α decreases.

When the valuation of the lead underwriter for information is high enough, she always prefers a diversified syndicate. Otherwise, the lead underwriter only forms a diversified syndicate when α is lower than α^*. Moreover, decreasing α, extends the region of diversification. Intuitively, when α increases, the informational rents increase. As there are more rents under diversification this makes a diversified organization less profitable. When the lead underwriter places a high valuation for the accuracy of information, the previous effect has no impact on the optimal organization. However, when her valuation for information is lower, diversification is more profitable only when rents are not too costly, i.e. when α is low enough.

Finally, let me examine the effects of a variation of π, the probability that information exists.

Corollary 5 *1. If the valuation of the lead underwriter for information is high enough, she prefers to form a diversified syndicate rather than a specialized one, for π higher than π^*.*

2. The lead underwriter always forms a specialized syndicate, whatever the value of π, if information is not enough valuable.

3. The region of diversification is extended when π increases.

When her valuation for information is high enough, there exists π^* such that the lead underwriter forms a diversified syndicate for π higher than π^*. Otherwise, the lead underwriter always prefers a specialized syndicate. Increasing π, increases the region of diversification. The intuition for this result is the following. When π increases, the probability that information exists increases. This raises the differences in accuracy between the different organizations. The benefits from diversification are therefore increased. However, this is only the case when the lead underwriter places a high valuation for the accuracy of information. When her valuation for information decreases, the impact of this effect is reduced.

5.2 Empirical implications

My theoretical analysis emphasizes the role of expertise in the organizational design of IPO syndicates. It proves that if the lead underwriter may select different syndicate structures depending on her valuation for price accuracy. It also provides prediction on the links between the organization of the syndicate and the ex-ante prior about the firm, as well as the retail investors' participation in the IPO.

To empirically test my model, one would need to have datas on syndicate members' line of expertise. Such datas are available to check if each syndicate member is for instance,

either a regional or an international underwriter, or also, either an investment bank or a commercial bank. Those characteristics could be obtained in a quite easy way.

Empirical evidence that syndicate members play an important role in the IPO process through information production is presented in Corwin and Schultz (2005). They note that different underwriters have different investors' clientele, but also specialize by geographic region. Their information production hypothesis suggests that an underwriter is added to a syndicate in order to gather specific information about demand for an IPO. Diversified syndicates would therefore arise when the lead underwriter needs a higher amount of information for this particular offering. This is likely to be the case when she has a high valuation for price accuracy. They also find that another strong determinant for inclusion within a syndicate is the existence of previous relationships with the lead underwriter. Those relationships may reduce agency problems and induce syndicate members to exert the necessary effort to gather information. In my model, previous relationships should be reflected by a higher probability that the information exists, π meaning that a diversified syndicate also emerges when the probability that the information is collected, π, is high. Corwin and Schultz's (2005) predictions are therefore consistent with my model's predictions.

Song (2004a) shows that syndicates with both investment and commercial banks arise when firms have lower common stock ranking and less prior access to capital. As investment banks and commercial banks possess different comparative advantages in their underwriting technologies, one could think about them as having different expertise. Hybrid syndicates, composed with both investment and commercial banks, are therefore diversified syndicate in my framework, while pure investment bank syndicates are specialized syndicates. Firms which have lower common stock ranking and less prior access to capital seem to be more difficult to underwrite due to a greater information problem. Thus, the lead underwriter has a great need for informational efficiency for such firms (λ high). This is also consistent with my results.

In the literature of syndicated loans, Sufi (2005) finds that the syndicate structure is more concentrated when the firm is opaque and when it is not too risky. With respect to their notations, opaque firms are firms with no publicly available information and risky firms have non negligible probabilities of default and relatively high leverage ratios. In my framework, opaque firms are represented by a low π and risky firms by a low α. Let's also remark that a more concentrated syndicate is a syndicate whom syndicate members have the same expertise. Those empirical results are confirmed by this paper's results.

This model also highlights new testable empirical implications on the organizational design of IPO syndicates. For instance, it could explain a difference in syndicate structure among different market places. Firms listed on the NASDAQ in the US or on the "Nouveau Marche" in France are new technology firms. Thus, they suffer a greater information problem than firms listed on the NYSE in the US or on the "Premier Marche" in France

which are bigger and better known. My predictions suggest that firms going public within the NASDAQ or the "Nouveau Marche" need to form a more diversified syndicate than firms within the NYSE or the "Premier Marche".

