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ABSTRACT

Entrepreneurs and New Ideas*

Innovative ideas are novel combinations of productive resources potentially addressing an economic need (Schumpeter, 1926). Even promising ideas can be unprofitable if the proposed combination fails on at least one dimension, e.g., it is technically unfeasible or does not respond to a genuine customer need. To screen good ideas the entrepreneur needs to hire experts who evaluate the idea along their dimensions of expertise. Yet sharing the idea creates the risk that an expert would steal it. In this case, the idea-thief cannot contact any other expert, lest he should in turn steal the idea. Thus idea stealing leads to incomplete screening and is unattractive if the information of the other expert is critical or highly complementary. In such cases the entrepreneur can form a partnership with the experts. Yet very valuable ideas cannot be shared because it is too tempting to steal them.

JEL Classification: G31
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Entrepreneurs and new ideas

1 Introduction

Schumpeter (1942, Chapter 12, Part I) emphasized "the role of the entrepreneur ... in reforming or revolutionizing routines of production through taking advantage of an invention or, more generally, hitherto unknown or unused techniques." This role is a difficult one, in particular because innovative ideas are not easy to evaluate and implement. The goal of this paper is to analyze the process through which new ideas are appraised and implemented. In line with Schumpeter (1926, Chapter 2, Part III), we focus on the entrepreneur's crucial function in conceiving and organizing "new combinations of productive factors."[1]

Valuable new ideas represent combinations whose components can be aggregated in a functional way. A possible approach to find innovative solutions is to try out all possible combinations of resources, as in large pharmaceutical firms, specializing in large scale testing. Yet most random combinations are non functional.[2] In contrast, most biotech start ups pursue specific solutions arising from scientific research which identifies ex–ante a specific biological process. The greater success rate of such firms suggests that it is more effective to identify criteria for promising combinations ex–ante than to search over all random combinations. "Ideally, companies should be catching potential failures and terminating them in the early discovery phase" (The Economist, 2002).

Eliminating unprofitable ideas to focus on profitable ones requires examining different aspects such as their technical feasibility, the extent of the potential market, the ability to secure the necessary property rights, their compliance with regulations, and the identification of essential contacts to access scarce logistic or managerial resources. The failure of the idea along a single dimension may be sufficient to reveal that it is not viable. Thus the entrepreneur needs to identify the critical dimensions along which the idea must be assessed, and then secure the collaboration of the relevant experts.

Our emphasis on the collaboration between innovative entrepreneurs and experts is in line with findings in the sociology of sciences. Innovation is a process which relies crucially on the interaction between several individuals (see Dodgson, 1993, Callon, 1989 and Latour, 1979). De Koning and Muzyka (2001) analyse the success factors in the approach of serially successful entrepreneurs and identify "the iterative process in discussing, investigating and evaluating ideas." They note that: "the building of business concepts could

[1] The notion that innovative ideas are novel combinations of pre-existing elements is consistent with the combinatorial theory of innovation developed by Weitzman (1998).

[2] A rule of thumb is that only one out of 10,000 screened molecules will turn out to be of some use for a specific condition (The Economist, 2002).

not be conducted in isolation." Bhide (2000) cites the reliance on experts as a success factor in a number of daring new ventures. There is much evidence that specialized individuals join new ventures early in its life. Specialized individuals, such as business angels, industry specialists, former colleagues contribute significant human capital in early stages of a venture. Eisenhardt and Schoonhoven (1990) report that founding teams of 4 or 5 people are common in start-ups in knowledge intensive industries. Cooper (1986) estimates a 70 % median percentage of start-up firms with two or more full-time partners. Mustar (1998) reports that almost all French hi–tech ventures initiated by scientists involve managerial, finance and marketing partners.[3]

Yet interaction with experts raises the risk that the better ideas, once communicated, may be stolen. Innovative ideas at an early stage of elaboration cannot be protected by patents, hence the idea–stealing problem is much more acute than in the case of more established and formalized ideas. In practice, innovating entrepreneurs are extremely concerned with confidentiality issues[4] (Anton, and Yao, 1994, 2002, 2003; Ueda, 2000; Rajan and Zingales, 2001). De Koning and Muzyka (2001) report a diffuse concern among entrepreneurs that "open discussions could lead to costly theft of ideas and opportunities." They report the case of an entrepreneur who "needs to discuss ideas with his partners and others ... Without 100% confidence that others will not steal his ideas he would not be able to discuss and therefore would not be as successful." Thus, entrepreneurs are faced with a dilemma similar to Arrow's (1962) paradox: On the one hand, potential buyers are not willing to pay before being told the idea and checking its value. On the other hand, they no longer need to pay for idea once they have been told it.

