Financing and managerial support with (some) optimistic entrepreneurs[1]

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Abstract

This paper analyses optimal financing and advising contracts between potentially optimistic entrepreneurs and potentially supportive financiers. The presence of optimistic entrepreneurs (who may overestimate their managerial abilities) leads realistic financiers to bring managerial support even if entrepreneurs are self-confident in their abilities, i.e. even if they believe they don't need support. Because of the suspicion of optimism, self-confident entrepreneurs are denied access to pure debt finance. When the suspicion of optimism is low, self-confident entrepreneurs select securities with more debt-like features (i.e. less support from the financier, higher downside protection and lower upside potential for the financier) than the ones selected by self-unconfident entrepreneurs. However, the prevalence of entrepreneurial optimism renders more difficult for self-confident entrepreneurs to signal themselves through the choice of financing contracts and favors the selection of a "one-fit all contract" that combines high downside protection and moderate upside potential for the financier.

1 Introduction

It is now commonly accepted that many entrepreneurs overestimate their chances of success (Cooper et al. 1988, Landier and Thesmar 2009). This upward bias would be primarily due to the fact that a large fraction of entrepreneurs are "self-enhancers" and overestimate their ability to manage a new venture (Koellinger et al. 2007, Townsend et al. 2010). Another common finding is that venture capital (VC) financing positively affects new venture performance. This extra performance is often attributed to the dual role of VCs that bring both financial resources and management expertise to their portfolio companies (Gorman and Sahlman 1989, Hellmann and Puri 2002).

Since optimism in managerial abilities is pervasive among entrepreneurs and VCs are supposed to bring management expertise to entrepreneurial firms, it is logical to investigate how potentially optimistic entrepreneurs interact with potentially supportive financiers. Still, little is known about this interaction. For instance, why entrepreneurs would be interested by the supporting activity of VCs if they believe having the necessary skills to succeed on their own? To the extent that there is group-level variation in the accuracy of entrepreneurs' beliefs about their own management skills, how entrepreneurs and investors shape the design of financing contracts under the risk of unrealistic optimism?

In this paper, we answer these questions by developing a model examining how the presence of optimistic entrepreneurs affects optimal contracting by the whole population of entrepreneurs (optimistic and realistic ones). Our model starts from a classical cash-flow rights/ "double-sided moral hazard" framework where an entrepreneur seeks to finance his venture by proposing a contract to a financier and where both agents choose to exert an effort after contracting (Casamatta 2003, Schmidt 2003). We introduce two additional ingredients based on certain stylized facts. First, in contrast with existing double-moral hazard models, we consider that the investor's supporting effort does not always add value. Investor activism increases firm value and is complementary with entrepreneurial effort in the only case when the entrepreneur lacks management expertise.[1] The second important assumption states that some

[1] The idea that the value added by investor support decreases with the entrepreneur's managerial skills is indirectly corroborated by the findings that less experienced entrepreneurs tend to value more VC advice (Barney et al. 1996) and that VCs typically focuse on firms founded by scientists who lack management expertise (Baum and Silverman 2004, Colombo and Grilli 2010, Petty and Gruber 2011).

but not all entrepreneurs overestimate their managerial abilities.[2] Before contracting, each entrepreneur forms beliefs about his skills and can be either *self-confident* or *self-unconfident*. These beliefs depend on the entrepreneur's psychological type. An *optimist* is always self-confident irrespective of his true ability. In contrast, a *realist* correctly assesses his managerial skills. It follows a divergence in opinion between a self-confident entrepreneur and a realistic financier. Whereas the former is sure that he is skilled, the financier is more doubtful and considers the risk that the self-confident entrepreneur exhibits *unrealistic optimism* (which is the case of an entrepreneur who is jointly unskilled and optimistic).[3]

In this setup, the main insight of our model is to show that the presence of some optimistic entrepreneurs impedes the "natural" equilibrium where self-confident entrepreneurs sell pure-debt contracts that limit investor involvement and where self-unconfident issue equity-like contracts that give investors high incentives to provide non-financial support. Not only, self-confident entrepreneurs, among which optimistic ones, have never access to pure debt financing but also all the entrepreneurs issue the same "one-fit-all" mixed security when optimism is highly prevalent.

When investors observe entrepreneurial self-confidence, self-confident entrepreneurs, even if they prefer issuing straight debt and contracting with a passive investor, are obliged to issue a mixed security that gives some upside to the financier and that involves a minimal level of investor activism. This security, while including an equity component, has more debt-like features (i.e. higher downside protection and lower upside for the investor, less investor involvement) than the one adopted by self-unconfident entrepreneurs. Two points are to be made here. In our model, the reason why self-confident entrepreneurs prefer debt is somewhat different from the ones invoked in the literature. Self-confident (and possibly optimistic) entrepreneurs do not prefer debt because they believe that their companies risky securities

[2] While entrepreneurial optimism is common, it is not universal. For instance, Landier and Thesmar (2009) compare expectations of a large sample of French entrepreneurs on future sales and employment to ex post realized outcomes. They find that the fraction of entrepreneurs who underestimate venture growth is higher than the fraction of those who overestimate growth.

[3] The distinction between self-confidence, optimism and unrealistic optimism (or overoptimism) is similar to the one used by psychologists. Self-confidence is similar to the concept of self-efficacy which represents the self-perception of having the necessary skills to complete a given task (Bandura 1982). Optimism is similar to dispositional optimism defined as the generalized positive expectancy that one will experience good outcomes (Scheier and Carver 1985). Finallly, unrealistic optimism refers to the fact that inviduals in general and entrepreneurs in particulars tend to have positive illusions about themselves (Weinstein 1980).

are undervalued by external capital providers (Heaton 2002), but because they believe that financier involvement is wasteful, i.e. both costly and without any effect on firm value. Despite his certainty of being highly-skilled and his preference for contracting with a passive creditor, a self-confident entrepreneur is however unable to signal his realism and recognizes that he is part of a group in which the financier suspects the presence of unrealistic optimists.[4] This suspicion of unrealistic optimism explains why optimists and more generally self-confident entrepreneurs cannot issue straight debt and rather sell a mixed security. While this security always provides strong downside protection to investors, its equity component is stronger, investors receive more upside and are more active when the suspicion of unrealistic optimism increases. This security resembles US-style venture capital contracts that take most of the time the form of convertible debt or convertible preferred securities with strong downside protection (Kaplan and Strömberg 2003, 2004).

In an adverse selection setting where entrepreneurial self-confidence is not observed directly by investors, self-unconfident entrepreneurs may have incentives to issue the same security than self-confident ones. Such a mimicking strategy is however a double-edged sword. On the one hand, it may reduce payments to the financier because self-confident entrepreneurs have on average higher managerial capacities than self-unconfident ones. On the other hand, adopting the same poorly-supportive contract than self-confident entrepreneurs reduces the chances of success of unskilled/ self-unconfident entrepreneurs. In this setting, we show that two regimes arise. When there are few optimistic entrepreneurs and/or when the productivity of financier effort is high, self-confident and self-unconfident entrepreneurs issue differentiated contracts which are debt-like and equity-like respectively. In contrast, when optimism is very common and/or when the productivity of financier effort is low, both types of entrepreneurs select the same "one-fit-all" mixed security that is characterized by high downside protection and intermediate upside for the investor and that induces moderate investor activism. Importantly, the possibility for self-confident entrepreneurs to signal themselves through the design of contracts does not only depend on the intensity of unrealistic optimism but also on its origin. For a given suspicion of unrealistic optimism, self-confident entrepreneurs separate more easily

[4] In conformity with this idea, Kaplan and Strömberg (2004) find that management quality is the primary source of internal risk perceived by VCs and notice that internal risk may measure managerial overconfidence as ascertained by VCs.

from self-unconfident ones when they are primarily suspected of being unskilled rather than optimistic.

Our model generates a set of implications about both the nature and the diversity of interactions between investors and entrepreneurs. Consider for instance our key result, i.e. the fact that financing and advising contracts should be less differentiated when entrepreneurial optimism is high. Precise empirical predictions can be derived by identifying the factors that may influence the intensity of entrepreneurial (over)optimism. Two such factors have been identified. First, experienced entrepreneurs tend to be less prone to unrealistic optimism that novice ones (Parker 2006, Koellinger et al. 2007). Then, our model predicts that less experienced entrepreneurs should tend to issue a "one-fit-all" mixed security whereas more experienced entrepreneurs should issue more differentiated securities according to their self-confidence. A second factor that may influence entrepreneurial optimism is national culture. Recent research suggests that (national) culture affects cognition. People in general (Markus and Kitayama 1991, Heine et al. 1999) and investors in particular (Chui et al. 2010) tend to be more prone to self-enhancement, unrealistic optimism and overconfidence in countries where individualism, a national index, is higher. Koellinger et al. (2007) also report large cross-variations in entrepreneurs' perceptions about their own skills and optimism. On the ground of these results, another prediction of our model is that self-confident and self-unconfident entrepreneurs should be more prone to issue the same "one-fit-all" mixed security with strong downside protection for investors in countries where individualism is high. This could provide a novel explanation on the stylized fact that VCs use almost one type of security, i.e. convertible preferred security, in certain countries while using a greater variety of securities in other countries (Cumming 2005, Lerner and Schoar 2005).

Ours is not the first paper to explore the impact of optimism on financing choices. Heaton (2002) and Hackbarth (2008) have proposed models in which optimistic managers prefer debt rather than equity financing, a prediction in line with the empirical findings of Malmendier et al. (2005). There are three key differences with our analysis. First, in contrast to these models, we consider that investors can bring non-financial support to their portfolio companies. Second, we consider a different rationale for why optimists prefer debt, i.e. because they underestimate the value added by investors' non-financial support. Third, we show that optimists have no other choice but to issue a security with a minimal equity component when confronted to supportive financiers.

Some other theoretical papers analyze the impact of optimism on the design of debt contracts or on the investment choice of entrepreneurs. In an adverse selection setting, Landier and Thesmar (2009) show the existence of a separating equilibrium where optimists self-select into short-term debt and realists into long-term debt. A key assumption in their model is that entrepreneurs are risk-averse, which explains why realists prefer long-term debt. There are other important differences. The most obvious one is that they focuse on non-supportive financiers. Also, they focuse exclusively on separating equilibria whereas our analysis of pooling equilibria allows us to determine in which circumstances it will be optimal for firms to distort their financing contracts. Manove and Padilla (1999) show that the presence of optimists makes difficult for realists to signal their type through collateral and affects the investment policy of realists. Like ours, their paper considers the problem of optimism through a market equilibrium approach. However, their setup is quite different from ours in that they consider only passive financiers.

Lastly, there exists an extended literature on the design of optimal contracts in a double-moral hazard context (Casamatta 2003, Schmidt 2003, Chemmanur and Chen 2006). Like ours, these models consider the need to give the financier incentives to add value to the firm while maintaining the incentives of the entrepreneur to exert effort. However, none of these models consider explicitly that some entrepreneurs are optimistic.

The rest of the paper is organized as follows. Section 2 contains the basic model. Section 3 examines optimal contracts when financiers observe entrepreneurs' self-confidence. Section 4 deals with the case where financiers cannot observe directly entrepreneurs' self-confidence. Section 5 discusses the empirical implications of our theory and provides some extensions. Section 6 concludes. All proofs are in the appendix.

2 The basic model

We consider an entrepreneur (EN) who seeks to finance a project that requires a fixed initial investment $I > 0$. The EN is characterized by his psychological type and by his ability to manage the project. The EN may be a realist (R) or an optimist (O) with probabilities γ

and $(1-\gamma)$ respectively. ENs may also differ according to their ability to manage the project without external support. The EN may be a good manager (G) or a bad manager (B) with probabilities θ and $(1-\theta)$.

The EN cannot observe directly his managerial abilities before implementing the project. He rather observes a signal $s = g, b$. If the signal is g, the EN infers that he is a good manager and is *self-confident*. In contrast, the EN receiving a b-signal believes that he is a bad manager and is considered as *self-unconfident*. The value of the signal depends both on the actual skills of the EN (G,B) and on his psychological type (R,O). A *realist* always observes a signal that corresponds to his actual managerial skills while an *optimist* always observes a good signal:

$$\Pr(g|\, R, G) = \Pr(b|\, R, B) = 1, \Pr(g|\, O) = 1 \tag{1}$$

The EN always believes that he is a realist and hence always considers the signal he observes as perfectly informative.[5]

After having observed the signal s, the EN proposes a contract to the financier that specifies the allocation of cash flow rights depending on the project's final return. We consider that the project's final return is X^H if the project is successful and X^L in case of failure (with $X^L < X^H$). We denote by $\Delta X = X^H - X^L > 0$ the project's differential revenue between success and failure. The financing contract is characterized by α_H^s, the share of the project's final revenue obtained by the EN with a s-signal in case of success (if the project's revenue is X^H), and by α_L^s, the share of the project's revenue obtained by the EN in case of failure (if the project's revenue is X^L).

After contracting, the investor and the EN choose simultaneously their effort level. Both efforts are assumed to be non-contractible and will only take place if agents are given appropriate incentives to make effort. More precisely, we note m the intensity of the financier's effort (with $m \in [0,1]$) and $\frac{km^2}{2}$ the associated cost of effort. We consider only two levels of effort for the EN: whether the EN exerts effort and incurs a cost e; alternatively, the EN exerts no effort and supports no cost.[6]

[5] This way of modelling optimism (and realism) is similar to Manove and Padilla (1999) and Dushnitsky (2010).

[6] The modelisation of the financier's and of the entrepreneur's efforts is similar to Chemmanur and Chen (2006).

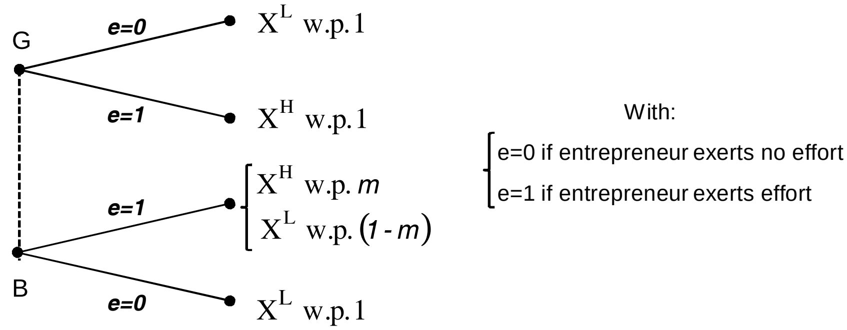

Figure 1: Project payoff structure

The project's final return depends both on the EN's managerial ability (G or B) and on the joint effort of the EN and the financier (see figure 1).[7] The project's payoff is always low (X^L) if the EN makes no effort. If the EN exerts effort, the project's final revenue depends on the EN's managerial ability and on the financier's effort. When the EN is a good manager, the project yields a high payoff X^H with probability one whatever the financier's effort. When the EN is a bad manager, the project yields a high payoff X^H with probability m and a low payoff X^L with probability $(1-m)$. We follow here some previous theoretical models (Casamatta 2003, Repullo and Suarez 2004, Chemmanur and Chen 2006) by assuming that the financier has a management support role. However, in our setting, this support role increases the venture's value in the only case where the EN's skill level is low.

With this payoff structure in mind, it is straightforward to characterize the ENs' preferences when they come to choose their financing contract. The self-confident EN ($s = g$) prefers a contract with less support from the financier because he believes that financier involvement adds no value to his venture. On the contrary, the self-unconfident EN ($s = b$) prefers a contract that induces more financier involvement in the management of the firm. Also, depending on the signal they receive, ENs have different preferences about the allocation of cash flows. When $s = g$, the EN does not consider failure as possible and has incentive to select a contract that gives the financier the entire project's revenue in case of failure. On the contrary, the EN with a b-signal knows that failure is possible even if the financier provides support. Then,

[7] We assume implicitly here that all the ENs have similar high-quality projects (and that investors observe this quality). In reality, both the intrinsic quality of the project and the venture's human capital may determine the final output. We will discuss later the consequences of relaxing this assumption (see section 5.3).

the self-unconfident EN with is more reluctant than the self-confident one to dedicate all the project's revenues to the financier in case of failure.

Because our model is based on the premise that some ENs overestimate their managerial abilities whereas financiers are realistic, the EN might disagree with the actions that the financier would like to implement.[8] In this case, we assume that the financier has sufficient control rights to carry out those actions against the will of the EN. The consequences of relaxing this assumption is analyzed later (see Section 5).

We note r the financiers' (dollar) net opportunity cost of capital and R the cost for the financier to invest I in the firm, i.e. $R = (1 + r)I$. We assume that, without any support from the financier, only ENs with high managerial ability should be financed:

Assumption 1: $X^L < R < X^H - e$

The information structure of the model is the following. At the time the financing contract is signed, neither the EN nor the financier can observe directly the EN's managerial ability nor his psychological type. The signal s, which represents the degree of entrepreneurial self-confidence, is the EN's only information before contracting. The question is then to determine precisely the status of this signal. In other words, is this signal the EN's private information or is this signal observable by the financier? In the first part of the paper (section 3), we consider that investors observe directly entrepreneurial self-confidence (s). Even if there is no asymmetric information in this case, optimal contracting is affected by potential *asymmetric interpretation of information* between investors and self-confident ENs. In the second part of the paper (section 4), we consider instead that the signal s is the EN's private information. In this setting, the interactions between investors and entrepreneurs are influenced both by *asymmetric information* and by *asymmetric interpretation of information.*

The sequence of events is the following:

(a). Nature chooses the psychological type of the EN and his managerial ability. The EN is a realist w.p. γ and an optimist w.p. $(1 - \gamma)$. The EN is a good manager w.p. θ and a bad manager w.p. $(1 - \theta)$. Probabilities γ and θ are known by everybody.

[8] In conformity with this idea, Sahlman (1997) asserts: "*Typically, they (entrepreneurs) are wildly optimistic, padding their projections. Investors know about the padding effect and therefore discount the figures in business plans.*" (p.98). He also notices that "*...entrepreneurs looking to finance their ventures...are also looking for investors who will remain as passive as a tree while they go about building their businesses* "(p.107).

(b). The EN neither observes his psychological type nor his ability. He is certain of being a realist. In order to evaluate his ability he receives a signal $s = g, b$ from Nature. The signal is bad ($s = b$) with probability $\gamma(1-\theta)$ and good ($s = g$) with probability $1-\gamma(1-\theta)$. We will consider two alternative settings concerning the information of the financier. In section 3, the financier observes the signal s. Alternatively, we will consider in section 4 that the signal s is the EN's private information.

(c). After having observed s, the EN chooses a contract in order to finance his project. In exchange of an amount I, the contract proposes to pay $(1-\alpha_H^s)X^H$ to the financier in case of success and $(1-\alpha_L^s)X^L$ in case of failure.