According to my results, the active participation of retail investors changes with the syndicate structure. Indeed, when the lead underwriter selects a diversified syndicate structure, retail investors get a larger amount of shares and a positive rent. One could therefore test this hypothesis by checking if firms with a high level of retail investors when they go public are also those which have been underwrote with a diversified syndicate.

6 Conclusion

I have argued in this paper that if the lead underwriter maximizes the total proceeds from the IPO, but also takes into account price accuracy in the market, it could be in her interest to collect all the available information in forming a diversified syndicate.

I have shown that when the lead underwriter forms a diversified syndicate, each investors' clientele has a local monopoly power on their private information. To extract this information, she must concede larger informational rents to the investors. This implies that the shares of the firm are underpriced in more states of the nature than in the previous case. But, as more information is available to the lead underwriter, informational efficiency is improved. Even though this allocates higher informational rents to investors, this could be profitable for the lead underwriter depending on her valuation for accurate pricing.

Indeed, if the information gathered about the value of the firm is enough valuable, no matter the degree of participation of the retail investors, selecting institutional investors with different lines of expertise is always more profitable than selecting them with the same line of expertise. However, if information is less valuable, but high enough, there exists a degree of participation of the retail investors from which selecting institutional investors with different lines of expertise is more profitable than selecting them with the same line of expertise. Moreover, diversification is more profitable than specialization when the firm going public is more transparent or riskier, and when the capacity of the retail investors increases.

Another interesting result of this paper is in contrast with previous IPO studies. In the classic IPO literature, the retail investors have a quite passive role since they only get shares when shares are not underpriced whereas they earn positive rents in my framework. This could be a reasonable reason to explain why they should bear the risk to participate to the IPO.

An interesting extension could be to assume that collusion between syndicate members may arise as it is one of the major critics against the "book building" process. They could in this new framework share their information and therefore earn higher rents, more particularly under specialization. In this case, it seems that the mechanism should not be robust

and so, that the underwriter has to design a new incentive compatible mechanism in order to elicit the information she needs. One could also relax the time constraint, and then assume that institutional investors can gather information in both directions. However, this will introduce a multi dimensional screening problem. Finally, due to my results one can reasonably think that forming a diversified syndicate may induce retail investors to participate to the IPO. Informational rents to institutional investors may therefore be reduced and the lead underwriter's willingness to form a diversified syndicate should be reinforced, as I note in Section 4. This effect has to be taken into account in a future extension of this model. These issues are left for future research.

7 Appendix

Proof of Proposition 1. First, note that despite its unusual form, the objective of the lead underwriter is increasing in the prices, due to the ex post participation constraints.

Despite the perfect correlation of the two institutional investors' signals, the lead underwriter cannot extract all the investors' surplus, as in Cremer and McLean (1988), in giving no share to the institutional investors if they announce different signals, on one hand, because there exists a non zero probability not to obtain an informative signal, and on the other hand, because the retail investors cannot absorb the whole issue.

But, the lead underwriter, in order to reduce the incentives to lie, should not give any shares to the institutional investors, if they announce two contradictory informative signals, $((g,b),(b,g))$.

As the signals are perfectly correlated, the quantity allocated to each investor is zero if one of them announce a good signal while the other one announce a bad signal, $q(b,g) = q(g,b) = 0$.

The incentive constraints are now:

$$\begin{aligned}&(1-\pi)q(g,u)\left[V(g)-p(g,u)\right]+\pi q(g,g)\left[V(g)-p(g,g)\right]\\ &\geq(1-\pi)q(u,u)\left[V(g)-p(u,u)\right]+\pi q(u,g)\left[V(g)-p(g,u)\right],\end{aligned}\tag{A.1}$$

$$\begin{aligned}&(1-\pi)q(u,u)\left[V(u)-p(u,u)\right]+\alpha\pi q(u,g)\left[V(u)-p(g,u)\right]+(1-\alpha)\pi q(u,b)\left[V(b)-p(b,u)\right]\\ &\geq(1-\pi)q(g,u)\left[V(u)-p(g,u)\right]+\alpha\pi q(g,g)\left[V(g)-p(g,g)\right],\end{aligned}\tag{A.2}$$