Anton and Yao (1994) offer a solution to this paradox. They analyze how the seller of the idea can secure rents by credibly threatening to destroy the profits of thiefs by transmitting the idea to competitors. Cestone and White (1998) and Baccara and Razin (2002) also emphasize how the threat of competition can deter information leakage and idea stealing. Anton and Yao (2002) enrich these analyses by considering partial disclosure of ideas. An alternative solution is to control access to knowledge, as in Rajan and Zingales (2002) where the internal organization of the firm is designed to deter idea-stealing by employees.

We complement this literature by exploring further the implications of

[3] While business angels can play a significant role at the very preliminary idea formation stage whe analyse in the present paper, venture capitalists tend to intervene much later in the business development process.

[4] According to Bhide', over 70 % of the founders of firms in the Inc 500 list of fast growing young firms replicated or modified ideas encountered in their previous employment. Besen and Raskind (1991) discuss how difficult it is to legally protect intellectual property rights.

the Schumpeterian view that novel ideas are new combinations of productive factors. We show that the entrepreneur can take advantage of the complementarity between the different dimensions of her innovative idea, to mitigate the risk of idea–stealing.

To conduct this analysis we develop the following simple model. The entrepreneur has an innovative idea, i.e. a novel combination of productive factors, which requires evaluation on two dimensions. The idea is at an early stage of development, so it is not patentable. The entrepreneur contacts two advisors, who observe privately if, along their own line of expertise, the project is viable. For the venture to be profitable, it must be feasible along both dimensions. The entrepreneur must extract this private information from the two experts, without letting them steal the idea. Additionally, in order for the idea to be implemented, critical resources (human, physical or financial capital) associated to each dimension of expertise need to be engaged.[5] These resources can be contributed by the experts themselves, if they agree to participate in the implementation phase. For simplicity, we assume that the provision of these resources is observable and contractible.[6]

The entrepreneur presents the idea separately to the experts and offers them a compensation contingent on the output of its implementation, if they both report a positive signal. To ensure a reliable appraisal, it is necessary that i) the experts do not falsely report a good signal when they have observed a bad one, and ii) they prefer to join the venture rather than stealing the idea. We show that if implemented, the venture resembles a partnership.

It is of course very tempting to steal the very best ideas. Yet, idea-stealing is constrained by its very nature. Suppose the first expert decides to steal the idea. Could he contact another expert and disclose the idea, to obtain information on the complementary dimension of the venture? If by doing so he reveals his own signal, then the second expert does not need him any longer. She steals the idea to implement it herself. Suppose on the contrary that the offer of the first expert does not reveal his signal. For this offer to be acceptable by the second expert, the venture must be profitable conditional on her own signal. But, in that case, the second expert is better off using the idea on her own, to avoid sharing the profits with the first expert. Hence, the first expert, when tempted to steal the idea, realizes that he would himself suffer from Arrow's paradox. Thus, we show that if the first expert decides to steal the idea, he must undertake

[5] For example, venture capitalists and business angels typically offer crucial managerial guidance and financial resources, technical partners can further elaborate the product, marketing partners may develop an active marketing strategy, and firms active in the industry may contribute specialized equipment, access to distribution channels, or simply accept to place a first order. We owe this last suggestion to Amar Bhide'.

[6] The differentiates the specialized resources from the expert signals, which are not observable and do require sharing the idea.

the venture alone, and cannot benefit from the expertise of another expert. This reduces the attractiveness of idea–stealing, particularly when the two signals are strongly complementary.

Whether signals on an idea may be reliably aggregated via a partnership depends on the criticality of the information of the experts. Criticality is related to the ex–ante probability of a positive signal. An expert is critical if his signal is so informative that the other expert would not venture alone without his screening. The entrepreneur's ability to elicit evaluations from the experts is enhanced by the fact that joining the partnership allows either expert to benefit from the evaluation offered by the other. Thus when at least one signal is critical, a reliable partnership can be formed. When instead none of the two signals is critical, the project is so attractive from an ex–ante perspective that each expert could profitably undertake it alone. In this case the idea–stealing problem can lead to a market breakdown, in line with Arrow's (1962) paradox: Unless the two dimensions of the project are so complementary that collaborating within the partnership enhances value considerably, efntrepreneurs cannot share the idea with experts, since the rents they would have to concede to deter idea stealing would exceed the cash flows from the project.