(d). The EN and the financier simultaneously choose the intensity of their effort. The EN exerts an effort or not. If he exerts effort, he incurs a cost e. The financier chooses m, the intensity of his support activity. He incurs a cost $\frac{km^2}{2}$.

(e). The project's final payoff is realized and is shared between the EN and the financier conforming to the contract signed at stage (c).

3 Optimal contracts with symmetric information about entrepreneurial self-confidence

We start with the case when the financier knows the EN's self-confidence at the time of contracting, i.e. when the financier observes the signal s. Depending on the value of the signal, both agents may have similar or divergent opinions on the EN's management skills and on the required level of managerial support.

Consider first the case of a self-unconfident EN ($s = b$). In this case, the EN and the financier have similar opinions since they are both sure that the self-unconfident EN is a realist (R) with low managerial skills (B). The optimal contract for the self-unconfident EN is the solution to the following problem:

$$\underset{\alpha_H^b,\alpha_L^b}{Max} \quad m^b\alpha_H^b X^H + \left(1-m^b\right)\alpha_L^b X^L - e \tag{2}$$

$$m^b \in \arg\max\left\{m^b\left(1-\alpha_H^b\right)X^H + \left(1-m^b\right)\left(1-\alpha_L^b\right)X^L - \frac{k\left(m^b\right)^2}{2}\right\} \tag{3}$$

$$m^b\alpha_H^b X^H + \left(1-m^b\right)\alpha_L^b X^L - e \geq \alpha_L^b X^L \tag{4}$$

$$m^b\left(1-\alpha_H^b\right)X^H+\left(1-m^b\right)\left(1-\alpha_L^b\right)X^L-\frac{k\left(m^b\right)^2}{2}\geq R \tag{5}$$

$$m^b\alpha_H^bX^H+\left(1-m^b\right)\alpha_L^bX^L-e\geq 0 \tag{6}$$

$$0\leq\alpha_H^b\leq 1 \text{ and } 0\leq\alpha_L^b\leq 1 \tag{7}$$

Here, (2) represents the objective of the self-unconfident EN. The financier's and the EN's incentive compatibility constraints are given by (3) and (4) respectively. Equations (5) and(6) are the participation constraints of the financier and of the EN respectively. Lastly, (7) are limited liability constraints.

Being aware of the EN's low managerial abilities, both agents agree on the fact that the self-unconfident EN needs intensive support. As a benchmark, we compute the first-best level of managerial support m_{FB}^b, i.e. the one that would prevail if the investor's effort were contractible. This first-best effort maximizes the social value of the venture managed by a self-unconfident EN, which is:

$$m^bX^H+\left(1-m^b\right)X^L-\frac{k\left(m^b\right)^2}{2}-R-e \tag{8}$$

The first-order condition yields:

$$m_{FB}^b=\frac{\Delta X}{k} \tag{9}$$

We assume that $\Delta X\leq k$. Logically, the first-best level of support depends on the investor's ability to increase the value of the venture (ΔX) and on the cost of investor involvement (k). It may be considered as a measure of the investor's capacity to add value to a venture managed by an unskilled EN.

In reality, efforts are not contractible and the investor chooses the intensity of his supporting effort according to (3). The equilibrium management support provided to a self-unconfident is then:

$$m^{b*}=\frac{\left(1-\alpha_H^b\right)X^H-\left(1-\alpha_L^b\right)X^L}{k}=\frac{P^{b*}}{k} \tag{10}$$

where $P^{b*} = \left(1-\alpha_H^b\right)X^H - \left(1-\alpha_L^b\right)X^L$ represents the additional compensation received by the financier for a successful venture. This additional compensation can also be interpreted as the incentive package allocated to the financier. By definition, P^{b*} cannot be higher than ΔX. Moreover, P^{b*} must be strictly less than ΔX because otherwise the EN's incentive compatibility constraint would not hold. This implies that investor support is less than the first-best level, i.e. $m^{b*} \leq m_{FB}^b$.

In order for the project to be financed, the social value of the project with the equilibrium levels of EN's and investor's efforts must be positive:

$$\frac{P^{b*}}{k}\Delta X - \frac{\left(P^{b*}\right)^2}{2k} - e - \left(R - X^L\right) \geq 0 \tag{11}$$

where $R - X^L$ represents both the financier's loss if the EN and/or the financier exert no effort and the (negative) NPV of the project if an unskilled EN manages the project without any support from the financier. The term $\frac{P^{b*}}{k}\Delta X - \frac{\left(P^{b*}\right)^2}{2k} - e$ represents the net marginal value created by both agents exerting effort at equilibrium. In the rest of the paper, we will assume that (11) always holds and that even an unskilled EN should be financed.[9] Note that this condition is satisfied if the increased payoff that could be generated by both agents' efforts is sufficiently high as regard to both agents' costs of effort, that is ΔX is high in comparison with k and e. In the rest of the paper, we will also consider that the net marginal value created by both agents exerting effort is limited upward.[10] In summary, we assume that:

Assumption 2: $R - X^L \leq \frac{P^{b*}}{k}\Delta X - \frac{\left(P^{b*}\right)^2}{2k} - e \leq R$

We derive now the optimal contract between the self-unconfident EN and the financier.

Proposition 1 *When information about entrepreneurial self-confidence is symmetric, the optimal contract C^{b*} between the self-unconfident EN ($s = b$) and the investor takes the following form:*

[9] In our setting, we assume that financiers have already screened the quality of the projects. Then, even a poorly skilled manager holds a high-quality project and should be financed.

[10] If the net marginal value created by both agents exerting effort were very high, i.e. if $\frac{P^{b*}}{k}\Delta X - \frac{\left(P^{b*}\right)^2}{2k} - e > (1+r)\,I$, the contract described in proposition 1 would not work. This is because this contract would set a too high incentive package for the financier and would imply $1 - \alpha_L^{b*} < 0$, which is impossible as regard to the limited liability constraints. In this particular case, the optimal contract would be set such that $1 - \alpha_L^{b*} = 0$. The proofs and the precise description of the optimal contract when the net marginal value created by both agents exerting effort is very high are available on demand.

(a). The incentive package for the investor is $P^{b*} = \frac{\Delta X + \sqrt{(\Delta X)^2 - 4ke}}{2}$ *and the intensity of investor support is* $m^{b*} = \frac{P^{b*}}{k} \leq m^b_{FB}$

(b). The investor receives a fraction $\left(1 - \alpha_L^{b*}\right) = \frac{R - \frac{\left(P^{b*}\right)^2}{2k}}{X^L}$ *of the venture's cash-flows in case of failure and a fraction* $\left(1 - \alpha_H^{b*}\right) = \frac{R + P^{b*} - \frac{\left(P^{b*}\right)^2}{2k}}{X^H}$ *in case of success.*

(c). The self-unconfident EN has an expected payoff: $\Pi^{b*} = \alpha_L^{b*} X^L = \frac{\left(P^{b*}\right)^2}{2k} - \left(R - X^L\right)$

Clearly, the security issued by the self-unconfident EN has a strong equity-like component. The contract C^{b*} allocates a substantial part of the cash-flows to the investor in case of success and provides him only limited downside protection in case of failure (because $1 - \alpha_L^{b*} < 1$). This equity-like orientation gives the investor high incentives to provide effort and induces high investor involvement (P^{b*} and m^{b*} are high). Furthermore, this involvement increases in the investor's capacity to add value to a venture managed by an unskilled EN (m^b_{FB}). This result is quite logical here because in a symmetric information framework the self-unconfident EN and the investor agree on the fact that managerial support is valuable. However, two factors limit the intensity of support. First, the marginal cost of support is an increasing function of its intensity. Furthermore, P^{b*} and m^{b*} are bounded above by the fact that in our double-moral hazard environment the EN has to receive sufficient monetary incentives to make effort. This explains in particular why the contract C^{b*} provides (limited) downside protection to the investor. Indeed, attributing a large stake of cash flows to the EN in case of failure, i.e. $\alpha_L^{b*} \to 1$ and $\left(1 - \alpha_L^{b*}\right) \to 0$, would destroy the EN's incentive to make an effort.

Consider next the case when the EN is self-confident in his management skills. When $s = g$, the EN is convinced of being a good manager (G) and believes that his conditional probability of success is equal to 1. Recognizing that a self-confident EN may be an unrealistic optimist, a realistic financier interprets a g-signal differently and estimates that a self-confident is a good manager w.p. $\Pr\left(G|\, g\right) = \frac{\theta}{(1-\gamma)(1-\theta)+\theta} \leq 1$ and a bad one w.p. $\Pr\left(B|\, g\right) = \frac{(1-\gamma)(1-\theta)}{(1-\gamma)(1-\theta)+\theta} \geq 0$. In the rest of the paper, we will denote by $\phi \equiv \Pr\left(B|\, g\right) = \frac{(1-\gamma)(1-\theta)}{(1-\gamma)(1-\theta)+\theta}$ this conditional probability. Strictly speaking, ϕ represents the probability, as ascertained by the financier, of a self-confident EN being overly optimistic about his managerial skills. It can also be interpreted as a measure of the divergence of opinions between the financier and the self-confident EN and of the internal risk faced by the financier when confronted to a self-confident EN (Kaplan and Strömberg 2004). Recall also that the financier is supposed to hold sufficient control rights to influence the operating decisions of the venture even if the EN disagrees with those decisions.[11]

The optimal contract C^{g*} designed by the self-confident EN is the solution of the following program:

$$\underset{\alpha_H^g,\alpha_L^g}{Max} \ \alpha_H^g X^H - e \tag{12}$$

$$m^g \in \arg\max\left\{(1-\phi)\left(1-\alpha_H^g\right)X^H + \phi\left[m^g\left(1-\alpha_H^g\right)X^H + (1-m^g)\left(1-\alpha_L^g\right)X^L\right] - \frac{k(m^g)^2}{2}\right\} \tag{13}$$

$$\alpha_H^g X^H - e \geq \alpha_L^g X^L \tag{14}$$

$$(1-\phi)\left(1-\alpha_H^g\right)X^H + \phi\left[m^g\left(1-\alpha_H^g\right)X^H + (1-m^g)\left(1-\alpha_L^g\right)X^L\right] - \frac{k(m^g)^2}{2} \geq R \tag{15}$$

$$\alpha_H^g X^H - e \geq 0 \tag{16}$$

$$0 \leq \alpha_H^g \leq 1 \text{ and } 0 \leq \alpha_L^g \leq 1 \tag{17}$$

where (12) represents the subjective expected profit of the g-EN; (13) and (14) are the incentive compatibility constraints for the financier and the EN respectively; (15) and (16) are the individual rationality constraints for the financier and the EN. Lastly, (17) represents limited liability constraints.

The first element that influences the design of the optimal contract is the self-confident EN's certainty of being a good manager (see(12)). With this belief, it is immediate that a self-confident EN has more incentives to exert effort than a self-unconfident EN who knows that failure is possible even if he incurs e. This explains why the self-confident IC constraint (14) is not binding in C^{g*} whereas the self-unconfident IC contraint (4) was binding in C^{b*}. Being certain of success, the self-confident EN is also prone to abandon all the cash-flow rights to the financier in case of failure.

The second influential element is the divergence of opinion concerning the need for managerial support. The self-confident EN believes that success is guaranteed without any help

[11] One important implication is that the financier's support activity may add value to the venture even if the self-confident EN believes that VC advice is useless. We relax this assumption in section 5 (see proposition 7).

from the investor. Support being costly, he would then prefer to deal with a perfectly passive investor, i.e. $m^g = 0$. The self-confident however knows that he is part of a group in which the financier suspects the presence of unrealistic optimists, i.e. $\phi > 0$. This suspicion has a direct effect on the intensity of the financier's effort since by (13):

$$m^{g*} = \frac{\phi P^{g*}}{k} \tag{18}$$

Finally, the self-confident EN has not other choice but to recognize that a higher-than-preferred investor involvement, i.e. $m^{g*} > 0$ if $\phi > 0$, is necessary to satisfy the investor's participation constraint. Under this constraint, he minimizes investor involvement by setting the lowest possible P^{g*}. This is done by issuing a security that gives the highest possible downside protection to the financier, i.e. by setting $1 - \alpha_L^{g*} = 1$.

Proposition 2 *When information about entrepreneurial self-confidence is symmetric, the optimal contract C^{g*} between the self-confident EN ($s = g$) and the financier takes the following form*

(a). The incentive package for the investor is $P^{g*} = \frac{k}{\phi^2}\left[\sqrt{d_g} - (1-\phi)\right]$ *with* $d_g = [1-\phi]^2 + \frac{2\phi^2}{k}\left(R - X^L\right)$ *and the intensity of investor support is* $m^{g*} = \frac{\phi P^{g*}}{k}$

(b). The investor receives a fraction $\left(1 - \alpha_L^{g*}\right) = 1$ *of the venture's cash-flows in case of failure and a fraction* $\left(1 - \alpha_H^{g*}\right) = \frac{X^L + P^{g*}}{X^H}$ *in case of success.*

(c). The self-confident EN's subjective expected payoff is: $\Pi^{g*} = \Delta X - P^{g*} - e$

Importantly, Proposition 2 illustrates the fact that self-confident ENs perceive that the presence of optimists unduly increase their cost of financing. If the proportion of optimists was negligible, the suspicion of unrealistic optimism would be very low (ϕ tends to 0 when $1-\gamma$ tends to 1), and the financier's incentive package P^{g*} would tend to $R - X^L$ whatever the proportion $1-\theta$ of ENs with poor managerial skills (see Corollary 1 hereafter). With the supposed presence of optimists, the self-confident EN must propose a package $P^{g*} > R - X^L$. This is clearly for him a wasted cost as his (perceived) expected payoff Π^{g*} is a decreasing function of P^{g*}, illustrating the fact that the EN believes here that the financier cannot bring any value-added services. Also, we show in the appendix that P^{g*} is an increasing function of the internal risk ϕ. In our setting, this result confirms the idea that ENs with a g-signal perceive optimism (of other entrepreneurs) to have a negative impact on their own welfare.[12]

Corollary 1 *In the optimal contract C^{g*}, P^{g*} increases with ϕ and tends to $R - X^L$ when ϕ tends to* 0*.*

The following proposition summarizes the main differences between the contract adopted by self-unconfident ENs (C^{b*}) and the one adopted by self-confident ENs (C^{g*}).

Proposition 3 *The financier receives a higher incentive package and is a more supportive partner when contracting with a self-unconfident EN rather than with a self-confident EN, i.e. $P^{b*} \geq P^{g*}$ and $m^{b*} \geq m^{g*}$. The contract C^{b*} has more equity-like features (higher investor involvement and higher upside for the investor) and the contract C^{g*} has more debt-like features (less investor involvement and higher downside protection for the investor). The higher the proportion of (unrealistic) optimists in the population, the higher is the investor's involvement in the management of firms conducted by self-confident ENs.*

These results can be confronted with the existing literature dedicated to the design of VC contracts and to the choice between VC and debt contracts. Studies of US venture capital contracts show that investor contracts take most of the time the form of convertible debt or convertible preferred securities that give high downside protection for the financier (Kaplan and Strömberg 2003, 2004). This almost corresponds to the contract C^{g*} adopted by self-confident ENs. In contrast, the contract C^{b*} adopted by self-unconfident ENs has more equity-like features and resemble more common equities, a form of VC contract which is more often found outside the US (Kaplan et al. 2007). The fact that the optimal contract for self-confident ENs resembles more US style contracts than the one for self-unconfident ENs appears clearly by analyzing the empirical findings of Kaplan and Strömberg (2003). They find that US VC contracts typically allocate a lower stake of cash-flow rights to the VC under good performance compared to the bad performance state. This is precisely what we find in the contract C^{g*} where $\left(1-\alpha_H^{g*}\right) < \left(1-\alpha_L^{g*}\right)$. In contrast, the optimal contract C^{b*} for self-

[12] A crucial point of our model is that self-confident ENs are sure that they are good managers even if they recognize that some self-confident ENs are optimists and bad managers. In other words, each self-confident EN believes himself being more skilled than the "average" self-confident EN. This corresponds to the stylized fact that individuals in general and ENs in particular tend to believe that they are better-than-average (Camerer and Lovallo 1999).

unconfident ENs does not systematically imply that $\left(1-\alpha_H^{b*}\right) < \left(1-\alpha_L^{b*}\right)$. This is because the self-unconfident EN wants to give high incentives to the financier but optimally prefers a contract that leaves him with a relatively high payoff in case of failure (low $1-\alpha_L^{b*}$).[13]

Importantly, the reasons governing the design of financing contracts in our model are partially different from the ones advanced in previous theories. Like ours, several theories justify the use of mixed securities in VC contracts by the need to give both agents incentives to put in effort (Casamatta 2003, Schmidt 2003). In these models, the debt component of the security gives the VC a high downside protection and enhances the EN's incentive to exert effort, while the equity component increases the VC's incentive to provide effort. In our model, the investor's high downside protection in the contract C^{g*} is not only driven by the need to give ENs high powered incentives but but also by the self-confident EN's desire to limit investor involvement. This is because, in the eyes of the self-confident EN, investor assistance is perceived as useless and unduly costly. However, we find that self-confident ENs have no other choice but to accept a minimal level of assistance because of the suspicion of unrealistic optimism.

Our results bring also some insights on the choice between debt financing and VC financing. In our model, self-confident ENs prefer contracts with more passive financiers and with higher downside protection for the financier. Put simply, self-confident ENs prefer debt financing rather than VC financing. While this result is not novel, the explanation is different from existing theories. Most of the time, this preference is explained by the fact that optimistic ENs attribute a higher value to their project than external financiers and prefer a debt-like contract that limits (perceived) undervaluation (Heaton 2002, Hackbarth 2008). Our theory considers instead that self-confident ENs (among which some are optimistic) prefer debt because this type of financing reduces financier activism in the course of business.

4 Optimal contracts with asymmetric information about entrepreneurial self-confidence

Assume now that the financier does not observe entrepreneurial self-confidence, i.e. the case where the signal s is the EN's private information. In this context, a self-unconfident EN

[13] In the contract C^{b*}, the case where $\left(1-\alpha_H^{b*}\right) < \left(1-\alpha_L^{b*}\right)$ is more likely to occur when the EN's cost of effort (e) is high, i.e when the EN must be given high incentives to exert effort (see the proof of Proposition 1).

may have incentive to adopt the same contract than a self-confident one. At first glance, such a mimicking strategy seems to be sub-optimal because the EN with a b-signal values more investor support than the EN with a g-signal. Then, mimicking should be costly for a self-unconfident and unskilled EN because it implies lower management support and a lower chance of success. On the other hand, mimicking could be beneficial because the average management skills of self-confident ENs are higher than the ones of self-unconfident ENs. Therefore, in certain cases, mimicking may decrease the payment demanded by the financier in order to finance the venture.