$$\begin{aligned}&(1-\pi)q(b,u)\left[V(b)-p(b,u)\right]+\pi q(b,b)\left[V(b)-p(b,b)\right]\\ &\geq(1-\pi)q(u,u)\left[V(b)-p(u,u)\right]+\pi q(u,b)\left[V(b)-p(b,u)\right],\end{aligned}\tag{A.3}$$

$$\begin{aligned}&(1-\pi)q(u,u)\left[V(u)-p(u,u)\right]+\alpha\pi q(u,g)\left[V(u)-p(g,u)\right]+(1-\alpha)\pi q(u,b)\left[V(b)-p(b,u)\right]\\ &\geq(1-\pi)q(b,u)\left[V(u)-p(b,u)\right]+(1-\alpha)\pi q(b,b)\left[V(b)-p(b,b)\right].\end{aligned}\tag{A.4}$$

To solve this problem, I only consider the upward incentive constraints, i.e., (1), and (4) and I will check ex post that downward incentive constraints are satisfied[23].

Let's first show that $q(b,u) = 0$ and $p(b,b) = V(b)$. Indeed, as $p(b,u) \leq V(b)$ by the ex post participation constraint, and $V(b) < V(u)$, one must set $q(b,u)$ to its minimum, in order to relax the constraint (4), i.e., $q(b,u) = 0$. In the same way, since the uninformed investors cannot absorb the whole issue, and by (6), one cannot set $q(b,b) = 0$. To make (4) more slack without violate the ex post participation constraint, on must therefore set $p(b,b)$ to its minimum, i.e., $p(b,b) = V(b,b)$.

The incentive constraints are now:

$$\begin{aligned}&(1-\pi)q(g,u)\left[V(g)-p(g,u)\right]+\pi q(g,g)\left[V(g)-p(g,g)\right]\\&\geq(1-\pi)q(u,u)\left[V(g)-p(u,u)\right]+\pi q(u,g)\left[V(g)-p(g,u)\right],\end{aligned}\tag{A.5}$$

$$\begin{aligned}(1-\pi)q(u,u)\left[V(u)-p(u,u)\right]+\alpha\pi q(u,g)\left[V(u)-p(g,u)\right]\\+(1-\alpha)\pi q(u,b)\left[V(b)-p(b,u)\right]\geq 0.\end{aligned}\tag{A.6}$$

The incentive constraint (4) is then automatically satisfied (with ex post participation constraints), so one can drop it. Moreover, as $p(b,u)$ only appears in this constraint and the objective of the lead underwriter is increasing in the prices, it is optimal to set $p(b,u)$ to its maximum, $p(b,u) = V(b)$

Now, two cases are possible.

First, when there is no underpricing if one institutional investor announce a good signal and the other that he is uninformed, i.e., $p(g,u) = V(g)$. (1) becomes:

$$\pi q(g,g)\left[V(g)-p(g,g)\right]\geq(1-\pi)q(u,u)\left[V(g)-p(u,u)\right].$$

Secondly, when there is underpricing in state (g,u), $p(g,u) < V(g)$, to relax (1), one must set $q(u,g)$ to its minimum, $q(u,g) = 0$, and (1) becomes

$$(1-\pi)q(g,u)\left[V(g)-p(g,u)\right]+\pi q(g,g)\left[V(g)-p(g,g)\right]\geq(1-\pi)q(u,u)\left[V(g)-p(u,u)\right].$$

Then, the first case is only a particular case of the second one. Hence, I only consider the case in which there is underpricing in state (g,u), $p(g,u) < V(g)$ and $q(u,g) = 0$.

Again, to make (1) slack, and as $q(u,u) > 0$ (by (6), let me set $p(u,u)$ to its maximum, $p(u,u) = V(u)$.

The incentive constraint (1) becomes:

$$\begin{aligned}&(1-\pi)q(g,u)\left[V(g)-p(g,u)\right]+\pi q(g,g)\left[V(g)-p(g,g)\right]\\&\geq\theta_g(1-\pi)q(u,u).\end{aligned}\tag{A.7}$$

This constraint must be binding. Indeed, if it is not the case, and as the objective of the lead underwriter is increasing in the prices, it would suffice to increase the prices to bind it.