Other insightful papers studying contracts and innovations include Aghion and Tirole (1994) who analyze the optimal allocation of control rights on innovation when the outcome of the R&D process is not contractible, and Hellmann (2000) who studies the sequence of resource commitments in a bargaining setting when potential partners can add information. Our paper is also related to the analysis of experts with private signals by Garmaise (2001). These papers do not consider the risk of idea stealing, however. Casamatta and Haretchabalet (2002) analyse the choice by venture capitalists between syndicating with partners to benefit from their expertise, and investing alone to avoid sharing rents. This is similar to the choice by the experts in our model between stealing the idea and staying in the partnership.

Our approach is quite consistent with Lazear's (2002) model and findings (using a sample of Stanford MBAs with their education history) that entrepreneurs are typically nonspecialists with training or skills in different areas, and that an important aspect of their task is to combine talents. In our view the entrepreneur is often not an expert, but rather someone who knows enough about related aspects of business ventures to see some potential functional fit among existing resources, and needs specialists for advice and implementation.

Section 2 presents the model. Section 3 analyzes the conditions under which the entrepreneur can contact experts while avoiding idea stealing and describes the equilibria arising in our model. Section 4 discusses the robustness of various aspects of the analysis. Section 5 concludes. The proofs are in the appendix.

2 Model

2.1 Assumptions

2.1.1 Ideas

We start by modelling the Schumpeterian notion of "combinations of productive factors". For simplicity we consider the case where new combinations involve only two dimensions. For example, the first dimension could correspond to a technological concept while the other could correspond to a business concept. An example of an innovative combination which led to a very profitable project is offered by Federal Express. Its founder, Frederick Smith, "had a bold vision for a company that would operate a national network of jets, trucks and personnel to provide reliable overnight delivery of letters and small packages" (Bhidé, 2000, page 16). Here we can think of the first dimension as the set of transportation techniques, and the second dimension as the demand for rapid post delivery.

Denote $\mathcal{X}$ the set of productive factors in the first dimension, and $\mathcal{Y}$ the set of productive factors in the second dimension. For simplicity we assume that $\mathcal{X}$ and $\mathcal{Y}$ are intervals. An idea is a combination of productive factors from the two sets: $(\omega_x \in \mathcal{X}, w_y \in \mathcal{Y})$. Denote the set of all possible ideas:

$$O = \{(\omega_x, \omega_y), \omega_x \in \mathcal{X}, \omega_y \in \mathcal{Y}\}.$$

Geometrically, O corresponds to the rectangle formed by the two intervals $\mathcal{X}$ and $\mathcal{Y}$.

Most combinations of elements of $\mathcal{X}$ and $\mathcal{Y}$ are valueless and generate zero cash flow. Only a small subset of ideas are promising. Denote O^* the subset of promising ideas. Combinations of productive factors drawn from O^* can generate cash flow equal to H, h, or 0. We assume that O^* has 0 mass with respect to the Lebesgue measure on O. For example, O^* can be a finite set of points in O, or it can be a curve in the space O. Thus, the probability that a random draw from O is in O^* is negligible. Hence, randomly trying arbitrary combinations of productive factors is not a profitable exercise given (even very small) evaluation costs.

While most agents are totally ignorant about O^*, the entrepreneur is endowed with the private information that a given point in O: (ω_x^*, ω_y^*) is a promising idea. This is our definition of an entrepreneur. That is, the entrepreneur knows that:

$$(\omega_x^*, \omega_y^*) \in O^*.$$

2.1.2 Experts

Even promising ideas are not always valuable. To be profitable, they must be feasible along each of the two dimensions. For example, before launching Federal Express, F. Smith had to find out if his idea was technically feasible, if planes and trucks could actually be used in combination to efficiently ship express mail, and if there was sufficient demand for such a service.

While the entrepreneur has intuition, she lacks the technical knowledge to ascertain the feasibility of her innovative idea. Hence, to find out if the idea is feasible, the entrepreneur must obtain advice from specialized experts. Again, in the case of Federal Express, Frederick Smith commissioned a study from A.T. Kearney: "Smith really wanted to know if the concept was practical" said the consultant who led the study (cf Bhidé, 2000, page 172).