In this asymmetric information framework, we are looking for pure-strategy perfect Bayesian equilibria (PBE). In order to characterize these equilibria, define C^s as the contract chosen by the EN of type s with $s = g, b$. Let $\mu_0(s)$ and $\mu_0(i)$ be the prior probabilities that the EN is of type s and has managerial skills $i = G, B$ respectively. Let $\mu(s\,|C^s)$ and $\mu(i\,|C^s)$ be the beliefs of the financier on the EN receiving a s-signal and being a i-type manager after observing C^s. Each equilibrium will be summarized by the choice of contracts C^s and by the financier's posterior beliefs $\mu(s\,|C^s)$. As usual, a multiplicity of equilibria arises in our game since PBE does not impose any restrictions on the financier's beliefs following out-of-equilibrium contracts. To select the most likely equilibrium outcomes, we will restrict the set of out-of-equilibrium beliefs by jointly applying two well-known refinements: the "undefeated equilibrium" criterion (Mailath et al. 1993) and the D1 criterion (Cho and Kreps 1987, Cho and Sobel 1990).[14]

We proceed in three steps. We first identify the separating equilibria where both types of ENs issue different securities. We consider next the possibility that self-confident and self-unconfident ENs adopt the same pooling contract. In the final step, we show that our refinement criterion enables us to identify one unique equilibrium which, depending on the cost of the financier's effort on the intensity of optimism, is either separating or pooling.

4.1 Separating equilibria

We start by defining the conditions under which self-confident and self-unconfident ENs separate by issuing distinct types of securities, i.e. $C^g \neq C^b$. In this case, it is straightforward

[14] See Hoang and Ruckes (2011) and Nöldeke and Samuelson (1997) who also jointly use these two refinements. Appendix B provides further details on the joint implementation of these refinements in our setting.

that the financiers' beliefs upon observing the contracts proposed by ENs are similar to the ones prevailing in the symmetric information case. That is $\mu\left(g\left|C^{g}\right.\right)=1$, $\mu\left(g\left|C^{b}\right.\right)=0$, $\mu\left(B\left|C^{b}\right.\right)=1$ and $\mu\left(B\left|C^{g}\right.\right)=\phi$.

To determine whether there exists a separating equilibrium, we first need to check that a self-unconfident is better off by revealing his type and by issuing his symmetric information security C^{b*} rather than by mimicking the contract C^{g}. Denoting by $\Pi^{b}_{mim}\left(C^{g}\right)$ the expected payoff of the self-unconfident EN when he mimics the self-confident one, the truth-telling condition for the self-unconfident EN is given by:

$$\Pi^{b*}\geq\Pi^{b}_{mim}\left(C^{g}\right)\equiv m^{g}\alpha^{g}_{H}X^{H}+\left(1-m^{g}\right)\alpha^{g}_{L}X^{L}-e \tag{19}$$

This condition is equivalent to:

$$\underbrace{\left(m^{b*}-m^{g}\right)\alpha^{b*}_{H}X^{H}}_{\text{1}^{\text{st}}\text{ cost: lower support}}+\underbrace{\left(1-m^{b*}\right)\left(\alpha^{b*}_{L}-\alpha^{g}_{L}\right)X^{L}}_{\text{2}^{\text{nd}}\text{ cost: lower payoff if failure}}\geq\underbrace{m^{g}\left(\alpha^{g}_{H}-\alpha^{b*}_{H}\right)X^{H}}_{\text{Benefit: Higher payoff if success}} \tag{20}$$

The LHS of (20) represents the costs of mimicking. The first cost derives from the fact that the self-unconfident EN, in sharp contrast with the self-confident one, prefers a contract that induces high financier involvement, which implies $m^{b*}>m^{g}$. By mimicking, the self-unconfident EN loses the incremental gain associated to high financier involvement and has to assume a lower probability of success. The second cost of mimicking is due to the fact that the self-confident EN has incentives to provide more downside protection to the financier than the b-EN, which implies $\alpha^{b*}_{L}>\alpha^{g}_{L}$. On the other hand, the RHS of (20) shows that mimicking may be beneficial because the self-unconfident EN retains a higher part of cash-flows in case of success if he opts for C^{g} rather than for C^{b*} (i.e. $\alpha^{g}_{H}>\alpha^{b*}_{H}$).

The second truth-telling condition stipulates that a self-confident EN has no incentives to mimic a self-unconfident one:

$$\Pi^{g}\left(C^{g}\right)\geq\Pi^{g}_{mim}\left(C^{b*}\right) \tag{21}$$

It can be easily demonstrated that (21) always holds in any separating equilibrium (see the Appendix). This illustrates the fact that a self-confident EN has no incentives to issue a contract that induces the financier to provide high support.

As usual, there exist a multiplicity of separating equilibria in our game. However, it is immediate that one type of separating equilibrium defeats any other separating equilibrium. This separating equilibrium is the one where the b-EN adopts his symmetric information contract C^{b*} and where the g-EN opts for the contract that maximizes his expected payoff under conditions (13) to (17) and under the truth-telling conditions (19) and (21).[15]

In this setting, the next proposition shows that two distinct separating equilibria emerge depending on the cost k of financier support and on the suspicion ϕ of unrealistic optimism: an equilibrium where the self-confident EN separates with the same security C^{g*} than in the symmetric information case and an equilibrium where the self-confident EN separates with a contract C^g_{sep} that gives the financier more upside than C^{g*}.

Proposition 4 *There always exists a separating equilibrium when s is not observable:*

(i) If either (a) $k \leq k_{mim}$ or (b) $k > k_{mim}$ and $\phi \in [0, \phi'] \cap [\phi'', 1]$ with $\Pi^b_{mim}(C^{g*}, \phi') = \Pi^b_{mim}(C^{g*}, \phi'') = \Pi^{b*}$, there exists a separating equilibrium at (C^{g*}, C^{b*}) where both ENs issue the same securities than in the symmetric information case. This equilibrium defeats all the other separating equilibria.

(ii) If $k > k_{_{mim}}$ and $\phi \in \,]\phi', \phi''[$, i.e. when the separating equilibrium at (C^{g*}, C^{b*}) does not exist, there exists a separating equilibrium (C^g_{sep}, C^{b*}) that defeats all the other separating equilibria. The contract C^g_{sep} quoted by the self-confident EN has the following form: (a). the financier's incentive package is $P^g_{sep} = \frac{\Delta X}{2} + \frac{\sqrt{d_{sep}}}{2\phi}$ with $d_{sep} = \phi^2 (\Delta X)^2 - 4k\phi \left(\Pi^{b*} + e\right)$ and $P^g_{sep} > P^{g*}$.(b). The intensity of investor support is $m^g_{sep} = \frac{\phi P^g_{sep}}{k}$.(c). The fractions of the venture's cash-flows allocated to the investor are $\left(1 - \alpha^g_{L_{sep}}\right) = 1$ and $\left(1 - \alpha^g_{H_{sep}}\right) = \frac{X^L + P^g_{sep}}{X^H}$.(d). The g-EN's subjective expected payoff is: $\Pi^g_{sep} = \Delta X - P^g_{sep} - e$

Part (i) establishes the conditions under which a no-distortion equilibrium, i.e. an equilibrium that induces the same choice of contracts (C^{g*}, C^{b*}) than when s is observable, is feasible. In other words, it corresponds to the case where truth-telling conditions (19) and (21) are not binding when the self-confident EN chooses his optimal symmetric information contract C^{g*}.

[15] Our equilibrium refinement leads here to the same result than the well-known intuitive criterion Cho and Kreps (1987). Then, the separating equilibria presented in Proposition 4 are also the least-cost separating equilibria of our signalling game.

This no-distortion equilibrium exists first when the cost of the financier's effort is low ($k \leq k_{mim}$). This is because in this case the self-unconfident EN highly values investor support (m^b_{FB} and m^{b*} are very high) and has hence no incentives to opt for the contract C^{g*} that would substantially reduce investor activism and his venture's chances of success. Clearly, the first cost of mimicking in (20) is very high when $k \leq k_{mim}$. This is illustrated in Figure 2 where $\Pi^{b*} > \Pi^b_{mim}\left(C^{g*}\right)$ and where the no-distortion equilibrium $\left(C^{g*}, C^{b*}\right)$ exists whatever the proportion of overoptimistic ENs ϕ when $k = 3$ and $k = 3.4$.[16]

When the cost of the financier's effort increases above k_{mim}, separation is more difficult because the self-unconfident's preference for a highly-supportive contract is less pronounced. However, as suggested in Part (i), separation with C^{g*} is still possible if the suspicion of unrealistic optimism is either very low, $\phi \in [0, \phi']$, or very high, $\phi \in [\phi'', 1]$. To understand the intuition, let consider the effect of a variation of ϕ on $\Pi^b_{mim}\left(C^{g*}\right)$:

$$\frac{d\Pi^b_{mim}\left(C^{g*}\right)}{d\phi} = \underbrace{\frac{dm^{g*}}{d\phi}\left[\Delta X - P^{g*}\right]}_{\text{Positive effect}} + \underbrace{m^{g*}\frac{d\left(\Delta X - P^{g*}\right)}{d\phi}}_{\text{Negative effect}} \tag{22}$$

The first effect is positive because any increase in the suspicion of overoptimism increases investor assistance to self-confident ENs ($\frac{dm^{g*}}{d\phi} \geq 0$), which reduces the first cost of mimicking defined in (20). On the other hand, an increase in ϕ reduces the stake of the cash flows obtained by the EN in case of success (because $\frac{dP^{g*}}{d\phi} \geq 0$ and $\Delta X - P^{g*} = \alpha^{g*}_H X^H$). This second effect reduces the benefit of mimicking defined in the RHS of (20).

Which effect dominates when $k > k_{mim}$ depends on the proportion of overoptimistic ENs. When ϕ is low, the contract C^{g*} induces very few investor support and the self-unconfident EN would never opt for this type of contract. However, starting from this situation, an increase in ϕ makes the contract C^{g*} more attractive for the self-unconfident EN ($\frac{d\Pi^b_{mim}(C^{g*})}{d\phi} > 0$). This explains why separation with $\left(C^{g*}, C^{b*}\right)$ is possible when $k > k_{mim}$ and $\phi \in [0, \phi']$ with $\Pi^b_{mim}\left(C^{g*}, \phi'\right) = \Pi^{b*}$. The no-distortion equilibrium also exists when $k > k_{mim}$ and $\phi \in [\phi'', 1]$. The fact that the self-unconfident is better off by revealing his type when the

[16] A subtle distinction can be made between the case when k=3 and the one when k=3.4. When k is low (e.g. $k = 3$), the expected payoff from mimicking always increases in ϕ but is still less than Π^{b*} when $\phi = 1$. When k is slighlty higher (e.g. $k = 3.4$), the expected payoff from mimicking is not a strictly increasing function of ϕ. This distinction is discussed further in the Appendix.

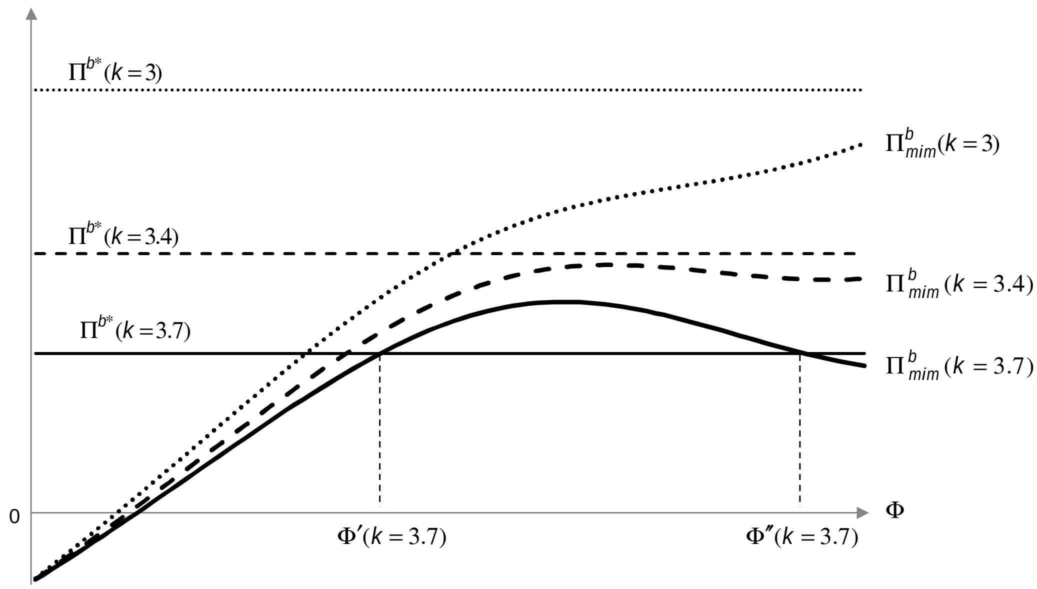

Figure 2: The joint effect of the financier's cost of effort k and of the suspicion of unrealistic optimism ϕ on the self-unconfident EN's incentive to mimic C^{g*}. Π^{b}_{mim}represents the b-EN's expected profit when he issues the security C^{g*}. For a given k, the self-unconfident has no incentives to mimic $C^{g*}$when $\Pi^{b*}\geq \Pi^{b}_{mim}$. The data used are $X^{L}= 0.6$, $X^{H}= 4$, $I = 1.6$, $r = 15\%$, and $e = 0.1$. With these values $3\left(X^{H}-R\right)/2 = 3.24$ and $k_{mim}= 3.4522$.

suspicion of unrealistic optimism is high seems a priori surprising because in this case the financier provides high support to self-confident ENs (high m^{g*}). However, one should notice that (i) Even if the first cost of mimicking in (20) is reduced when ϕ is high, it still exists because m^{g*} is lower than m^{b*} whatever ϕ; (ii) the second cost of mimicking defined in (20) is unchanged when ϕ increases, illustrating the fact that the self-confident EN always gives the investor a downside protection that is too high from the point of view of the self-unconfident; (iii) the benefit of mimicking in (20) is reduced when ϕ is high because the financier infers that the average skills of self-confident ENs are almost the same than the ones of self-unconfident ENs ($\Pr(G\,|g) \to 0$ when $\Phi \to 1$). The case when $k = 3.7$ in Figure 2 illustrates clearly the fact that the no-distortion equilibrium exists only for intermediate values of ϕ when $k > k_{mim}$.

Let consider now Part (ii) of Proposition 4, that is the situation when the no-distortion separating equilibrium (C^{g*}, C^{b*}) does not exist. The question is now to understand how the self-confident EN modifies his choice of contract in order to separate. Intuitively, the self-confident EN can prevent mimicking by modifying the allocation of cash flows and hence the financier's incentive to bring managerial support. The effect of a variation of P^g on $\Pi^b_{mim}(C^g)$ for a given level of ϕ is:

$$\frac{d\Pi^b_{mim}(C^g)}{dP^g} = \frac{\phi}{k}\left[\Delta X - 2P^g\right] \tag{23}$$

The sign of (23) is negative if $P^g > \frac{\Delta X}{2}$. Considering that P^{g*} is higher than $\frac{\Delta X}{2}$ when $\phi > \phi'$, it follows that the self-confident EN can prevent mimicking by increasing the financier's incentive package above P^{g*}. When the no-distortion equilibrium does not exist, the optimal way for separating is then to adopt a contract C^g_{sep} that gives the financier the lowest incentive package that prevents mimicking. We denote by P^g_{sep} this incentive package for which $\Pi^b_{mim}(P^g_{sep}) = \Pi^{b*}$. Obviously, the fact that $P^g_{sep} > P^{g*}$ implies that the self-confident EN has to transfer a part of his symmetric-information rent to the financier in order to separate when $k > k_{mim}$ and $\phi \in \,]\phi', \phi''[$.

Corollary 2 *The lower is k (or equivalently the higher is $m^b_{FB} = \frac{\Delta X}{k}$), the larger is the region $\phi \in [0, \phi'] \cap [\phi'', 1]$ where the no-distortion separating equilibrium (C^{g*}, C^{b*}) prevails. For a given proportion $(1-\theta)$ of unskilled ENs and when $k > \widetilde{k}$ with $\widetilde{k} > k_{mim}$ and $\phi''(\widetilde{k}) = 1-\theta$, the self-confident EN can never separate with C^{g*} when $\phi > \phi'$ even if all the ENs are suspected of being optimistic $(1 - \gamma = 1)$.*

This corollary suggests first that asymmetric information has a less pronounced effect on equilibrium outcomes when investor support is highly valuable for a self-unconfident EN, that is when k is low or when $m^b_{FB} = \frac{\Delta X}{k}$ is high. In this case, self-unconfident ENs have stronger incentives to reveal their type by selecting the highly-supportive contract C^{b*}, which makes separation more easy and less costly for self-confident ENs. It also appears that the conjunction of high cost of support $(k > \widetilde{k})$ and of high optimism $(\phi > \phi')$ can reduce the self-confident EN's ability to separate with his symmetric information security. To understand why, notice first that when $1 - \theta$ is fixed, the suspicion of overoptimism cannot exceed $1 - \theta$ (because $\phi = 1 - \theta$ when $1 - \gamma = 1$). Also, we know that separating without distortion is more difficult when k increases, partly because the threshold ϕ'' is increasing in k. Then, when k increases, it arrives a moment when ϕ'' becomes equal to $1 - \theta$. This happens precisely when

$k = \widetilde{k}$. Above this threshold, ϕ cannot be higher than ϕ'' even if all ENs are supposed to be optimistic, which implies that the self-confident EN has no other choice but to opt for costly separation with C^g_{sep} when $\phi > \phi'$.