[23] See Laffont and Martimort (2002) for a general characterization of adverse selection problems.

I can now write the objective function of the lead underwriter in this way:

$$E(\Pi_1) = SE(V) - [2\alpha\pi U_g + 2(1-\alpha)\pi U_b + 2(1-\pi)U_u + U_n] - \lambda f(1) \ , \tag{A.8}$$

where, U_g, U_b, U_u, are, respectively the informational rents of institutional investors who have received a good signal, a bad signal, an uninformative signal and U_n is the rent that retail investors expect to get ex ante.

The lead underwriter maximizes this objective function with respect to the prices, under the constraints:

$$\begin{array}{l}(1-\pi)q(g,u)\left[V(g)-p(g,u)\right]+\pi q(g,g)\left[V(g)-p(g,g)\right]=\theta_g(1-\pi)q(u,u),\\ p(b,b)=V(b),\\ p(b,u)=V(b),\\ p(u,u)=V(u).\end{array}$$

Then, this objective function is now:

$$\begin{array}{rcl} E(\Pi_1) & = & SE(V)-\lambda f(1) \\ & & -2\theta_g\alpha\pi(1-\pi)q(u,u) \\ & & -2\alpha\pi(1-\pi)\left[S-q(g,u)\right]\left[V(g)-p(g,u)\right] \\ & & -\alpha^2\pi^2\left[S-2q(g,g)\right]\left[V(g)-p(g,g)\right] \end{array} \tag{A.9}$$

As this objective is decreasing in $q(u,u)$, one must set $q(u,u)$ to its minimum, i.e., $q(u,u) = kS/2$. It is increasing in $q(g,u)$ and $q(g,g)$ as long as there is underpricing in the corresponding state of nature. If it is not the case the quantity is not determined by equilibrium conditions. Let's remark that there is underpricing in at least one of the states of nature, (g,g) or (g,u). $q(g,g)$ and $q(g,u)$ must therefore be set to their maximum, i.e. $q(g,g) = S/2$ and $q(g,u) = S$ when there is underpricing in the corresponding state of nature and are not determined otherwise.

Let's also remark that $q(b,b)$ and $q(u,b)$ are indeterminate. Thus, the optimal mechanism does not require that retail investors do not participate to the mechanism.

And, finally, we have

$$\left\{\begin{array}{l} U_g = (1-\pi)\theta_g\frac{kS}{2} \\ U_u = U_b = U_n = 0 \end{array}\right.$$

Moreover, when at least one good signal is sent, prices are indeterminate as long as the incentive compatibility conditions are satisfied.

Finally, the expected benefits of the lead underwriter are:

$$\begin{array}{l} E(\Pi_1) = SE(V) \\ -\alpha\pi(1-\pi)\theta_g kS - \lambda f(1) \end{array} \tag{A.10}$$

I can now verify that all constraints are satisfied with this optimal contract. ■

Proof of Proposition 2. The incentive constraints of this problem, using the informational rents of the institutional investors, are:

$$\begin{aligned}
U_g &\geq U_u + \theta_g \left[(1-\pi)q(u,u) + \alpha\pi q(u,g) + (1-\alpha)\pi q(u,b)\right] \\
U_u &\geq U_g - \theta_g \left[(1-\pi)q(g,u) + \alpha\pi q(g,g) + (1-\alpha)\pi q(g,b)\right] \\
U_b &\geq U_u - \theta_b \left[(1-\pi)q(u,u) + \alpha\pi q(u,g) + (1-\alpha)\pi q(u,b)\right] \\
U_u &\geq U_b + \theta_b \left[(1-\pi)q(b,u) + \alpha\pi q(b,g) + (1-\alpha)\pi q(b,b)\right] \\
U_b &\geq U_g - (\theta_g + \theta_b) \left[(1-\pi)q(g,u) + \alpha\pi q(g,g) + (1-\alpha)\pi q(g,b)\right] \\
U_g &\geq U_b + (\theta_g + \theta_b) \left[(1-\pi)q(b,u) + \alpha\pi q(b,g) + (1-\alpha)\pi q(b,b)\right]
\end{aligned}$$

In adding the incentive constraints of an institutional investor whose type is (g) and (u) and of one whose type is (u) and (b), I get:

$$\begin{aligned}
&(1-\pi)q(g,u) + \alpha\pi q(g,g) + (1-\alpha)\pi q(g,b) \\
&\geq (1-\pi)q(u,u) + \alpha\pi q(u,g) + (1-\alpha)\pi q(u,b) \\
&\geq (1-\pi)q(b,u) + \alpha\pi q(b,g) + (1-\alpha)\pi q(b,b)
\end{aligned} \tag{A.11}$$

Thanks to this monotonicity constraint, one can show that local incentive constraints, (8) and (9) imply the global one, (10).

One can remark that institutional investors receiving a signal tend to lie and to announce a lower signal. Thus, let's only consider these incentive constraints and check ex post that incentives constraints where the institutional investor announce a better signal than he has received are satisfied.

Let me write the relevant incentive constraints and check ex post that the others are satisfied:

$$\begin{aligned}
&(1-\pi)q(g,u)\left[V(g,u) - p(g,u)\right] + \alpha\pi q(g,g)\left[V(g,g) - p(g,g)\right] \\
&+(1-\alpha)\pi q(g,b)\left[V(g,b) - p(g,b)\right] \geq (1-\pi)q(u,u)\left[V(g,u) - p(u,u)\right] \\
&+\alpha\pi q(u,g)\left[V(g,g) - p(g,u)\right] + (1-\alpha)\pi q(u,b)\left[V(g,b) - p(b,u)\right]
\end{aligned} \tag{A.12}$$

$$\begin{aligned}
&(1-\pi)q(u,u)\left[V(u,u) - p(u,u)\right] + \alpha\pi q(u,g)\left[V(g,u) - p(g,u)\right] \\
&+(1-\alpha)\pi q(u,b)\left[V(b,u) - p(b,u)\right] \geq (1-\pi)q(b,u)\left[V(u,u) - p(b,u)\right] \\
&+\alpha\pi q(b,g)\left[V(g,u) - p(b,g)\right] + (1-\alpha)\pi q(b,b)\left[V(b,u) - p(b,b)\right]
\end{aligned} \tag{A.13}$$

In order to make these constraints more slack, let me set $q(b,u)$ and $q(b,g)$ to their minimum, because due to the ex post participation constraints, one have $p(b,u) \leq V(b,u) < V(u,u)$, and $p(b,g) \leq V(b,g) < V(g,u)$. This implies that $q(b,u) = q(b,g) = 0$. In the same way, as by (6) $q(b,b) > 0$, set $p(b,b)$ to its maximum, $p(b,b) = V(b,b)$.

As in the proof of Proposition 1 to make the incentive constraints more slack, one can either set $q(u,g)$ to its minimum, or set $p(g,u)$ to its maximum. The program of the lead underwriter in the second case being a particular case of the program in the first one, let's only consider the latter. So let me set $q(u,g) = 0$.

This allows me to write the incentive constraints as:

$$U_g \geq U_u + \theta_g \left[(1-\pi)q(u,u) + (1-\alpha)\pi q(u,b)\right] \tag{A.14}$$

$$U_u \geq U_b + \theta_b \left[(1-\alpha)\pi q(b,b)\right] \tag{A.15}$$

Again, these constraints must be binding. Indeed, if it was not the case, and as the objective of the sell is increasing in the prices, it would suffice to increase the prices to bind it. So, one have:

$$U_u = \theta_g \alpha\pi q(b,b), \tag{A.16}$$

$$U_g = \theta_g \left[(1-\pi)q(u,u) + (1-\alpha)\pi q(u,b) + \alpha\pi q(b,b)\right], \text{ with } \alpha\theta_g = (1-\alpha)\theta_b), \tag{A.17}$$

Since, according to (6), I have $q(b,b) > 0$, the only way to satisfy this constraint is to underprice when at least an institutional investor receives either an uninformative signal or a good one.