4.2 Pooling equilibria

The existing literature on optimal contracting suggests that (i) poorly confident ENs separate from highly confident ones (e.g. Bester 1985); (ii) realistic ENs separate from optimistic ones (e.g. Landier and Thesmar 2009). There are two main reasons why in our setting highly confident ENs may prefer pooling rather than separation. First, and contrary to Bester (1985), the more confident ENs have potentially upwarded beliefs about their type and this is known by the financier. This contributes to makes accessible securities for self-confident ENs more similar to the ones issued by self-unconfident ENs. Second, in contrast with Landier and Thesmar (2009), self-confident ENs perceive separation as being costly. Then, it may be the case that even self-confident ENs may be better off by pooling when the suspicion of unrealistic optimism is very high.[17]

To examine this possibility, we consider now the conditions under which a pooling equilibrium may exist. Obviously, if both types select the same contract $\widetilde{C} = C^g = C^b$, the financier cannot extract any information on the ENs' self-confidence and $\mu\left(g\left|\widetilde{C}\right.\right) = \mu_0(g) = 1-\gamma(1-\theta)$. Also, his inability to infer the EN's self-confidence precludes the financier from updating his prior beliefs on the EN's managerial skills, i.e. $\mu\left(G\left|\widetilde{C}\right.\right) = \mu_0(G) = \theta$ and $\mu\left(B\left|\widetilde{C}\right.\right) = \mu_0(B) = 1-\theta$. As a consequence, the financier's expected payoff and his course of actions are not influenced by the proportion $1-\gamma$ of optimistic ENs and only depend on the proportion $1-\theta$ of poorly-skilled managers This is straightforward if we consider the financier's IC condition in a pooling equilibrium $\widetilde{C}$:

$$\widetilde{m} \in \arg\max \theta\left(1-\widetilde{\alpha}_H\right) X^H + (1-\theta)\left\{\widetilde{m}\left(1-\widetilde{\alpha}_H\right) X^H + (1-\widetilde{m})\left(1-\widetilde{\alpha}_L\right) X^L\right\} - \frac{k\left(\widetilde{m}\right)^2}{2} \quad (24)$$

where $\widetilde{\alpha}_H$ and $\widetilde{\alpha}_L$ represent the shares of the project's final revenue paid to the financier

[17] A more technical reason is that most signalling models apply the Intuitive Criterion (Cho and Kreps 1987). With this refinement, equilibrium selection is insensitive to the initial distribution of types and omits the fact that separation may become prohibitively costly for a self-confident EN when the suspicion of optimism $(1-\gamma)$ tends to one.

in case of failure and in case of success respectively and where $\widetilde{m}$ represents the equilibrium intensity of financier's support in a pooling contract. More precisely:

$$\widetilde{m} = \frac{(1-\theta)\widetilde{P}}{k} \tag{25}$$

From (25), it naturally follows that a pooling equilibrium cannot exist when the proportion $(1-\theta)$ of unskilled ENs is too extreme. Consider for instance the extreme case when $(1-\theta)$ is very low. If pooling at $\widetilde{C}$ occurs, the financier would provide low support and the chance of success of the self-unconfident EN would be very limited. Then, the self-unconfident EN would be better off by revealing his type. Similarly, pooling cannot exist when $(1-\theta)$ is very high because the self-unconfident EN's benefit from pooling versus separating, which depends on $\widetilde{\alpha}_H - \alpha_H^{b*}$, would be low and could not compensate the two costs induced by pooling (i.e. reduced managerial support and a lower payoff in case of failure).

Except these extreme cases where pooling does not exist, there exists a continuum of feasible pooling contracts. Some of these contracts are more favorable to self-unconfident ENs because they are more equity-like and are characterized by high financier involvement, (relatively) low downside protection and high upside for the financier. Others have more debt features, e.g. lower $\widetilde{m}$ and higher $1-\widetilde{\alpha}_L$, and are hence more favorable to self-confident ENs. We can, however, narrow down the set of pooling equilibria by appealing the D1 criterion. As we prove in the Appendix, this criterion suggests that it is reasonable to restrict attention to the pooling equilibrium that is the best from the point of view of a self-confident EN. We will refer to this equilibrium as the most plausible pooling equilibrium. The following proposition sums up the conditions of existence of pooling equilibria and characterizes the most plausible pooling equilibrium.

Proposition 5 *Except the cases when $1-\theta$ is either very low or very high, there always exists pooling equilibria where self-confident and self-unconfident ENs issue the same security. If pooling is feasible, the most plausible pooling equilibrium is the one that is the most favorable to the self-confident EN (D1 criterion). The security $\widetilde{C}$ issued in this most plausible equilibrium is such that (i) $1-\widetilde{\alpha}_L < 1$ if $k \leq \widetilde{k}$;(ii). $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$ and $1-\widetilde{\alpha}_L = 1$ if $k > \widetilde{k}$. The security $C^{g*}(\phi = 1-\theta)$ is the one issued by self-confident ENs when information is symmetric* *and when all the ENs are optimistic* $(1-\gamma=1)$*.*

Proposition 5 shows that the most plausible pooling security provides the financier the highest possible downside protection $(1-\widetilde{\alpha}_L = 1)$ in the only case when the cost of financier support k is sufficiently high $(k > \widetilde{k})$. Obviously, this feature is favorable to the self-confident EN who sees failure as impossible. It is a priori more difficult to understand why self-unconfident ENs may accept to abandon all their cash-flow rights in failure when $k > \widetilde{k}$. This can be explained by the fact that the self-unconfident EN's incentive to reveal his type decreases in k (see Corollary 2). Then, when $k > \widetilde{k}$, the self-confident EN can impose high financier's downside protection without destroying the self-unconfident EN's incentive to pool.

It is also important to notice that the self-confident EN can pool with a security that resembles to his optimal symmetric-information contract C^{g*} in the precise case when it is the more difficult and the more costly for him to separate at high levels of optimism, i.e. when $k > \widetilde{k}$ (see Corollary 2). This suggests that the self-confident EN may prefer pooling rather than separating with C^{g}_{sep} when the suspicion of optimism $1-\gamma$ tends to one and when the cost of financier involvement is high.

4.3 The choice between separating or pooling

As shown precedently, our model admit both separating and pooling equilibria when the proportion $1-\theta$ of unskilled ENs is not too extreme. A crucial issue is then to determine which type of equilibrium prevails.

The above propositions have demonstrated that the design of separating contracts depends on ϕ, which measures the suspicion of overoptimism, whereas the design of pooling contracts depends on $1-\theta$, the suspicion of managerial incompetence. Also, we know that ϕ depends jointly on $1-\theta$ and on the proportion $1-\gamma$ of optimistic ENs in the population. Then, predicting which type of equilibrium prevails demands to control for one of these parameters. As our paper deals primarily with the effect of optimism on financing contracts, we consider the case where the proportion of unskilled ENs $1-\theta$ is fixed and where any variation of ϕ is entirely due to a variation in the proportion of optimistic ENs. In this setting, the region $\phi \in]\phi', \phi''[$ where self-confident EN cannot separate with their symmetric contract C^{g*} when

$k > k_{mim}$ (see Proposition 4) is equivalent to the region $1-\gamma \in]1-\gamma', 1-\gamma''[$, where $1-\gamma'$ and $1-\gamma''$ represent, respectively, the minimum and the maximum proportion of optimistic ENs for which the no-distortion separating equilibrium (C^{g*}, C^{b*}) does not exist.[18]

With this in mind, we apply now our equilibrium refinement and show in the next proposition that a unique type of equilibrium survives in each region.

Proposition 6 *When the proportion* $(1-\theta)$ *of bad managers is fixed and is not too extreme:*

(i) If $k \leq k_{mim}$*, the unique equilibrium is separating with (*C^{g*}*,* C^{b*}*)*

(ii) If $k_{mim} < k \leq \widetilde{k}$ *and:*

(iia). $1-\gamma \in [0, 1-\gamma'] \cap [1-\gamma'', 1]$*, the unique equilibrium is separating with (*C^{g*}*,* C^{b*}*)*

(iib).$1-\gamma \in]1-\gamma', 1-\gamma''[$*, the unique equilibrium is separating with (*C^{g}_{sep}*,* C^{b*}*)*

(iii) If $k > \widetilde{k}$ *and:*

(iiia). $1-\gamma \in [0, 1-\gamma']$*, the unique equilibrium is separating with (*C^{g*}*,* C^{b*}*)*

(iiib). $1-\gamma \in]1-\gamma', 1-\widetilde{\gamma}]$*, the unique equilibrium is separating with (*C^{g}_{sep}*,* C^{b*}*)*

(iiic). $1-\gamma \in]1-\widetilde{\gamma}, 1]$*, the unique equilibrium is pooling with* $\widetilde{C} \equiv C^{g*}$ $(\phi = 1-\theta)$.

Whether separation or pooling prevails depends both on the cost of managerial support and on the proportion of optimists in the population. More precisely, separation prevails most of the time except in case (iiic) where the cost of support and the proportion of optimists are both high.

In order to understand the intuition, consider first case (i). When $k \leq k_{mim}$, the self-unconfident EN has no incentive to mimic the debt-like/low-supportive contract adopted by the self-confident in the symmetric information case. Then, the no-distortion equilibrium (C^{g*}, C^{b*}) prevails whatever the proportion of optimistic ENs (see panel (a) in Figure 3).When $k_{mim} < k \leq \widetilde{k}$ (case ii), the cost of financier involvement is sufficiently high to prevent self-confident ENs to separate with their symmetric information contract C^{g*} when the suspicion of optimism lies in an intermediate range ($1-\gamma \in]1-\gamma', 1-\gamma''[$). However, because this cost is not too high, the separating contract C^{g}_{sep} is only slighlty different from C^{g*}, which

[18] By the mere definition of ϕ, we have the following correspondence when $(1-\theta)$ is fixed: $\phi' = \frac{(1-\theta)(1-\gamma')}{(1-\theta)(1-\gamma')+\theta}$ and $\phi'' = \frac{(1-\theta)(1-\gamma'')}{(1-\theta)(1-\gamma'')+\theta}$.

implies that separation can be obtained at a reduced cost (Π^g_{sep} is only slightly lower than Π^{g*}). On the other hand, pooling is here particularly costly for the self-confident EN because it supposes adopting a contract $\widetilde{C}$ that gives the financier only partial downside protection ($1 - \widetilde{\alpha}_L < 1$). This explains why self-confident ENs are always better off by separating rather than by pooling when $k_{mim} < k \leq \widetilde{k}$. This is illustrated in panel (b) of Figure 3.

The situation is quite different when $k > \widetilde{k}$ because in this case the self-unconfident EN values less financier support and has hence more incentives to mimic the low-supportive contract preferred by self-confident ENs. Compared with the preceding case, this implies that the self-confident EN must abandon a larger part of his rent to the financier if he wants to separate and that the cost of separation (measured by the difference between Π^{g*} and Π^g_{sep}) is larger. Moreover, this cost increases with the suspicion of optimism, i.e. $\frac{d\Pi^g_{sep}}{d(1-\gamma)} < 0$. In contrast, the self-confident's profit if pooling is insensitive to the proportion of optimists and pooling occurs with a contract that gives the financier the highest downside protection, a preferred debt-like feature for the self-confident EN. This explains why the self-confident EN prefers pooling at $\widetilde{C} \equiv C^{g*}\,(\phi = 1 - \theta)$ rather than separating if the proportion of optimists is sufficiently high, i.e. if $1 - \gamma > 1 - \widetilde{\gamma}$. Case (iii) is illustrated in panels (c) and (d) of Figure 3.

Corollary 3 *All other things equal, the lower the productivity m^b_{FB} of the financier's support vis-à-vis unskilled ENs, the higher is the probability that self-confident and self-unconfident ENs adopt the same "one-fit-all" security at high levels of optimism..*

This corollary follows directly from Proposition 4 and permits to interpret it in a more intuitive way. As illustrated in Figure 3, pooling occurs at high levels of optimism in the only cases when the productivity of financier support is sufficiently low (as in panels (c) and (d) of Figure 3)). This is because a low $m^b_{FB} = \frac{\Delta X}{k}$ reduces the self-unconfident's incentive to select a highly-supportive contract and makes him more prone to mimic the debt-like and low-supportive security issued by self-confident ENs. In contrast, the self-unconfident has less incentive to mimic and separation dominates when the financier has a higher ability to add value to a venture created by a founder who lacks managerial skills (as in panel (a) and (b) of Figure 3).

Corollary 4 *For a given suspicion of unrealistic optimism $\phi > \phi'$ for which the self-confident*

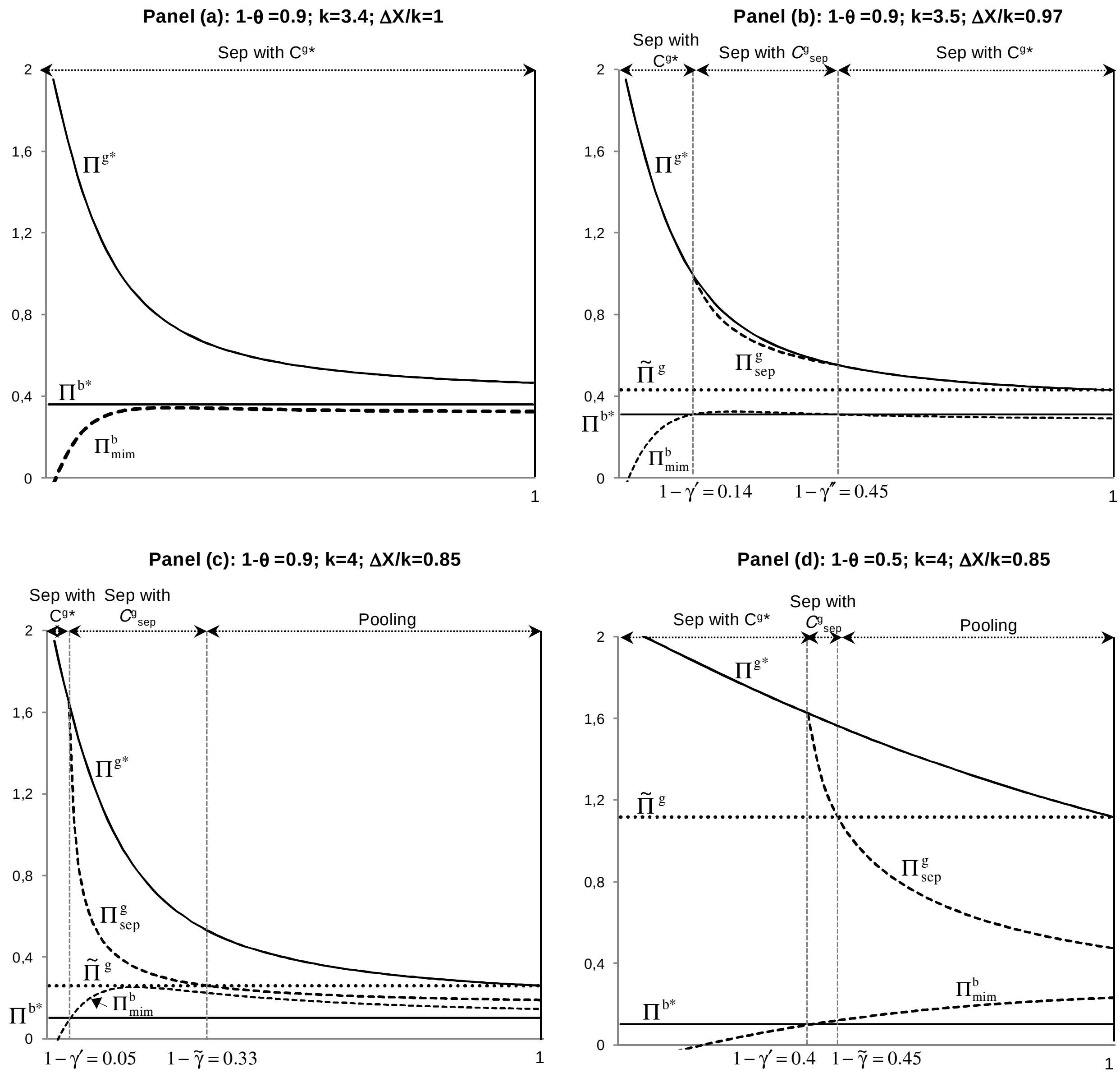

Figure 3: **The impact of the proportion of optimistic ENs on equilibrium financing contracts**. The horizontal axis represents the proportion of optimists $(1-\gamma)$ and the vertical axis the expected gains of ENs under different contract choices. The label "Sept with C^{g*}"defines the region where the g-EN and the b-EN choose the contracts C^{g*} and C^{b*} respectively. The label "Sep with C^{g}_{sep}" represents the region where the g-EN and the b-EN choose the contracts C^{g}_{sep} and C^{b*} respectively. The label "Pooling" is for the region where both ENs choose the same contract $\widetilde{C} \equiv C^{g*}$ $(\phi = 1-\theta)$. The common data for the four panels are: $X^L = 0.6; X^H = 4; I = 1.6; e = 0.1$ and $r = 15\%$. With these values, $k_{mim} = 3.4522$ and $\widetilde{k} = 3.634$. The values of $1-\theta$ and k for each panel are indicated above.

EN runs the risk of being mimicked, i.e. when (C^{g*}, C^{b*}) is not an equilibrium:

- the self-confident EN has more incentives to separate with C^g_{sep} (rather than pooling) when he is primarily suspected of having low management skills (when $1-\theta$ is high in comparison with $1-\gamma$).

- the self-confident EN has more incentives to pool (rather than separating with C^g_{sep}) when he is primarily suspected of being an optimistic entrepreneur (when $1-\gamma$ is high in comparison with $1-\theta$).

Corollary 4 permits to disentangle the effects of the two sources of unrealistic optimism (ϕ) in our model: (i) entrepreneurial optimism ($1-\gamma$), which illustrates the fact that some ENs have a systematic tendency to view themselves as having the necessary management skills to succeed without external help; (ii) managerial incompetence ($1-\theta$), which illustrates the fact that a fraction of ENs precisely lack these necessary skills and hence need external support. The intuition is quite simple. In our model, one source of unrealistic optimism, i.e. optimism, is specific to self-confident ENs while the other source of internal risk, i.e. managerial incompetence, exists for both types of ENs and is even more frequent for self-unconfident ones. For the self-confident EN, the decision to pool or to signal his type must be analyzed by considering the gains from pooling (reassuring the financier about his psychological type) and the costs associated to this strategy (devaluing in the eyes of the financier the probability of being highly skilled). Logically, the self-confident EN has more incentives to pool when optimism is the primary source of unrealistic optimism, i.e. when ($1-\gamma$) is high in comparison with ($1-\theta$). In contrast, he is better off by separating when managerial incompetence is the main source of the overoptimism risk assessed by investors (when $1-\theta$ is high in comparison with $1-\gamma$). In this case, separation is optimal in order to (partially) reassure the financier on the EN's actual management skills.

5 Implications and extensions

5.1 Empirical predictions about the influence of entrepreneurial optimism

The main insight of our theory is to show the influence of two sets of factors on ENs' contractual choices and investor activism: (i) ENs' beliefs in their personal management abilities (represented by the signal $s = g, b$), (ii) the prevalence of entrepreneurial (over)optimism (represented by $1-\gamma$ and by ϕ).[19] We predict that the nature and the diversity of financing contracts follow two regimes. The first one (hereafter Regime 1), which arises when optimism $(1-\gamma)$ is relatively uncommon, is characterized by a great variety of contractual choices, with self-confident ENs issuing securities with more debt-like features and receiving less investor assistance than self-unconfident ENs. When optimism is more prevalent, we predict the existence of a second regime (hereafter Regime 2) where contracts should be less differentiated and where ENs, irrespective of their self-confidence, should adopt the same "one-fit-all" security with high downside protection for investors and intermediate investor support.

To check the validity of our theory, an empirical strategy could consist in identifying the situations where entrepreneurial optimism may vary. Along this view, an extent empirical literature shows that experienced entrepreneurs are less likely to exhibit an optimistic bias (Fraser and Greene 2006, Koellinger et al. 2007, Dai and Ivanov 2009). This suggests that Regime 1 should prevail for experienced ENs, whereas Regime 2 should prevail for novice ENs. This leads to the following prediction:

Prediction 1: Experienced ENs should use a greater variety of contracts than novice ENs. Experienced ENs should be more likely to issue straight debt (if they are self-confident) or common equity (if they are self-unconfident) whereas novice ENs should be more prone to issue mixed securities with high downside protection and intermediate upside for the financier.