I also have to add the only relevant ex post participation constraints of the uninformed investors which are:

$$\begin{gathered} q_u(u,b)\left[V(b,u) - p(b,u)\right] \geq 0 \\ q_u(u,u)\left[V(u,u) - p(u,u)\right] \geq 0 \\ q_u(g,u)\left[V(g,u) - p(g,u)\right] \geq 0 \\ q_u(g,b)\left[V(g,b) - p(g,b)\right] \geq 0 \\ q_u(g,g)\left[V(g,g) - p(g,g)\right] \geq 0 \end{gathered}$$

Let me write the objective function of the lead underwriter in this way:

$$E(\Pi_2) = SE(V) - SE(V-p) - \lambda f(1-\pi^2) \tag{A.18}$$

The lead underwriter maximizes this objective function with respect to the prices and the quantities, under the constraints:

$$\begin{aligned} &U_g = \theta_g \left[(1-\pi)q(u,u) + (1-\alpha)\pi q(u,b) + \alpha\pi q(b,b)\right] \\ &U_u = \theta_g \left[\alpha\pi q(b,b)\right] \\ &p(b,b) = V(b,b) \end{aligned}$$

This allows me to write the lead underwriter's objective as

$$E(\Pi_2) = SE(V) - S \left[\begin{array}{c} (1-\pi)^2 \left[V(u,u) - p(u,u)\right] \\ +2(1-\alpha)\pi(1-\pi)\frac{U_u - (1-\pi)q(u,u)\left[V(u,u)-p(u,u)\right]}{(1-\alpha)\pi q(u,b)} \\ +2\alpha\pi(1-\pi)\left[V(g,u) - p(g,u)\right] \\ +\alpha^2\pi^2\left[V(g,g) - p(g,g)\right] \\ +2\alpha(1-\alpha)\pi^2\frac{U_g - (1-\pi)q(g,u)\left[V(g,u)-p(g,u)\right] - \alpha\pi q(g,g)\left[V(g,u)-p(g,g)\right]}{(1-\alpha)\pi q(g,b)} \end{array} \right]$$

This expression being decreasing in $q(b,b)$, and increasing in $q(g,g)$, $q(g,u)$ and $q(g,b)$, I must set $q(b,b)$ to its minimum, i.e., $q(b,b) = kS/2$, and $q(g,g)$, $q(g,u)$, and $q(g,b)$ to their maximum, i.e.: $q(g,g) = S/2$, and $q(g,u) = q(g,b) = S$.

However, I cannot compute $q(u,u)$ and $q(u,b)$ in a direct way because U_g depends on those quantities. Let's first derive the derivatives with respect to $q(u,u)$, $q(u,b)$, $p(u,u)$ using $q(g,b) = S$.

$$\frac{dE(\Pi_2)}{dq(u,u)} = \frac{2(1-\pi)^2 S}{q(u,b)}\left[V(u,u) - p(u,u)\right] - 2(1-\pi)\alpha\pi\theta_g$$

$$\frac{dE(\Pi_2)}{dq(u,b)} = \frac{2(1-\pi)(1-\alpha)\pi S}{q(u,b)}\left[\frac{U_u - (1-\pi)q(u,u)\left[V(u,u) - p(u,u)\right]}{(1-\alpha)\pi q(u,b)}\right] - 2(1-\alpha)\alpha\pi^2\theta_g$$

$$\frac{dE(\Pi_2)}{dp(u,u)} = \frac{(1-\pi)^2 S}{q(u,b)}\left[q(u,b) - 2q(u,u)\right]$$

Moreover, as (A.15) is binding, $\frac{dE(\Pi_2)}{dp(u,u)}$ and $\frac{dE(\Pi_2)}{dp(u,b)}$ have opposite signs. Consequently, the sign of those derivatives only depends on the sign of $\left[q(u,b) - 2q(u,u)\right]$. This allows me to derive three cases.

1. $\left[q(u,b) - 2q(u,u)\right] = 0$. In this case, I must have $\frac{dE(\Pi_2)}{dq(u,u)} < 0$ and $\frac{dE(\Pi_2)}{dq(u,b)} < 0$. Indeed, if it was not the case, those derivatives would both be non negative. This would imply that

$$\begin{aligned} & q(u,u)\frac{dE(\Pi_2)}{dq(u,u)} + q(u,b)\frac{dE(\Pi_2)}{dq(u,b)} \geq 0 \\ \iff & \alpha\pi\theta_g S\left[(k-1)(1-\pi) - 2(1-\alpha)\pi\right] \geq 0 \end{aligned}$$

   However, this is impossible as $k \leq 1$. Thus, when $\left[q(u,b) - 2q(u,u)\right] = 0$ $\frac{dE(\Pi_2)}{dq(u,u)}$ and $\frac{dE(\Pi_2)}{dq(u,b)}$ are negative and the optimal quantities are $q(u,u) = \frac{kS}{2}$, and $q(u,b) = kS$.