Prediction 1 is consistent with the finding that more experienced ENs are more likely to be financed with common equity and are less likely to be financed with convertible preferred equity than less experienced ENs (Cumming and Johan 2007, 2008). This is also in line with Hartmann-Wendels et al. 2011 who show, on a sample of German VC-backed firms, that start-up firms tend to issue mixed securities with equity-like orientation whereas mature firms are more prone to issue either mixed securities with a strong debt-like orientation or straight equity.

Our theory could also explain why the design of VC contracts differs across countries. Several papers have shown that US VCs use almost one type of convertible preferred equity whereas VCs operating in other countries use a greater variety of securities (e.g. Cumming

[19] In reality, our model also underlines the effect of a third factor, that is the "productivity" of investor support (k and m^b_{FB}). We report the discussion on this factor to section 5.3.

2005). In line with Prediction 1, this could be explained by the fact that US VCs finance less experienced entrepreneurs than other VCs and are hence specialized in a sub-population of entrepreneurs where optimism is more prevalent. Cross-countries variations in VC contracts could also be due to cross-countries differences in entrepreneurial optimism. In support of this idea, are the findings that entrepreneurial self-confidence and optimism vary substantially across countries (Koellinger et al. 2007) and that the valuation of VC-backed ventures decreases with an index of national optimism (Dushnitsky 2009). Interestingly, this idea is also present in the psychological literature where it has been found that people in individualistic cultures think more positively about themselves and are more susceptible to overestimate their abilities than in collectivistic cultures (Heine et al. 1999, Markus and Kitayama 1991). Furthermore, the fact that (national) individualism is positively associated with trading volume, volatility and the magnitude of momentum profit, a recent finding of Chui et al. (2010), confirms the existence of cross-countries variations in optimism and their substantial impact on people's behavior. Coupled with our theory, this suggests that Regime 1 (high diversity of financing contracts) should prevail in countries where optimism is less prevalent, whereas Regime 2 ("one-fit-all" mixed security) should prevail for countries where optimism is more common:

Prediction 2: VC contracts should more often take the form of a one-fit-all mixed security (with high downside protection) in countries where entrepreneurial optimism is more prevalent (individualistic countries), whereas straight debt or common equity should be more frequent in countries where optimism is less prevalent.

Interestingly, all the above studies converge on the fact that US people score high in optimism. Then, Prediction 2 seems consistent with the common finding that US VCs use almost one type of convertible preferred equity (with strong downside protection) whereas a greater variety of contracts is observed in other countries.

5.2 The question of control rights

Until now, we have supposed that investor support adds value to a venture managed by an unskilled EN even if the latter believes this support is unnecessary. In other words, the financier was supposed to hold sufficient control rights in order to force the implementation of value-adding actions. In reality, nothing says a priori that the security issued by a self-confident EN allocates the control rights to the financier.

In order to introduce control rights in our model, we suppose that the EN takes a non-contractible decision as to whether to implement the financier's advice or not. This decision is taken by the owner of control rights and takes place after the financier has exerted his supporting effort. There are two possibilities: the EN has control rights, in which case we say $\delta = 1$, or control resides with the financier, in which case we say $\delta = 0$. We also consider that the EN and the VC can renegotiate at the time of this decision. We denote by ρ the EN's bargaining power. The initial contract specifies both the allocation of cash-flow rights and the allocation of control.

In this amended framework, we aim to derive optimal financing contracts when information is symmetric. As a preamble, it should be obvious that the allocation of control does not matter when the EN is self-unconfident because in this case both agents agree on the benefits from implementing financier advice. The optimal contract for a self-unconfident EN is then similar to C^{b*} with either $\delta = 0$ or $\delta = 1$.

The reasoning is less straightforward when the EN is self-confident. Notice first that the optimal contract is similar to the contract C^{g*} described in Proposition 2 if the financier has control ($\delta = 0$). If instead the EN has control rights ($\delta = 1$), he can threaten not to implement financier advice. This threat is credible because the self-confident EN perceives that implementing financier's advice does not affect his expected payoff. From the financier's perspective, the incremental value of implementing advice is $\phi m^g_{\delta=1} P^g_{\delta=1}$, where $m^g_{\delta=1}$ and $P^g_{\delta=1}$ are for the intensity of financier support and for the financier's incentive package when $\delta = 1$. It follows that the self-confident EN can extract $\rho\phi m^g_{\delta=1} P^g_{\delta=1}$ from the financier through renegotiation when $\delta = 1$. Anticipating this, the financier has ex ante less incentives to search for value-adding actions and $m^g_{\delta=1} < m^g_{\delta=0} \equiv m^{g*}$ when $\rho > 0$. Controlling the implementation of advice is however not without cost for the self-confident EN because it implies abandoning some additional upside to the financier in order to convince him to finance the firm. More precisely, the optimal contract for the self-confident EN when $\delta = 1$, denoted by $C^g_{\delta=1}$, is such that $P^g_{\delta=1} > P^g_{\delta=0} \equiv P^{g*}$ with $\alpha^g_{H,\delta=1} > \alpha^{g*}_H$ and $\alpha^g_{L,\delta=1} = \alpha^{g*}_L = 0$. In sum, whether the self-confident EN sets $\delta = 1$ instead of $\delta = 0$ depends on the trade off between beneficing from lower support and from the possibility to hold-up the financier on the one side, and being obliged to issue a security that gives initially more upside to the financier. The following proposition shows that the self-confident EN always benefits from allocating control to the financier, i.e. he is better off with C^{g*} rather than with $C^{g}_{\delta=1}$.[20] It also confirms that our previous results still hold when optimal contracts allocate both cash flow and control rights.

Proposition 7 *When information is symmetric, the self-confident EN is strictly better off by allocating all the control rights to the financier ($\delta = 0$). The optimal contract is then similar to C^{g*}. For the self-unconfident EN, the allocation of control rights does not matter and the optimal contract is similar to C^{b*} with $\delta = 0$ (financier control) or $\delta = 1$ (EN control) indifferently..*

Consider now the case when the financier is in weak position in case of conflict, i.e. when $\delta = 1$ and ρ is high, a situation that could correspond to the one encountered in countries where legal enforcement is difficult and where the judicial system has a tendency to systematically arbitrate conflicts in favor of ENs.

In this case, the financier anticipates that implementing advice against the will of the EN will be very costly and has then weak incentives to support a self-confident EN (m^g is low). The impossibility to commit to implement advice may prevent financing of self-confident ENs. This is because the investor knows that a proportion ϕ of self-confident ENs will fail and accepts to finance the firm if and only if ϕ is sufficiently low ($\phi \leq \phi_{\min}$).

When the suspicion of overoptimism lies above this threshold ($\phi > \phi_{\min}$), self-confident ENs have no other choice but to mimick self-unconfident ones in order to be financed. The latter cannot separate from self-confident ENs because the only way to prevent mimicking would consist in increasing the financier's upside (i.e. decreasing α^b_H), which would destroy their own incentives to provide effort. Separation being impossible, there are only two possible regimes: whether both self-confident and self-unconfident ENs are denied financing, whether both issue a security with equity-like features (e.g. with limited donwisde protection for the investor). Which situation prevails depends on the financier's initial beliefs on the proportion

[20] This result is in line with Hellmann (1998) who demonstrates that ENs sometimes prefer relinquishing their control rights ex ante even if they know that this could lead ex post to a change in management with negative net benefit for them.

of self-confident ENs in the population. If self-confident ENs are not too numerous, because $1-\gamma$ lies in an intermediate range, both types of ENs issue the same equity-like security. In contrast, both types of ENs are denied financing when self-confident are numerous (which is the case if the proportion $1-\gamma$ of optimists is high).

Proposition 8 *When the financier is in weak position in case of conflict (when $\delta = 1$ and ρ is high), presumably because legal enforcement is difficult:*

(a). If $\phi \leq \phi_{\min}$: The self-confident EN issues a debt-like security (with low support and $1-\alpha_L^{g*} = 1$) and the self-confident EN issues the equiy-like security C^{b*} defined in proposition 1.

(b). If $\phi > \phi_{\min}$, there are two solutions:

- If self-confident ENs are not too numerous (intermediate $1-\gamma$), all the ENs issue the same security with intermediate support and $1-\widetilde{\alpha}_L^* < 1$.

- If instead $1-\gamma$ is high, both types of ENs are denied financing.

Proposition 8 suggests that the effects of entrepreneurial overoptimism on optimal contracting may depend on a country's legal system. A simple comparison with the results of Proposition 6 shows that, at high levels of optimism, financing is more difficult, optimal contracts have more equity-like features and provide less downside protection to investors when legal enforcement of control rights is difficult (Proposition 8) rather than when legal enforcement is easy (Proposition 6). This is consistent with Lerner and Schoar (2005) who show that private equity investors in civil law countries and in countries where legal enforcement is difficult are far more likely to employ common stock and less likely to use convertible preferred stocks.

5.3 Complementarity vs substituability of efforts and the nature of entrepreneurial optimism

A crucial assumption of our model is that investor support adds value in the only case when ENs lack managerial abilities. Contrary to most existing models of VC-EN interaction (e.g. Casamatta 2003), we consider then that investor and EN efforts are not always complementary and are sometimes substitutes (when the EN is highly skilled). This difference in assumption comes from the fact that our model focuses on ENs' management skills, which are in direct competition with VCs' management expertise, while other models consider that ENs and VCs possess different skills, technological skills for ENs and management skills for VCs. We aim to demonstrate here that these two views are not uncompatible. We however argue that an EN's confidence in his technological skills (or in the quality of his business idea) has only a second-order effect on the design of contracts.

To consider the joint effect of ENs' confidence in their management skills and in the quality of their project, we slightly amend our model by assuming that the chance of success of ENs with weak management skills increases jointly in EN effort ($\epsilon = 1$ if EN provides effort and 0 otherwise), in VC assistance (m) and in the quality of the business idea κ (with $\kappa \leq 1$), whereas the chance of success of ENs with high management skills depends only on ϵ and κ :

$$\Pr ob \left(X^H \left| B \right. \right) = \epsilon \kappa m; \; \Pr ob \left(X^H \left| G \right. \right) = \epsilon \kappa$$

Denoting by $\widehat{\kappa}$ the EN's confidence in the quality of his business idea, it is intuitive that contractual choices depend both on $\widehat{\kappa}$ and the EN's confidence in his management skills ($s = g, b$). However, because investors provide only management expertise, ENs who are highly confident in their management skills ($s = g$) always issue a security with more debt-like features than the one issued by self-unconfident ENs ($s = b$). This result holds whatever $\widehat{\kappa}$. This is not to say that one's confidence in the quality of his business idea has no influence on optimal contracting. Rather this effect is limited to the contractual choices of ENs poorly confident in their management skills ($s = b$) and who value investor managerial assistance. In conformity with this idea, the "equity-like" orientation of securities issued by b-ENs is more pronounced and financier assistance is higher when ENs are more confident in the (technical) quality of their project (when $\widehat{\kappa}$ increases). This corresponds to the idea that investors, whatever their management expertise, cannot transform a bad idea into a successful company but can permit to enhance the chance of success of a good idea.

Even if ENs who are both self-unconfident in their management abilities and highly confident in their business idea, i.e. b-ENs with high $\widehat{\kappa}$, prefer highly-supportive investors, they have however no other choice but to issue securities which provide minimal downside protection to investors and to receive at equilibrium less assistance than their preferred level. This is because investors consider the risk that ENs with high $\widehat{\kappa}$ might overestimate the technical quality or the innovativeness of their projects.

In an asymmetric information framework where investors cannot observe the b-ENs' confidence in the quality of their idea, it is also obvious that b-ENs with high $\widehat{\kappa}$ might prefer to pool with the same mixed security than b-ENs with moderate $\widehat{\kappa}$ when the risk of overoptimism on κ is high. Even if this pooling security contains more debt-like features and induces less assistance than the one issued by b-ENs highly confident in their idea, it still provides investors less downside protection and more incentives to support the firm than the one chosen by ENs who are self-confident in their management skills ($s = g$).

Proposition 9 *Whatever $\widehat{\kappa}$, i.e. the EN's confidence in the quality of his idea, ENs confident in their management abilities ($s = g$) issue more debt-like securities and receive less investor assistance than self-unconfident ENs ($s = b$). Self-unconfident ENs issue securities with more equity-like features and receive more investor assistance when $\widehat{\kappa}$ increases. ENs who are both unconfident in their management skills and highly confident in the quality of his idea, i.e. b-ENs with high $\widehat{\kappa}$, receive less assistance and provide more downside protection to investors than their preferred level because of the investors' suspicion that ENs might overestimate the quality of their idea.*

From an empirical point of view, this proposition suggests that the choice of financing and advising contracts jointly depends on ENs' perceived management and technological capabilities. That said, Proposition 9 suggests a hierarchy between these two determinants, with management capabilities having a first-order effect and technological skills a second-order effect. To the extent that an EN is more confident in his management abilities when he has previous operational (MBA degree) or start-up experience whereas his confidence in the quality of his project depends more on his technical skills (PHD degree, high-tech industry) (Bengtsson and Hsu 2010), we make the following prediction:

Prediction 3: Whatever their technical skills (or the technicity of the industry), ENs with high operational or start-up experience should issue more debt-like securities, should match with less experienced investors, and should receive less investor assistance than ENs with little management experience. For ENs with little management experience, investor assistance and the equity-like orientation of contracts should increase in their technical skills (or in the *technicity of the industry).*

This prediction is consistent with the common findings that potentially supportive investors (VCs) preferentially match with ENs operating in high-tech industries and with weak management expertise (Baum and Silverman 2004, Colombo and Grilli 2010). To the extent that the productivity of investor activism (measured by k and m_{FB}^{b}) is positively related to VC experience (Chemmanur et al. 2011, Gompers et al. 2010), Prediction 3 also states that ENs poorly-confident in their management skills (presumably less experienced ones) prefer selling securities with a strong equity-like orientation to highly-experienced investors whereas self-confident ENs prefer issuing debt-like securities subscribed by less experienced investors.[21] Consistent with this prediction, Bengtsson and Sensoy (2011) show that more experienced VCs obtain significantly weaker downside protections. Lastly, the idea that EN's confidence in his management skills has a first-order effect on the design of contracts while confidence in the (technical) quality of his project has only a second-order effect finds some support in Hartmann-Wendels et al. (2011). On a sample of VC-backed firms, these authors show that start-up firms operating in high tech industries are the ones which are the most likely to issue equity-like contracts but also find that the start-up status has a stronger effect on the propensity to issue equity-like securities than the appartenance to high-tech industries.

6 Conclusion

It has been largely documented that entrepreneurs are more optimistic about their own capabilities than other individuals (Cooper et al. 1988). If a minimum level of self-confidence seems necessary to engage in entrepreneurship and to deal with the uncertainty inherent to this activity, excessive confidence could lead entrepreneurs to undervalue external help (Hayward et al. 2006). While entrepreneurs are likely to be overoptimistic about their management skills, studies examining the interaction between venture capitalists and entrepreneurs pass this cognitive bias under silence. This is all the more surprising that (i) venture capitalists are supposed to provide management expertise to their portfolio companies (e.g., Gorman and

[21] The prediction that less skilled ENs prefer issuing "equity-like" securities subscribed by experienced VCs derives from previous results. When m_{FB}^{b} is high (k is low), the self-unconfident EN prefers revealing his managerial incompetence (Proposition 6). Moreover, the higher is m_{FB}^{b}, the lower is the investor's downside protection $\left(1-\alpha_{L}^{b*}\right)$ and the higher are investor activism (m^{b*}) and, hence, the b-EN's expected profit (Proposition 1).

Sahlman 1989, Hellmann and Puri 2002), (ii) optimism may adversely affect the perceived need of entrepreneurs for (external) management expertise.

In this paper, we study optimal financing and advising contracts between potentially optimistic entrepreneurs and potentially supportive investors. We show that the presence of (some) optimistic entrepreneurs influences the contractual and non-contractual choices of a large class of entrepreneurs including realistic ones. In general, the impossibility for highly-skilled/realistic entrepreneurs to separate from optimists prevents the natural equilibrium where self-confident entrepreneurs issue straight debt and interact with passive investors and where self-unconfident entrepreneurs sell equity-like securities that give investors strong incentives to support the firm. Two regimes arise depending on the proportion of optimists in the population of entrepreneurs. When this proportion is low, self-confident and self-unconfident entrepreneurs issue distinct securities. Those who are self-confident issue a mixed security with debt-like features (high downside protection and limited investor assistance) whereas self-unconfident ones issue a more equity-like feature and receive more investor assistance. When entrepreneurial optimism is more prevalent, both self-confident and self-unconfident entrepreneurs issue the same "one-fit-all" security with high downside protection and intermediate investor activism.

More generally, our model shows that entrepreneurial optimism may explain the actual design of VC contracts (Kaplan and Strömberg 2003), the diversity of VC contracts across countries (Cumming 2005, Lerner and Schoar (2005)) and the matching between investors and entrepreneurs (Bengtsson and Hsu 2010).

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Appendix A. Proofs

Proof of proposition 1: Note first that the b-EN's IR always holds when the EN's IC is satisfied. This simplifies the problem as we can ignore (6) in the derivation of the optimal contract.

We know by (10) that investor support is set to $m^{b*} = \frac{P^{b*}}{k}$. Given that $\alpha_H^{b*} \geq 0$ and $\alpha_L^{b*} \leq 1$, the financier's incentive package $P^{b*} \equiv \left(1 - \alpha_H^{b*}\right) X^H - \left(1 - \alpha_L^{b*}\right) X^L \leq \Delta X$. In order to show that the inequality must be strict, i.e. $P^{b*} < \Delta X$, consider the EN's IC defined by (4) with the equilibrium investor support $m^{b*} = \frac{P^{b*}}{k}$. This yields:

$$\frac{P^{b*}}{k} \left(\Delta X - P^{b*}\right) \geq e \tag{A.1}$$

As $e > 0$, it is immediate that the EN's IC holds if and only if $P^{b*} < \Delta X$. It follows that $m^{b*} < m^b_{FB}$.

We analyze now the effect of a variation of α_H^b and of α_L^b on the financier's expected profit. This expected profit is:

$$m^b \left[\left(1 - \alpha_H^b\right) X^H - \left(1 - \alpha_L^b\right) X^L\right] + \left(1 - \alpha_L^b\right) X^L - \frac{k \left(m^b\right)^2}{2} - R \tag{A.2}$$

Considering that $P^b = \left(1 - \alpha_H^b\right) X^H - \left(1 - \alpha_L^b\right) X^L$ and that $m^b = \frac{P^b}{k}$ at equilibrium, the partial derivative of (A.2) with respect to α_H^b is $\frac{-P^b}{k} X^H$, which is stricly negative because at equilibrium $P^{b*} > 0$. Computing now the partial derivative of (A.2) with respect to α_L^b, we obtain $\frac{\left(P^b - k\right)}{k} X^L$ which is also strictly negative because at equilibrium $m^{b*} = \frac{P^{b*}}{k} < 1$. This proves that (i). increasing P^b through a decrease in α_H^b increases the financier's expected profit, (ii) increasing P^b through an increase in α_L^b has a negative impact on the financier's expected profit.

Consider now the EN's expected profit defined by:

$$m^b \left(\alpha_H^b X^H - \alpha_L^b X^L\right) + \alpha_L^b X^L - e \tag{A.3}$$

Derivating (A.3) with respect to α_H^b shows that the EN's profit is increasing in α_H^b if $P^b > \frac{\Delta X}{2}$. Also, the partial derivative of (A.3) with respect to α_L^b is strictly positive if $P^b < \frac{\Delta X + k}{2}$, which always holds at equilibrium because $k > \Delta X$ and $P^{b*} < \Delta X$. We conclude that (i) increasing P^b through a decrease in α_H^b yields to a lower (higher) profit for the EN if $P^b > \frac{\Delta X}{2}$ (if $P^b < \frac{\Delta X}{2}$), (ii) increasing P^b through an increase in α_L^b always yields to a higher profit for the EN.

We return now to the EN's IC defined in (A.1). It is direct that the LHS of (A.1) is decreasing in P^b if $P^b > \frac{\Delta X}{2}$ and is increasing in P^b if $P^b < \frac{\Delta X}{2}$.

With these results in mind, we demonstrate now that (a) no equilibrium exists if $P^{b*} < \frac{\Delta X}{2}$, (b) there exists an equilibrium contract C^{b*} if $P^{b*} > \frac{\Delta X}{2}$ for which the EN's IC and the financier's IR are binding.

(a). No equilibrium if $P^{b*} < \frac{\Delta X}{2}$: From the preceding results, we know that any increase of P^b above P^{b*} obtained through a decrease in α_H^b would increase the financier's profit, the EN's profit and the EN's incentive to exert effort. Then, there exists no equilibrium such that $P^{b*} < \frac{\Delta X}{2}$.

(b). Equilibrium contract C^{b*} if $P^{b*} > \frac{\Delta X}{2}$: Consider as a starting point that α_H^{b*} and α_L^{b*} are such that (A.1) is binding and (A.2) is equal to 0. Any deviation that would increase the financier's incentive package, i.e setting $P_{dev}^b > P^{b*}$, is impossible because in this case the EN's IC would not hold. Any deviation such that $P_{dev}^b < P^{b*}$ is also impossible. On the one hand, the EN has no incentive to propose $P_{dev}^b < P^{b*}$ through a decrease in α_H^b. On the other hand, proposing $P_{dev}^b < P^{b*}$ through an increase in α_L^b would violate the financier's IR. Then, if $P^{b*} > \frac{\Delta X}{2}$, the EN's IC and the financier's IR must be binding. This implies that the EN's profit at equilibrium Π^{b*} is equal to the social value of the project.

We characterize now the equilibrium contract. The EN's IC is binding if:

$$-\left(P^{b*}\right)^2 + P^{b*}\Delta X - ke = 0 \tag{A.4}$$

(A.4) is a second-order polynomial in P^{b*}. The discriminant, $\Delta X^2 - 4ke$, is strictly positive given the assumption that the social value of the project is positive at equilibrium (see Assumption 2). This polynom has two positive roots: $\left\{\frac{\Delta X - \sqrt{(\Delta X)^2 - 4ke}}{2}, \frac{\Delta X + \sqrt{(\Delta X)^2 - 4ke}}{2}\right\}$. Only the second root is compatible with our previous finding that $P^{b*} > \frac{\Delta X}{2}$ and we conclude that $P^{b*} = \frac{\Delta X + \sqrt{(\Delta X)^2 - 4ke}}{2}$.

We also know that the financier's IR is binding at equilibrium. From (5) and (10), this implies:

$$\left(1-\alpha_L^{b*}\right)X^L+\frac{\left(P^{b*}\right)^2}{2k}-R=0 \tag{A.5}$$

From (A.5), it is straightforward to derive $\left(1-\alpha_L^{b*}\right)$ and $\left(1-\alpha_H^{b*}\right)$ defined in Proposition 1.

At equilibrium, the EN's expected profit Π^{b*} is equal to $m^{b*}\alpha_H^{b*}X^H+\left(1-m^{b*}\right)\alpha_L^{b*}X^L-e$, equivalent to $\alpha_L^{b*}X^L+m^{b*}\left(\Delta X-P^{b*}\right)-e$. Using the fact that the EN's IC is binding, it is immediate that $\Pi^{b*}=\alpha_L^{b*}X^L$. With $(1-\alpha_L^{b*})$ defined in Proposition 1, we obtain $\Pi^{b*}=\frac{\left(P^{b*}\right)^2}{2k}-\left[R-X^L\right]$. Our initial assumption that the social value of the project is positive at equilibrium implies $\frac{k\left(m^{b*}\right)^2}{2}=\frac{\left(P^{b*}\right)^2}{2k}\geq\left[R-X^L\right]$ and $\Pi^{b*}\geq 0$. Also, our initial assumption that the net marginal value of both agents exerting effort is limited upward, i.e $\frac{P^{b*}}{k}\Delta X-\frac{\left(P^{b*}\right)^2}{2k}-e\leq R$ (see Assumption 2), guarantees that $\frac{k\left(m^{b*}\right)^2}{2}=\frac{\left(P^{b*}\right)^2}{2k}\leq R$ and that $(1-\alpha_L^{b*})\geq 0$.

Comparing the values of $\left(1-\alpha_L^{b*}\right)$ and $\left(1-\alpha_H^{b*}\right)$ presented in Proposition 1, it appears that $\left(1-\alpha_H^{b*}\right)<\left(1-\alpha_L^{b*}\right)$ if:

$$\Delta X\left[R-\frac{\left(P^{b*}\right)^2}{2k}\right]-P^{b*}X^L>0 \tag{A.6}$$

This condition is more likely to be satisfied when the EN's cost of effort is high and more generally when P^{b*} is low, i.e when ΔX is low and k is high.

Proof of proposition 2: From the EN's objective function defined by (12), we can infer that the g-EN is prone to sacrify his payoff in case of failure. As explained in the text, setting $\alpha_L^{g*}=0$ is beneficial for the EN because it decreases P^{g*} and m^{g*}. At equilibrium, the financier's IR is binding. With m^{g*} defined in (18) and $P^{g*}=\left(1-\alpha_H^{g*}\right)X^H-X^L$, (15) at equality is equivalent to:

$$\frac{\phi^2}{2k}\left(P^{g*}\right)^2+(1-\phi)P^{g*}-\left(R-X^L\right)=0 \tag{A.7}$$

The discriminant of this polynomial in P^{g*} is $d_g=(1-\phi)^2+\frac{2\phi^2}{k}\left(R-X^L\right)$, which is always positive because by Assumption 1 $R-X^L>0$. There is only one positive root: $P^{g*}=\frac{k}{\phi^2}\left[\sqrt{d_g}-(1-\phi)\right]$. Since $\alpha_L^{g*}=0$ and $P^{g*}=\left(1-\alpha_H^{g*}\right)X^H-X^L$, we also obtain $\left(1-\alpha_H^{g*}\right)=$

$\frac{X^L+P^{g*}}{X^H}$. With this expression of $\left(1-\alpha_H^{g*}\right)$, the expected payoff of the g-EN is : $\Pi^{g*} = \alpha_H^{g*}X^H - e = \Delta X - P^{g*} - e$.

The contract described in proposition 2 also necessitates that $P^{g*} \leq \Delta X - e$ (equivalent to $\Pi^{g*} \geq 0$) and that $P^{g*} \leq \frac{k}{\phi}$(equivalent to $m^{g*} \leq 1$). In order to prove that $P^{g*} \leq \Delta X - e$, we compute first $\frac{dP^{g*}}{d\phi}$. Direct computation yields to:$\frac{dP^{g*}}{d\phi} = \frac{k}{\phi^2}\left[\frac{-d_g+\sqrt{d_g}(2-\phi)-(1-\phi)}{\phi\sqrt{d_g}}\right]$. Considering that $\frac{k}{\phi^2}\left[-d_g+\sqrt{d_g}\,(2-\phi)-(1-\phi)\right] = P^{g*}\left(1-\sqrt{d_g}\right)$, we obtain:

$$\frac{dP^{g*}}{d\phi} = \frac{P^{g*}\left(1-\sqrt{d_g}\right)}{\phi\sqrt{d_g}} \tag{A.8}$$

The sign of (A.8) depends on the sign of $1-\sqrt{d_g}$. It is direct to demonstrate that $1-\sqrt{d_g} \geq 0$ if $\frac{2}{k}\left(R-X^L\right) \leq 1$. This is always true because $m^{g*} \leq 1$ and the upper value of m^{g*}, i.e. the one prevailing when $\phi = 1$, is equal to $\sqrt{\frac{2}{k}\left(R-X^L\right)}$. Then, the maximal value of P^{g*} is obtained when $\phi = 1$ and is such that $P^{g*}(\phi = 1) = \sqrt{2k\left(R-X^L\right)}$. We also know by Proposition 1 that $\Pi^{b*} \geq 0$ and $P^{b*} \geq \sqrt{2k\left(R-X^L\right)}$. Then, $P^{b*} \geq P^{g*}$. Proposition 1 has also demonstrated that the b-EN's IC constraint is binding at equilibrium, i.e. $m^{b*}\left(\Delta X - P^{b*}\right) = e$, which necessitates that $P^{b*} \leq \Delta X - e$ (because $m^{b*} \leq 1$). Since $P^{b*} \geq P^{g*}$ and $P^{b*} \leq \Delta X - e$, we have $P^{g*} \leq \Delta X - e$.

Consider now the second condition, i.e. $P^{g*} \leq \frac{k}{\Phi} \Leftrightarrow m^{g*} \leq 1$. We know that the upper value of m^{g*} is $m^{g*}(\phi = 1) = \sqrt{\frac{2}{k}\left(R-X^L\right)}$. The optimal contract for the b-EN is such that $\Pi^{b*} \geq 0$ and $m^{b*} \leq 1$, which implies $\sqrt{\frac{2}{k}\left(R-X^L\right)} \leq m^{b*} \leq 1$. Then, $m^{g*} \leq m^{b*} \leq 1$ whatever the suspicion of overoptimism Φ.

Proof of corollary 1: For the fact that P^{g*} increases with ϕ see the proof of Proposition 2. In order to prove that P^{g*} tends to $R - X^L$ when ϕ tends to 0, remember that $P^{g*} = \frac{k}{\phi^2}\left[\sqrt{d_g}-(1-\phi)\right]$ with $d_g = (1-\phi)^2 + \frac{2\phi^2}{k}\left(R-X^L\right)$. The limiting value of P^{g*} at the point ϕ is undefined. In order to find this limiting value, we apply the L'Hôpital's rule. Considering that $P^{g*}(\phi) = \frac{f(\phi)}{g(\phi)}$ with $f(\phi) = k\left[\sqrt{d_g}-(1-\phi)\right]$ and $g(\phi) = \phi^2$, the L'hôpital's rule states that: $\lim_{\phi\to 0} P^{g*}(\phi) = \lim_{\phi\to 0}\frac{f'(\phi)}{g'(\phi)}$. Computing $f'(\phi)$ and $g'(\phi)$, we obtain: $f'(\phi) = k\left[\frac{\phi+\frac{2}{k}\phi\left(R-X^L\right)-1+\sqrt{d_g}}{\sqrt{d_g}}\right]$ and $g'(\phi) = 2\phi$. This yields to $\lim_{\phi\to 0} P^{g*}(\phi) = \lim_{\phi\to 0}\left\{\frac{R-X^L}{\sqrt{d_g}} + \frac{k}{2}\frac{\phi-1+\sqrt{d_g}}{\phi\sqrt{d_g}}\right\}$. Clearly $\lim_{\phi\to 0}\left\{\frac{R-X^L}{\sqrt{d_g}}\right\} = R - X^L$ as $d_g = 1$ when $\phi = 0$. Unfortunately, $\lim_{\phi\to 0}\left\{\frac{k}{2}\frac{\phi-1+\sqrt{d_g}}{\phi\sqrt{d_g}}\right\}$ is undefined and we need to apply again the L'Hôpital's rule. We obtain: $\lim_{\phi\to 0}\left\{\frac{k}{2}\frac{\phi-1+\sqrt{d_g}}{\phi\sqrt{d_g}}\right\} = \lim_{\phi\to 0}\left\{\frac{k\left[\sqrt{d_g}+\phi\left[1+\frac{2}{k}\left(R-X^L\right)\right]-1\right]}{2d_g}\right\} = 0$. Then, we have $\lim_{\phi\to 0} P^{g*}(\phi) = R - X^L$.

Proof of proposition 3: For the fact that $m^{b*} \geq m^{g*}$ and $P^{b*} \geq P^{g*}$, see the proof of Proposition 2.

Proof of proposition 4: For notational simplicity, we write Π^b_{mim} instead of $\Pi^b_{mim}\left(C^{g*}\right)$. We first demonstrate that the b-EN has never incentives to mimick a g-EN who adopts his symmetric information contract C^{g*} when $\phi = 0$ or $\phi = 1$. When $\phi = 0$, $m^{g*} = 0$ and $\Pi^b_{mim} = -e < 0$. Then, the b-EN does not mimick the g-EN when $\phi = 0$. Consider now the case where $\phi = 1$. Using the fact that $P^{g*}(\phi = 1) = \sqrt{2k\left(R - X^L\right)}$ and $m^{g*}(\phi = 1) = \sqrt{\frac{2}{k}\left(R - X^L\right)}$ (see Proposition 2) and considering the LHS of (19), it is direct that: $\Pi^b_{mim}(\phi = 1) = \frac{\Delta X}{k}\sqrt{2k\left(R - X^L\right)} - 2\left(R - X^L\right) - e$. Considering the LHS of (11), it appears that this mimicking payoff is equal to the social value of the project managed by a b-EN when the financier's incentive package is equal to $P^{g*}(\phi = 1) = \sqrt{2k\left(R - X^L\right)}$. In reality, we know that the incentive package distributed to the financier in the contract C^{b*}, i.e. P^{b*} is higher than $P^{g*}(\phi = 1)$ (Proposition 3). Also, we know that the equilibrium social value of the project managed by a b-EN is equal to Π^{b*}. In order to prove that $\Pi^{b*} > \Pi^b_{mim}(\phi = 1)$, it is then sufficient to prove that the social value of the project defined by the LHS of (11) increases in P. The derivative of the LHS of (11) with respect to P^{b*} is always positive, which proves that the truth-telling condition of a b-type always holds when $\Phi = 1$.

We next prove that $\Pi^g_{mim}\left(C^{b*}\right) \leq \Pi^{g*}$, i.e. the self-confident EN has never incentives to adopt C^{b*}. By definition, this truth-telling holds if:

$$\Pi^g_{mim}\left(C^{b*}\right) \equiv \alpha^{b*}_H X^H - e \leq \Pi^{g*} \equiv \alpha^{g*}_H X^H - e \tag{A.9}$$

By propositions 1 and 2, $\alpha^{b*}_H X^H = X^H - R - P^{b*} + \frac{\left(P^{b*}\right)^2}{2k}$ and $\alpha^{g*}_H X^H = \Delta X - P^{g*}$. Then (A.9) is equivalent to:

$$P^{b*} - \Pi^{b*} \geq P^{g*} \tag{A.10}$$

(A.10) always holds when $\Pi^{b*} = 0$ because in this case P^{b*} and the LHS of (A.10) are equal to $\sqrt{2k\left(R-X^L\right)}$, which precisely corresponds to the highest possible value of P^{g*}, i.e. the one obtained when $\phi=1$. When $\Pi^{b*}>0$, $P^{b*}>\sqrt{2k\left(R-X^L\right)}$. Also, $P^{b*}-\Pi^{b*}$ increases in P^{b*} because $P^{b*}-\Pi^{b*}=P^{b*}-\frac{\left(P^{b*}\right)^2}{2k}+\left(R-X^L\right)$ and $\frac{\partial\left(P^{b*}-\Pi^{b*}\right)}{\partial P^{b*}}=1-\frac{P^{b*}}{k}>0$. Then, when $\Pi^{b*}>0$, $P^{b*}-\Pi^{b*}$ is always higher than $\sqrt{2k\left(R-X^L\right)}$ and $\Pi^g_{mim}\left(C^{b*}\right)<\Pi^{g*}$. This proves that (A.9) always holds.