2. $\left[q(u,b) - 2q(u,u)\right] < 0$. This imply that $\frac{dE(\Pi_2)}{dp(u,u)} < 0$ and $\frac{dE(\Pi_2)}{dp(u,b)} > 0$. I therefore have

$$\begin{cases} p(b,u) = V(b,u) \\ (1-\pi)q(u,u)\left[V(u,u) - p(u,u)\right] = U_u \end{cases}$$

   Adding this in $E(\Pi_2)$ gives that this expression is decreasing in $q(u,u)$, and $q(u,b)$, implying that $2q(u,u) = q(u,b) = kS$.

3. $\left[q(u,b) - 2q(u,u)\right] > 0$. This imply that $\frac{dE(\Pi_2)}{dp(u,u)} > 0$ and $\frac{dE(\Pi_2)}{dp(u,b)} < 0$. I therefore have

$$\begin{cases} p(u,u) = V(u,u) \\ (1-\alpha)\pi q(u,b)\left[V(b,u) - p(b,u)\right] = U_u \end{cases}$$

   Again, adding this in $E(\Pi_2)$ gives that this expression is decreasing in $q(u,u)$, and $q(u,b)$, implying that $2q(u,u) = q(u,b) = kS$.

Consequently, the optimal quantities are $q(u,u) = \frac{kS}{2}$, and $q(u,b) = kS$.

This allows me to write U_n the rent that retail investors expect to get ex ante as

$$U_n = 2(1-\pi)\frac{(1-k)}{k}U_u.$$

And, finally, we have

$$\begin{cases} U_g = \theta_g \left[(1-\pi)\frac{kS}{2} + (1-\alpha)\pi kS + \alpha\pi\frac{kS}{2}\right] \\ U_u = \alpha\pi\theta_g\frac{kS}{2} \\ U_b = 0 \\ U_n = (1-\pi)\alpha\pi\theta_g(1-k)S \end{cases}$$

Moreover, when at least one uninformative or one good signal is sent, prices are indeterminate as long as the incentive compatibility conditions are satisfied.

Finally, the expected benefits of the lead underwriter are:

$$\begin{array}{l} E(\Pi_2) = SE(V) \\ -\alpha\pi\theta_g S\left[\left[(1-\pi) + 2(1-\alpha)\pi + \alpha\pi\right]k + (1-\pi)\right] \\ -\lambda f(1-\pi^2) \end{array} \tag{A.19}$$

I can now verify that all constraints are satisfied with this optimal contract. ■

Proof of Proposition 3. Let me write the difference between the benefits if the lead underwriter selects institutional investors with different lines of expertise, and if she selects them with the same line of expertise:

$$\begin{array}{rc} E(\Pi_2) - E(\Pi_1) = -\alpha\pi\theta_g\left[S\left[\left[(1-\pi) + 2(1-\alpha)\pi + \alpha\pi\right]k + (1-\pi)\right]\right] & \\ +\alpha\pi\theta_g(1-\pi)kS & \\ +\lambda\left[f(1) - f(1-\pi^2)\right] & \end{array} \tag{A.20}$$

Finally, the expression of the difference of the benefits becomes:

$$\begin{array}{rc} E(\Pi_2) - E(\Pi_1) = -\alpha\pi\theta_g S\left[(1-\pi) + \left[2(1-\alpha)\pi + \alpha\pi\right]k\right] & \\ +\lambda\left[f(1) - f(1-\pi^2)\right] & \end{array} \tag{A.21}$$

The lead underwriter prefers to form a diversified syndicate when this difference is positive.