We next focus on the truth-telling condition for the b-EN. In this perspective, we first analyze the effect of ϕ on Π^b_{mim} and we try to find out the level of ϕ which maximizes Π^b_{mim}. From (A.8) and (22) we have:

$$\frac{d\Pi^b_{mim}}{d\phi}=\frac{P^{g*}}{k\sqrt{d_g}}\left[\left(\sqrt{d_g}-2\right)P^{g*}+\Delta X\right] \tag{A.11}$$

From (A.11), we see that the sign of $\frac{d\Pi^b_{mim}}{d\phi}$ depends on the sign of $\left(\sqrt{d_g}-2\right)P^{g*}+\Delta X$. Using P^{g*} and d_g defined in Proposition 2, this last expression is equivalent to $\Delta X+2\left[R-X^L\right]-(3-\phi)P^{g*}$. Then $\frac{d\Pi^b_{mim}}{d\phi}=0$ if $P^{g*}=\frac{\Delta X}{2-\sqrt{d_g}}$, equivalent to $P^{g*}=\frac{\Delta X+2\left[R-X^L\right]}{3-\phi}$. Replacing P^{g*} by its equilibrium value $\frac{k}{\phi^2}\left[\sqrt{d_g}-(1-\phi)\right]$, we find two values of ϕ that yield $\frac{d\Pi^b_{mim}}{d\phi}=0$:

$$\begin{aligned}\phi_1&=\frac{4k\left[R-X^L+2\Delta X\right]+\sqrt{\Delta_{mim}}}{2C}\\ \phi_2&=\frac{4k\left[R-X^L+2\Delta X\right]-\sqrt{\Delta_{mim}}}{2C}\end{aligned} \tag{A.12}$$

with $\Delta_{mim}=8k\left\{\Delta X+2\left(R-X^L\right)\right\}^2\left\{2k-3\left[\Delta X-\left(R-X^L\right)\right]\right\}$ and $C=\left\{\Delta X+2\left(R-X^L\right)\right\}^2+2k\left\{\Delta X+\left(R-X^L\right)\right\}$. It is direct that $\Delta_{mim}<0$ and $\frac{d\Pi^b_{mim}}{d\phi}$ is always positive for $\phi\in[0,1]$ if $k<\frac{3\left(X^H-R\right)}{2}$. If instead $k>\frac{3\left(X^H-R\right)}{2}$, then $\Delta_{mim}>0$ and we compute the second-order derivative in order to determine which of these two roots maximizes Π^b_{mim}:

$$\begin{aligned}\frac{d^2\Pi^b_{mim}}{d\phi^2}=\frac{1}{k^2d_g}&\left\{\left[\Delta X-P^{g*}\left(2-\sqrt{d_g}\right)\right]\left[\frac{dP^{g*}}{d\phi}k\sqrt{d_g}-kP^{g*}\frac{d\sqrt{d_g}}{d\phi}\right]\right.\\ &\left.-P^{g*}k\sqrt{d_g}\left[\frac{dP^{g*}}{d\phi}\left(2-\sqrt{d_g}\right)-P^{g*}\frac{d\sqrt{d_g}}{d\phi}\right]\right\}\end{aligned} \tag{A.13}$$

We know that $P^{g*}=\frac{\Delta X}{2-\sqrt{d_g}}$ for the level of ϕ that maximize Π^b_{mim} and the first term of (A.13) is equal to 0. Then, $\frac{d^2\Pi^b_{mim}}{d\phi^2}$ is negative if and only $\frac{dP^{g*}}{d\phi}\left(2-\sqrt{d_g}\right)>P^{g*}\frac{d\sqrt{d_g}}{d\phi}$, equivalent to

$\phi < \frac{6k}{4k+9(R-X^L)}$. With the expressions of ϕ_1 and ϕ_2 defined by (A.12), it is easy to show that this condition is satisfied when $\phi = \phi_2$ whereas $\phi > \frac{6k}{4k+9(R-X^L)}$ when $\phi = \phi_1$. This proves that the level ϕ^* of overoptimism that maximizes Π^b_{mim} is equal to ϕ_2 when $k > \frac{3(X^H-R)}{2}$. In this case, knowing that P^{g*} increases in ϕ (see corollary 1) and considering (A.11), it follows that $\frac{d\Pi^b_{mim}}{d\phi} > 0$ if $\phi < \phi^*$ and $\frac{d\Pi^b_{mim}}{d\phi} < 0$ if $\phi > \phi^*$.

We have now to establish the conditions under which the b-EN has incentives to mimick C^{g*}. We have already demonstrated that $\frac{d\Pi^b_{mim}}{d\phi} > 0$ when $k < \frac{3(X^H-R)}{2}$, which implies that in this case Π^b_{mim} is maximized when $\phi = 1$. We also know by the first part of this proof that $\Pi^b_{mim}(\phi = 1) \leq \Pi^{b*}$. Then, the b-EN has never incentive to mimick and there exists a separating equilibrium with (C^{g*}, C^{b*}) when $k < \frac{3(X^H-R)}{2}$. This is illustrated by the case when $k = 3$ in Figure 2.

Consider now the case where $k > \frac{3(X^H-R)}{2}$, i.e. the case where Π^b_{mim} is not strictly increasing in Φ and where there exists a level of overoptimism ϕ^* that maximizes Π^b_{mim}. Define k_{mim} as the lower k such as the mimicking risk may exist. This threshold is implicitly defined by $\Pi^b_{mim}(\phi^*, k_{mim}) = \Pi^{b*}(k_{mim})$ with ϕ^* depending on k_{mim}, which is equivalent to :

$$P^{g*}(\phi^*) = \frac{\Delta X}{2} + \frac{\sqrt{d_{mim}}}{2\phi^*} \tag{A.14}$$

with $d_{mim} = (\phi^*\Delta X)^2 - 4\phi^* k_{mim}\left[\Pi^{b*}(k_{mim}) + e\right]$. We also know that $P^{g*}(\phi^*) = \frac{\Delta X}{2-\sqrt{d_g}} = \frac{\Delta X + 2(R-X^L)}{3-\phi^*}$. Then, the threshold k_{mim} is implicitly defined by the following equation:

$$\frac{\Delta X + 2\left(R - X^L\right)}{3 - \phi^*} = \frac{\Delta X}{2} + \frac{\sqrt{d_{mim}}}{2\phi^*} \tag{A.15}$$

with $\phi^* = \phi_2$ defined by (A.12). Some tedious calculus shows that $\frac{d\Pi^b_{mim}(\phi^*)}{dk}$ and $\frac{d\Pi^{b*}}{dk}$ are both negative and that $\left|\frac{d\Pi^b_{mim}(\phi^*)}{dk}\right| < \left|\frac{d\Pi^{b*}}{dk}\right|$. This result, considered simultaneously with the fact that $\Pi^b_{mim}(\phi^*, k_{mim}) = \Pi^{b*}(k_{mim})$, proves that $\Pi^b_{mim}(\phi^*) > \Pi^{b*}$ when $k > k_{mim} > \frac{3[X^H-R]}{2}$. In this case, we can also conclude that there exists a threshold ϕ' such as $\Pi^b_{mim}(\phi') = \Pi^{b*}$ and $0 \leq \phi' < \phi^*$ because we know that $\frac{d\Pi^b_{mim}}{d\phi} > 0$ when $0 \leq \phi < \phi^*$ and that $\Pi^b_{mim}(\phi = 0) < \Pi^{b*}$. Similarly, the fact that Π^b_{mim} is decreasing in ϕ when $\phi > \phi^*$ and that $\Pi^b_{mim}(\phi = 1) < \Pi^{b*}$ proves that there exists a threshold ϕ'' such as $\Pi^b_{mim}(\phi'') = \Pi^{b*}$ and $\phi^* \leq \phi'' < 1$ when

$k > k_{mim}$. We conclude that, when $k > k_{mim}$, there exists a separating equilibrium (C^{g*}, C^{b*}) in the only case when $\phi \in [0, \phi'] \cap [\phi'', 1]$. When it exists, the separating equilibrium (C^{g*}, C^{b*}) defeats all the other putative separating equilibria because the g-EN is strictly better off with the equilibrium (C^{g*}, C^{b*}) while the b-EN is weakly better off with (C^{g*}, C^{b*}) than with any other separating equilibrium. This proves Case 1.

Consider now the case when separating with (C^{g*}, C^{b*}) is not feasible (Case 2). Define P^g_{sep} as the minimum feasible incentive package that dissuades mimicking. By Proposition 2, we know that in a separating contract where the g-EN sets $P^g = P^g_{sep}$ the financier's effort is $m^g_{sep} = \frac{\phi P^g_{sep}}{k}$, the allocation of cash-flows is such that $\left(1 - \alpha^g_{L_{sep}}\right) = 1$ and $\left(1 - \alpha^g_{H_{sep}}\right) = \frac{X^L + P^g_{sep}}{X^H}$, and the g-EN's expected payoff is $\Pi^g_{sep} = \Delta X - P^g_{sep} - e$. The problem is now to determine P^g_{sep}. By definition P^g_{sep} is such that $\Pi^b_{mim}(P^g_{sep}) = \Pi^{b*}$. That means that (19) is set to equality when we replace m^g and α^g_H by m^g_{sep} and $\alpha^g_{H_{sep}}$, respectively. This condition is equivalent to:

$$-\phi \left(P^g_{sep}\right)^2 + \phi \Delta X P^g_{sep} - k \left[\Pi^{b*} + e\right] = 0 \tag{A.16}$$

The discriminant of this polynomial in P^g_{sep} is $d_{sep} = \phi^2 (\Delta X)^2 - 4k\phi \left(\Pi^{b*} + e\right)$, which is strictly positive when $k > k_{mim}$. (A.16) has two positive roots: $\frac{\Delta X}{2} + \frac{\sqrt{d_{sep}}}{2\phi}$ and $\frac{\Delta X}{2} - \frac{\sqrt{d_{sep}}}{2\phi}$. If $k > k_{mim}$ and $\phi \in]\phi', \phi''[$, we know that $\frac{\Delta X}{2} - \frac{\sqrt{d_{sep}}}{2\phi} \leq P^{g*} \leq \frac{\Delta X}{2} + \frac{\sqrt{d_{sep}}}{2\phi}$. Decreasing the incentive package from P^{g*} to $\frac{\Delta X}{2} - \frac{\sqrt{d_{sep}}}{2\phi}$ is not a viable strategy because the financier's IR would not hold. Then, the only way to separate is to increase the incentive package from P^{g*} to $P^g_{sep} = \frac{\Delta X}{2} + \frac{\sqrt{d_{sep}}}{2\phi}$. Obviously, the financier obtains a positive expected payoff when the g-EN chooses C^g_{sep} characterized by $\left(1 - \alpha^g_{L_{sep}}\right) = 1$ and $P^g_{sep} = \frac{\Delta X}{2} + \frac{\sqrt{d_{sep}}}{2\phi}$. Also, it is straighforward to prove that when $k > k_{mim}$ and $\phi \in]\phi', \phi''[$, the separating equilibrium $\left(C^g_{sep}, C^{b*}\right)$ defeats all the other separating equilibria. Indeed, if we consider any putative separating equilibrium (C^g, C^{b*}), a g-EN is always strictly better off with C^g_{sep} than with any $C^g \neq C^g_{sep}$ while a b-EN is indifferent.

Proof of Corollary 2: We know by Proposition 4 that: (i)$\frac{d\Pi^{b*}}{dk} < 0$, (ii) $\Pi^b_{mim}(\phi') = \Pi^b_{mim}(\phi'') = \Pi^{b*}$, (iii) $\frac{d\Pi^b_{mim}}{d\phi} > 0$ when $\phi < \phi^*$ and $\frac{d\Pi^b_{mim}}{d\phi} < 0$ when $\phi > \phi^*$, (iv) $\phi' < \phi^*$ and $\phi'' > \phi^*$. Then, it is direct that ϕ' decreases and that ϕ'' increases when k increases. This demonstrates that the region $\phi \in [0, \phi'] \cap [\phi'', 1]$ where both types of ENs choose their symmetric information contracts (C^{g*}, C^{b*}) is reduced when k increases.

Proof of Proposition 5: In a pooling equilibrium, $C^g = C^b = \widetilde{C}$, $\mu\left(G\middle|\widetilde{C}\right) = \theta$, $\mu\left(B\middle|\widetilde{C}\right) = 1-\theta$ and $\widetilde{m} = \frac{\widetilde{P}(1-\theta)}{k}$. For simplicity, we will throughout place a restriction on the financier's beliefs off-the-equilibrium path, namely that he considers any deviating contract $C \neq \widetilde{C}$ to be quoted by a b-EN. Then, pooling exists if each type of EN is better off with $\widetilde{C}$ than with his "best" deviating contract C when the financier's beliefs are such that $\mu\left(b\middle|C\neq\widetilde{C}\right) = 1$. In this context, it is obvious that the best alternative strategy for a b-EN is to select C^{b*}defined in Proposition 1 which yields an outcome Π^{b*}. Then, in any pooling equilibrium, we must have $\widetilde{\Pi}^b \geq \Pi^{b*}$. Consider now the best alternative strategy for a g-EN. If $\mu\left(b\middle|C\neq\widetilde{C}\right) = 1$, a g-type who deviates from $\widetilde{C}$ is viewed as a self-unconfident and poorly-skilled manager by the financier. Then, his best deviating contract is $C^{g*}(\phi=1)$, i.e. his symmetric information contract when the financier is certain that a g-EN is overoptimistic. Then, $\widetilde{\Pi}^g \geq \Pi^{g*}(\phi=1)$ is a necessary condition for a pooling equilibrium to exist. More generally, the conditions for a pooling equilibrium to exist are:

$$\widetilde{\Pi}^b \geq Max\left[\widetilde{\alpha}_L X^L, \Pi^{b*}\right] \tag{A.17}$$

$$\widetilde{\Pi}^g \geq Max\left[\widetilde{\alpha}_L X^L, \Pi^{g*}(\phi=1)\right] \tag{A.18}$$

$$\frac{(1-\theta)^2}{2k}\widetilde{P}^2+\theta\widetilde{P}+(1-\widetilde{\alpha}_L)X^L \geq R \tag{A.19}$$

(A.17) and (A.18) are the incentive conditions for a b-EN and a g-EN, respectively. Each type $s=g,b$ must have incentives to exert effort with the pooling contract ($\widetilde{\Pi}^s \geq \widetilde{\alpha}_L X^L$) and must obtain more with the pooling contract than with his "best" deviating contract. (A.19) is the financier's IR condition.

Consider first the effect of $1-\theta$ on the existence of a pooling equilibrium. When $1-\theta$ tends to 0, we know by (25) that $\widetilde{m}$ tends to 0 and that $\widetilde{\Pi}^b$ tends to $\widetilde{\alpha}_L X^L - e$, which violates condition (A.17). There is no pooling equilibrium in this case. When $1-\theta$ tends to 1, $\widetilde{m}$ tends to $\frac{\widetilde{P}}{k}$. In this case, it is immediate that the two types of ENs are worse off with a pooling contract than with their best deviating contract. In particular, a b-EN has no incentives to mimic a g-EN whose managerial ability is almost the same than his own.

As common, there exist many pooling equilibria that satisfy conditions (A.17) to (A.19). Among these equilibria a distinction can be made between those that are more favorable to self-confident ENs and those that are more favorable to self-unconfident ones.

We proceed first to characterize the best pooling equilibrium from the point of view of the g-EN. It is obvious that a g-EN prefers a pooling equilibrium where the contract $\widetilde{C}$ sets $\widetilde{\alpha}_L = 0$ and gives the financier the lowest possible incentive package. From (A.19), it is straighforward that the lowest $\widetilde{P}$ that satisfies the financier's IR condition when $\widetilde{\alpha}_L = 0$ is $\widetilde{P} = \frac{k\left(\sqrt{\widetilde{d}}-\theta\right)}{(1-\theta)^2}$ with $\widetilde{d} = \theta^2 + 2\frac{(1-\theta)^2\left[R-X^L\right]}{k}$. Comparing this expression of $\widetilde{P}$ with P^{g*} defined in Proposition 2, it is immediate that $\widetilde{P} = P^{g*}(\phi = 1-\theta)$. Then, the best pooling contract for the g-EN, defined by $1-\widetilde{\alpha}_L = 1$ and $\widetilde{P} = P^{g*}(\phi = 1-\theta)$, is similar to the g-EN's optimal contract $C^{g*}(\phi = 1-\theta)$ when information is symmetric and when all ENs are optimistic, i.e. when $\phi = 1-\theta \Leftrightarrow 1-\gamma = 1$. It is immediate that condition (A.18) always holds with this contract because Π^{g*} decreases in ϕ and $\widetilde{\Pi}^g \equiv \Pi^{g*}(\phi = 1-\theta) \geq \Pi^{g*}(\phi = 1)$. Consider now the incentive condition for the b-EN. With this pooling contract, (A.17) holds if:

$$\widetilde{\Pi}^b \equiv \Pi^b_{mim}(\phi = 1-\theta) \geq \Pi^{b*} \tag{A.20}$$

By Proposition 4, it is direct that (A.20) never holds when $k < k_{mim}$, the case when the separating equilibrium with (C^{g*}, C^{b*}) always exists. In contrast, (A.20) holds and the best pooling contract for the g-EN exists if $k > k_{mim}$ and $1-\theta \in]\phi', \phi''[$. Also, we know by the proof of Corollary 2 that ϕ'' increases with k. Then, when $k > \widetilde{k}$ with $\widetilde{k}$ such that $\phi''(\widetilde{k}) = 1-\theta$, it is immediate that $\phi'' > 1-\theta$ and that the best pooling contract always exists.

We prove now that when $k > \widetilde{k}$, i.e. when pooling at $C^{g*}(\phi = 1-\theta)$ exists, this equilibrium is the sole to survive the equilibrium.refinement. In order to simplify notations, denote by $\widetilde{C}_1$ the contract $C^{g*}(\phi = 1-\theta)$ and by $\widetilde{C}_2$ any other pooling contract that is more favorable to a b-EN (less favorable to the g-EN). In other words, $\widetilde{\Pi}^g\left(\widetilde{C}_1\right) > \widetilde{\Pi}^g\left(\widetilde{C}_2\right)$ and $\widetilde{\Pi}^b\left(\widetilde{C}_2\right) > \widetilde{\Pi}^b\left(\widetilde{C}_1\right)$. From these inequalities, it is immediate that neither pooling at $\widetilde{C}_1$ nor pooling at $\widetilde{C}_2$ defeats the other pooling equilibrium.

We next apply the D1 criterion (Cho and Kreps 1987, Cho and Sobel 1990). For that, consider first the putative pooling equilibrium at $\widetilde{C}_1$. Financiers observing a deviation to $\widetilde{C}_2$ should eliminate the g-EN as the potential defector. They should infer $\mu\left(b \left| \widetilde{C}_2\right.\right) = 1$ and should set the intensity of their support to $\frac{\widetilde{P}_2}{k}$. By Proposition 1, we know that the maximum full information payoff of the b-EN is obtained with the contract C^{b*} and is equal to Π^{b*}. Thus, it is immediate that a b-EN identified as such by the financier is always worse off with $\widetilde{C}_2$ than with C^{b*}. Coupled with the fact that $\widetilde{\Pi}^b\left(\widetilde{C}_1\right) \geq \Pi^{b*}$ (otherwise pooling at $\widetilde{C}_1$ would not exist), this implies that the b-EN is better off not deviating to $\widetilde{C}_2$. It follows that pooling at $\widetilde{C}_1 = C^{g*}\left(\phi = 1-\theta\right)$ survives the D1 criterion.

Consider now the putative equilibrium at $\widetilde{C}_2$. A deviation to $\widetilde{C}_1$ should be attributed to a g-EN, i.e. $\mu\left(g \left| \widetilde{C}_1\right.\right) = 1$. With these beliefs, financiers should reduce the intensity of their support to $\frac{(1-\theta)\widetilde{P}_1}{k}$. However, the g-EN obtains exactly the same expected payoff $\widetilde{\Pi}^g\left(\widetilde{C}_1\right)$ than when pooling at $\widetilde{C}_1$ because his (subjective) exepected payoff only depends on the cash-flows he obtains in case of success. As $\widetilde{\Pi}^g\left(\widetilde{C}_1\right) \geq \widetilde{\Pi}^g\left(\widetilde{C}_2\right)$, it follows that the g-EN deviates to $\widetilde{C}_1$. It can also be easily checked that the financier's IR condition always holds with $\widetilde{C}_1$ and $\mu\left(g \left| \widetilde{C}_1\right.\right) = 1$. It results that $\widetilde{C}_2$ does not survive the D1 refinement.

Proof of proposition 6: In this case, it is useful to present the main findings of Propositions 4 to 5 by referring to *optimism* thresholds rather than to *overoptimism* thresholds. This is done in the following corollary.

Corollary to Propositions 4 to 5: When the proportion $(1-\theta)$ of bad managers is fixed and is not too extreme:

(i). If $k < k_{mim}$, the most plausible equilibrium with separation is $(C^{g*},\, C^{b*})$ whereas pooling may occur with $\widetilde{C} \neq C^{g*}\left(\phi = 1-\theta\right)$.

(ii). If $k_{mim} < k < \widetilde{k}$, the most plausible equilibrium with separation is $(C^{g*},\, C^{b*})$ when $1-\gamma \in [0, 1-\gamma'] \cap [1-\gamma'', 1]$ and $(C^g_{sep},\, C^{b*})$ when $1-\gamma \in]1-\gamma', 1-\gamma''[$. Then, $1-\gamma'$ and $1-\gamma''$ represent, respectively, the minimum and the maximum proportion of optimistic ENs for which the symmetric-information equilibrium $(C^{g*},\, C^{b*})$ does not exist. Also, in this case pooling may occur with $\widetilde{C} \neq C^{g*}\left(\phi = 1-\theta\right)$.

(iii). If $k > \widetilde{k}$, the most plausible equilibrium with separation is $(C^{g*},\, C^{b*})$ when $1-\gamma \in$

$[0, 1-\gamma']$ *and* (C^g_{sep}, C^{b*}) *when* $1-\gamma \in]1-\gamma', 1]$. *Also, the most plausible equilibrium with pooling is* $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$.

We proceed next in three steps.

Step 1. We start by proving that the separating equilibrium with (C^{g*}, C^{b*}), when it exists, always defeats any putative pooling equilibrium. This is true if $\Pi^{g*} > \widetilde{\Pi}^g$and $\widetilde{\Pi}^b \geq \Pi^{b*}$. Also we know by (A.17) and (A.18) that a pooling equilibrium exists if $\widetilde{\Pi}^b \geq \Pi^{b*}$ and $\widetilde{\Pi}^g \geq \Pi^{g*}(\phi = 1)$. A sufficient condition to prove that separating with (C^{g*}, C^{b*}) defeats any feasible pooling equilibrium is then to show that $\Pi^{g*} > \Pi^{g*}(\phi = 1)$. Because Π^{g*} decreases in ϕ and $\phi < 1$ (otherwise pooling would not be feasible), this condition always holds. This establishes parts (i), (iia) and (iiia) of Proposition 6.

Step 2. We prove next that the separating equilibrium with (C^g_{sep}, C^{b*}) always defeats putative pooling equilibria when the best pooling equilibrium for the g-EN, defined by $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$, does not exist. For that, we need just to demonstrate that $\Pi^g_{sep} > \widetilde{\Pi}^g$ when pooling at $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$ is impossible. From previous results, we know that: $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$ cannot be part of a pooling equilibrium if $k \leq \widetilde{k}$, equivalent to $\phi'' < 1-\theta$ (Proposition 5), $\Pi^g_{sep}(\phi'') = \Pi^{g*}(\phi'')$ (Proposition 4), Π^{g*} decreases in ϕ (Corollary 1) and $\widetilde{\Pi}^g < \Pi^{g*}(\phi = 1-\theta)$ when pooling at $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$ is impossible. Combining these previous findings, it follows that $\Pi^g_{sep}(\phi'') \equiv \Pi^{g*}(\phi'') > \Pi^{g*}(1-\theta) > \widetilde{\Pi}^g$ when $\phi'' < 1-\theta$. We also know that $\Pi^g_{sep}(\phi)$ decreases in ϕ and that ϕ'' is the lowest level of overoptimism for which separation with (C^g_{sep}, C^{b*}) is possible, which implies that $\Pi^g_{sep} > \widetilde{\Pi}^g$ when $\phi'' < 1-\theta$. This proves that the separating equilibrium with (C^g_{sep}, C^{b*}) always defeats pooling equilibria with $\widetilde{C} \neq C^{g*}(\phi = 1-\theta)$. This establishes part (iib) of Proposition 6.

Step 3. As a final step, we consider the case when the separating equilibrium with (C^g_{sep}, C^{b*}) coexists with the best pooling equilibrium for the g-type, i.e the one with $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$. By the above corollary, this case exists when $k > \widetilde{k}$ (which is equivalent to $\phi'' > 1-\theta$ when $1-\theta$ is fixed) and when $1-\gamma \in]1-\gamma', 1]$ (which is equivalent to $\phi \in]\phi', 1-\theta]$). By following the same reasoning than in steps 1 and 2, separating at (C^g_{sep}, C^{b*}) defeats pooling at $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$ if $\Pi^g_{sep} > \widetilde{\Pi}^g \equiv \Pi^{g*}(\phi = 1-\theta)$.

We first compare Π^g_{sep} and $\widetilde{\Pi}^g$ when $\phi = \phi'$. By definition, $\Pi^g_{sep}(\phi') = \Pi^{g*}(\phi')$. Because

$\phi' > 1-\theta$ (otherwise the equilibrium with C^g_{sep} and C^{b*} would not exist) and Π^{g*} increases in ϕ, it is immediate that $\Pi^g_{sep}(\phi') \equiv \Pi^{g*}(\phi') > \widetilde{\Pi}^g \equiv \Pi^{g*}(\phi = 1-\theta)$. Then, the separating equilibrium with (C^g_{sep}, C^{b*}) defeats the pooling equilibrium with $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$ when $\phi = \phi' \Leftrightarrow 1-\gamma = 1-\gamma'$. Let consider now the situation when $\phi = 1-\theta \Leftrightarrow 1-\gamma = 1$, i.e. when all ENs are optimistic. By the proof of Proposition 4, we know that $\Pi^g_{sep} < \Pi^{g*}$ when $k > k_{mim}$ and $\phi \in]\phi', \phi''[$, i.e. when the separating equilibrium with (C^g_{sep}, C^{b*}) defeats all the other separting equilibria. Combined with the fact that $\phi'' > 1-\theta$, this proves that $\Pi^g_{sep}(\phi = 1-\theta) < \widetilde{\Pi}^g \equiv \Pi^{g*}(\phi = 1-\theta)$ and hence that pooling at $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$ defeats separating at (C^g_{sep}, C^{b*}) when $1-\gamma = 1$.

Finally, when $1-\theta$ is fixed, $\widetilde{\Pi}^g \equiv \Pi^{g*}(\phi = 1-\theta)$ does not change when $1-\gamma$ varies and Π^g_{sep} decreases with $1-\gamma$ as:

$$\frac{dP^g_{sep}}{d\phi} = \frac{k\phi\left(\Pi^{b*}+e\right)}{\phi^2\sqrt{d_{sep}}} > 0 \tag{A.21}$$

The facts that $\Pi^g_{sep}(1-\gamma = 1-\gamma') > \widetilde{\Pi}^g > \Pi^g_{sep}(1-\gamma = 1)$ and that Π^g_{sep} decreases with $1-\gamma$ is sufficient to prove that there exists a proportion $1-\widetilde{\gamma} \in [1-\gamma', 1]$ such that the separating equilibrium with (C^g_{sep}, C^{b*}) defeats the pooling equilibrium with $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$ if $1-\gamma \in [1-\gamma', 1-\widetilde{\gamma}]$ and that the pooling equilibrium with $\widetilde{C} \equiv C^{g*}(\phi = 1-\theta)$ defeats the separating equilibrium with (C^g_{sep}, C^{b*}) if $1-\gamma \in]1-\widetilde{\gamma}, 1]$. This establishes parts (iiib) and (iiic) of Proposition 6.

Proof of corollary 3: We know from Proposition 4 that mimicking is more likely when $\frac{\Delta X}{k}$ is high. If the g-EN runs the risk of being mimicked but k tends to k_{mim}, the cost of separation is low, i.e P^g_{sep} is only slightly higher than P^{g*} in the interval $]\phi', \phi''[$. We also know that $\widetilde{P} = P^{g*}(\phi = 1-\theta)$ and $\frac{dP^{g*}}{d\phi} \geq 0$, which implies that $\widetilde{P} > P^{g*}$ if there are some optimistic ENs. Then, when k tends to k_{mim}, $\widetilde{P} > P^g_{sep}$ and separation is optimal. By the same reasoning, $\widetilde{P}$ increases ($\widetilde{\Pi}^g$ decreases) when $1-\theta$ increases and renders pooling less frequent (as regard to separation) when mimicking is an attractive strategy for the b-EN.

Proof of corollary 4: We already know that $\widetilde{P} = P^{g*}(\phi = 1-\theta)$ and $\frac{dP^{g*}}{d\phi} \geq 0$. Then, $\widetilde{P}$ is increasing in $1-\theta$ and does not vary when only $1-\gamma$ varies. In contrast, P^g_{sep} is increasing in $1-\theta$ and is also increasing in $1-\gamma$ because $\frac{dP^g_{sep}}{d\phi} > 0$ (A.21). Then, all else equal, increasing

$1-\gamma$ renders the pooling equilibrium more probable (because $\widetilde{P}$ does not change, P^g_{sep} increases and the pooling equilibrium prevails when $\widetilde{P} < P^g_{sep}$). For a given level of internal risk ϕ, P^g_{sep} is fixed and $\widetilde{P}$ is low when $1-\theta$ is low (and $1-\gamma$ is high) whereas $\widetilde{P}$ is high when $1-\theta$ is high (and $1-\gamma$ is low). Then, the separating equilibrium with C^g_{sep} is more probable when $1-\theta$ is low and $1-\gamma$ is high while the pooling equilibrium with C_{pool} is more probable when $1-\theta$ is high and $1-\gamma$ is low.

Proof of proposition 7: Consider first the value of implementing advice for the financier when confronted to a g-EN. Without implementation the expected payoff of the financier is $(1-\phi)\left(1-\alpha^g_H\right)X^H + \phi X^L$ (because the g-EN optimally sets $\alpha^g_L = 0$). With implementation, the financier obtains: $(1-\phi)\left(1-\alpha^g_H\right)X^H + \phi\left[m^g\left(1-\alpha^g_H\right)X^H + (1-m^g)X^L\right]$. By differentiation, the incremental value for the financier of implementing advice when the EN is self-confident is $\phi m^g P^g$ with $P^g = \left(1-\alpha^g_H\right)X^H - X^L$. If the EN has control ($\delta = 1$), he can holdup $\rho\phi m^g_{\delta=1}P^g_{\delta=1}$ through renegotiation where $m^g_{\delta=1}$ and $P^g_{\delta=1}$ depend on the initial contract $C^g_{\delta=1}$ signed between the g-EN and the financier when $\delta = 1$. Obviously, this ex post holdup has a direct effect on the initial contract $C^g_{\delta=1}$ because the financier anticipates this holdup when he computes his expected profit. The optimal contract when the EN is in control must then satisfy the following financier's participation constraint:

$$(1-\phi)P^g_{\delta=1} + (1-\rho)\phi m^g_{\delta=1}P^g_{\delta=1} - 0.5k\left(m^g_{\delta=1}\right)^2 - (R - X^L) \geq 0 \qquad \text{(A.22)}$$

The financier computes his supporting effort $m^g_{\delta=1}$ in order to maximize $(1-\phi)P^g_{\delta=1} + (1-\rho)\phi m^g_{\delta=1}P^g_{\delta=1} - 0.5k\left(m^g_{\delta=1}\right)^2 + X^L$, which yields to:

$$m^g_{\delta=1} = \frac{(1-\rho)\phi P^g_{\delta=1}}{k} \qquad \text{(A.23)}$$

Setting (A.22) at equality and using the value of $m^g_{\delta=1}$ defined by (A.23), it is direct that:

$$P^g_{\delta=1} = \frac{k\left[\sqrt{(1-\phi)^2 + \frac{2(1-\rho)^2\Phi^2}{k}\left(R - X^L\right)} - (1-\phi)\right]}{(1-\rho)^2\phi^2} \qquad \text{(A.24)}$$

It is straighforward that $P^g_{\delta=1} > P^{g*}$ if $(1-\rho) < 1$, which illustrates the fact that $C^g_{\delta=1}$

gives a higher upside to the financier when the EN has both control and a positive bargaining power (i.e. when $\rho > 0$).

Finally, we have to compare the g-EN's expected profit when the EN has control ($\delta = 1$) and when the financier has control (when $\delta = 0$, which corresponds to the case described in Proposition 2). It is immediate that the g-EN prefers allocating control rights to the financier if:

$$P^{g*} \leq P^g_{\delta=1}\left[1 - \rho\phi m^g_{\delta=1} P^g_{\delta=1}\right] \tag{A.25}$$

Simple computation shows that (A.25) holds at equality when $\rho = 0$ and that $P^g_{\delta=1}\left[1 - \rho\phi m^g_{\delta=1} P^g_{\delta=1}\right]$ is strictly higher than P^{g*} when $\rho > 0$. This permits us to conclude that the g-EN is always better off by allocating the control rights to the financier.

Proof of proposition 8: For the sake of simplicity, we consider here the extreme case where the EN has all the bargaining power if renegotiation occurs ($\rho = 1$). Not however that the results presented in Proposition 8 also hold when ρ is sufficiently high.

When the EN has control and has all the bargaining power, the optimal symmetric information contract for a g-EN sets $m^{g*} = 0$ and $\alpha^{g*}_L = 0$. The financier's participation constraint is:

$$(1-\phi)\left(1-\alpha^g_H\right)X^H + \phi X^L \geq R \tag{A.26}$$

The g-EN has incentives to provide effort if $\alpha^{g*}_H X^H \geq e$. This constraint holds when (A.26) is binding if:

$$\phi \leq \frac{X^H - R - e}{\Delta X - e} \equiv \phi_{\min} \tag{A.27}$$

If (A.27) holds, the g-EN issues a debt-like security (with $m^{g*} = 0$, $\alpha^{g*}_L = 0$ and $\alpha^g_H = 1 - \frac{R-\phi X^L}{(1-\phi)X^H}$), while the b-EN issues the security C^{b*} defined in Proposition 1. If (A.27) does not hold, the g-EN is denied financing if he reveals his type and has then incentives to mimick the b-EN. The latter cannot separate because any separating contract would suppose to set α^b_H such as $\alpha^b_H X^H - e \leq 0$ in order to dissuade mimicking, which would destroy the b-EN's incentive to provide effort. Consider now the conditions under which a pooling equilibrium exists. In a pooling equilibrium, the financier's chooses the intensity of his effort by maximizing

$(1-\widetilde{\alpha}_L)\,X^L+\widetilde{P}\,[\theta+\widetilde{m}\text{Pr}(s=b)]-\frac{k\widetilde{m}^2}{2}$, which yields to:

$$\widetilde{m}^*=\frac{\Pr(s=b)\,.\widetilde{P}}{k} \tag{A.28}$$

Also, pooling is feasible if and only if:

$$\frac{ke}{\widetilde{P}\left(\Delta X-\widetilde{P}\right)}\leq \Pr(s=b)<\frac{R-X^L-\theta\,(\Delta X-e)}{R-X^L} \tag{A.29}$$

The LHS of (A.29) represents the condition under which the b-EN has incentives to exert effort with the equilibrium financier's effort defined by (A.28). The RHS of (A.29) guarantees that the g-EN is denied financing if he reveals his type, i.e. $\phi>\frac{X^H-R-e}{\Delta X-e}\equiv\phi_{\min}$, and has then incentives to mimick the b-EN. Since $\Pr(s=b)=(1-\theta)\,\gamma$, it is immediate that pooling may exist if the proportion of optimistic ENs is not too high (in order for the LHS of A.29 to hold) nor too low (in order for the RHS of A.29 to hold). A full description of the pooling equilibrium is available upon request.

Proof of proposition 9: Obvious, hence omitted.

Appendix B. Perfect Bayesian Equilibria and equilibrium refinements

In this Appendix, we give additional details on the definitions of PBE and of equilibrium refinements used in Section 4.

The collection $(C^s, m, \mu(. | C^s))$ is a perfect Bayesian equilibrium if the following conditions hold:

- Given C^s and $\mu(. | C^s)$ the financier chooses m to maximize his expected payoff.
- Given its correct expectations about m, EN of type s maximize its expected payoff subject to the financier's IR condition and the EN's IC condition.
- The posterior beliefs $\mu(. | C^s)$ are correct on the equilibrium path. That is, if $C^g \neq C^b$, $\mu(g | C^g) = 1$ and $\mu(g | C^b) = 0$. By contrast, if $C^g = C^b = \widetilde{C}$, $\mu\left(g \middle| \widetilde{C}\right) = \mu_0(g)$.

As is common in signalling models, our model admits multiple PBE. To eliminate equilibria supported by unreasonable out-of-equilibrium beliefs we apply jointly the "undefeated equilibrium" and the D1 refinements. We apply first the "undefeated equilibrium" criterion (Mailath et al. 1993). For that, we require that financiers initially interpret an out-of equilibrium contract as an attempt by some type of EN to shift to another preferred equilibrium. In contrast with other well-known refinements, the "undefeated equilibrium" criterion considers that, starting from a given equilibrium, adjusting the beliefs at some out-of-equilibrium information set cannot be done without simultaneously adjusting beliefs at information sets on the equilibrium path. In our framework, the "undefeated equilibrium" criterion works as follows. Consider a proposed equilibrium σ and a contract $C^{\neq}$ that is not chosen in σ, but is chosen by at least one type in an alternative equilibrium, $\sigma^{\neq}$. Let T be the set of EN's types that choose $C^{\neq}$ in $\sigma^{\neq}$. The alternative equilibrium $\sigma^{\neq}$ defeats σ if each member of T prefers $\sigma^{\neq}$ to σ with a strict preference for at least one member of T. Upon observing $C^{\neq}$ the out-of-equilibrium beliefs must be consistent with the set T. In our model, this means that:

- a separating equilibrium $\sigma^{\neq}$ defeats σ if the g-type strictly prefers $\sigma^{\neq}$ while the b-type prefers σ: $\Pi^g\left(\sigma^{\neq}\right) > \Pi^g(\sigma)$ and $\Pi^b(\sigma) \geq \Pi^b\left(\sigma^{\neq}\right)$.

- a pooling equilibrium $\sigma^{\neq}$ defeats σ if each type of EN prefers $\sigma^{\neq}$ to σ with a strict preference for at least one type: $\Pi^{g}\left(\sigma^{\neq}\right) \geq \Pi^{g}\left(\sigma\right)$, $\Pi^{b}\left(\sigma^{\neq}\right) \geq \Pi^{b}\left(\sigma\right)$ with one inequality strict.

If multiple equilibria survive after applying the "undefeated equilibrium" criterion, we apply the D1 criterion (Cho and Kreps 1987, Cho and Sobel 1990). This refinement requires that a deviation $C^{\neq}$ is more likely to come from some EN's type (e.g. $s = g$) than from the other type (e.g. $s = b$). If so, financiers should put a zero probability on the type of EN that has the less incentive to deviate (e.g. $\mu\left(b \left| C^{\neq}\right.\right) = 0$). An equilibrium is said to survive the D1 refinement if neither of the EN's types has an incentive to deviate.