This defines a critical values λ^* and k^* such that for all $\lambda \geq \lambda^*$ or for all $k \leq k^*$, the lead underwriter forms a diversified syndicate. Those values are defined by

$$\begin{aligned} \lambda^* &= S\theta_g\frac{\alpha(2-\alpha)\pi^2 k + \alpha\pi(1-\pi)}{f(1) - f(1-\pi^2)} \\ k^* &= \frac{\lambda}{S\theta_g}\frac{f(1) - f(1-\pi^2)}{\alpha(2-\alpha)\pi^2} - \frac{(1-\pi)}{(2-\alpha)\pi} \end{aligned}$$

Let's note that,

$$\begin{aligned} & k^* \geq 0 \\ \Leftrightarrow \lambda & \geq S\theta_g \frac{\alpha\pi(1-\pi)}{f(1)-f(1-\pi^2)} \end{aligned}$$

So, when λ is high enough, the lead underwriter forms a diversified syndicate when k is lower than k^*. Otherwise, the lead underwriter never composes a diversified syndicate.

Let's also remark that as $E(\Pi_2) - E(\Pi_1)$ is non negative when $\alpha = 0$, and as

$$\frac{d\left[E(\Pi_2) - E(\Pi_1)\right]}{d\alpha} = -2k\pi^2(1-\alpha)S\theta_g < 0,$$

the lead underwriter forms a diversified syndicate for all $\alpha \leq \alpha^*$ if $\alpha^* \leq 1$ and for all α if $\alpha^* > 1$. Moreover, $\alpha^* > 1$ is equivalent to $E(\Pi_2) - E(\Pi_1) > 0$ for $\alpha = 1$. This gives

$$\begin{aligned} E(\Pi_2) - E(\Pi_1)|_{\alpha=1} = & -\pi\theta_g S\left[(1-\pi) + \pi k\right] \\ & +\lambda\left[f(1) - f(1-\pi^2)\right]. \end{aligned} \tag{A.22}$$

This expression is positive if and only if

$$\lambda > \frac{S\theta_g\pi\left[(1-\pi) + \pi k\right]}{f(1) - f(1-\pi^2)} \tag{A.23}$$

This means that when λ is high enough, the lead underwriter always prefers a diversified syndicate. Otherwise, the lead underwriter only forms a diversified syndicate when α is lower than α^*.

Analyzing the role of π on the region of diversification is less trivial. I first compute the derivative of the difference in benefits with respect to π.

$$\frac{d\left[E(\Pi_2) - E(\Pi_1)\right]}{d\pi} = -\alpha S\theta_g\left[(1-2\pi) + 2(2-\alpha)k\pi\right] + 2\pi\lambda f'(1-\pi^2)$$

This derivative is negative when $\pi = 0$. Moreover, when $\pi = 0$, $E(\Pi_2) - E(\Pi_1) = 0$. This means that this difference decreases when one rises a little bit from 0. However, for all $\lambda \geq \lambda^*$, one have

$$\frac{d\left[E(\Pi_2) - E(\Pi_1)\right]}{d\pi} \geq S\theta_g\left[\alpha + (2\alpha(2-\alpha)k\pi + 2(1-\pi))\left(\frac{\pi^2 f'(1-\pi^2)}{f(1) - f(1-\pi^2)} - 1\right)\right] \geq 0$$

Indeed, as $f''(.) \leq 0$, I have $\left(\frac{\pi^2 f'(1-\pi^2)}{f(1)-f(1-\pi^2)} - 1\right) \geq 0$.

This means that if there exists π^* such that $E(\Pi_2) - E(\Pi_1)$ is non negative, for all $\pi \geq \pi^*$, $E(\Pi_2) - E(\Pi_1)$ is non negative. Let me add that such a π^* exists if and only if $E(\Pi_2) - E(\Pi_1) > 0$ for $\pi = 1$, or

$$\begin{aligned} E(\Pi_2) - E(\Pi_1)|_{\pi=1} = & -\alpha\theta_g S\left(2-\alpha\right)k \\ & +\lambda\left[f(1) - f(0)\right] > 0 \end{aligned} \tag{A.24}$$

This gives

$$\lambda > \frac{S\theta_g \alpha (2-\alpha) k}{f(1) - f(0)} \tag{A.25}$$

Thus, when λ is high enough, there exists π^* such that the lead underwriter composes a diversified syndicate for π higher than π^*. Otherwise, the lead underwriter never forms a diversified syndicate.

Finally, one can check that λ^* is increasing in k and in α and is decreasing in π. In the same way, k^* is increasing in λ and in π and is decreasing in α. ■

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