To model expertise, we assume that, once he has heard the description of the project, each expert costlessly observes a *private* signal. In line with the notion that the two signals correspond to different dimensions of the idea, we assume they are ex–ante independently distributed. Denote the signals: $\tilde{X}$ and $\tilde{Y}$. Each private signal can be good (in which case it takes the value 1) or bad (corresponding to X or $Y = 0$).

Expert x (resp. y) receives a good signal with probability p_x (resp. p_y) or a bad signal with the complementary probability. If both experts have received good signals, the project is good. If one of the two signals is good and the other is bad, the two components of the idea "do not fit very well together" and the expected cash flow from the project is less than its cost. Finally, if both signals are bad the idea is completely worthless.

Note that, since we allow p_x and p_y to be different, the signals have different significance. An expert signal is more critical for the success of the venture if its ex ante chance of being positive is lower. This increases the value of its informational contribution. We elaborate on this point later.

2.1.3 Cash flows

The entrepreneur obtains the idea and contacts the experts at time 1. If the project is undertaken, it can generate cash flows at time 2. For simplicity we normalize the discount rate to 1.

If both experts observe good signals, the idea is excellent, and the cash flow from the project at time 2 can be equal to H with probability m or h with the complementary probability, with $H > h$.[7] If one of the signals is good and the other is bad, then the cash flow from the project at time 2 is only h. Finally, if both signals are bad, the project yields zero cash flow.

Denote $H(.,.)$ the function mapping the two signals into the expected time 2 cash flows from the project: $H(1,1) = mH + (1-m)h$, $H(1,0) = H(0,1) = h$, and $H(0,0) = 0$. Since by assumption the two signals play a symmetric role in the expected cash flow, slightly abusing notations, we can rewrite the function simply as a function of the number of signals that are good (n): $H(n), n \in \{0,1,2\}$.

[7] The residual uncertainty with two good signals is not necessary, but raises the possibility to distinguish different types of financial claims, such as debt or equity for example.

Associated to each dimension of expertise is a resource (reflecting specialized human, physical or financial capital) which needs to be contributed at time 1 for the implementation of the idea. We assume that such resources can be contributed by the experts, if they agree to participate in the venture. The opportunity cost of the resources committed by each specialist, denoted c, can be thought of implementation costs. For simplicity, we describe this resource contribution as observable and contractible, ruling out any moral hazard. Thus we focus only on the adverse selection problem in aggregating *privately* observed expert signals. We first consider the case where the development cost ($2c$) is paid by the experts. In Section 4 we show that our results are robust to an arbitrary division of this cost between the entrepreneur and the experts.

2.1.4 Complementarity

Although the signals play symmetrical roles, they are not substitutes; rather they correspond to the two different dimensions along which the project must be evaluated, and thus can be complementary.[8] Complementarity arises if the cash flow function $H(n)$ is convex. Convexity means that the marginal increase in value implied by a positive signal is greater if the other signal is also positive, or, more formally:

$$H(2) - H(1) = (mH + (1-m)h) - h \geq H(1) - H(0) = h,$$

that is:

$$H \geq \frac{1+m}{m} h.$$

We assume this inequality holds, to focus on the complementary case, which we believe to be the most realistic for innovative projects. The argument is that in an innovative project, both components of the idea must have a good functional fit, so that if one does fit but the second not, the concept is worth much less.

An extreme form of complementarity is when the project will generate positive cash flows only if both signals are good (i.e., $h = 0$). For example, a start–up would generate a positive cash flow only if its product is technically feasible *and* there is a sufficient market for it. In that case the signals enter in the value function in a multiplicative form, i.e.: $H(X, Y) = XYmH$, which corresponds to the case of maximum convexity of the cash flow function $H(n)$.[9] At the opposite extreme is the case where the cash flow function $H(n)$ is linear in the number of good signals, as it is the case when $H =$

[8] This differs from the typical assumption in the analysis of financial prices under heterogeneous information, where signals are equal to the sum of a common underlying value and individual noise.

[9] Arguably, this case probably describes particularly complex ideas, in which each dimension of the idea "must fit exactly".

$\frac{1+m}{m}h$.[10] The cash flow as a function of n is graphically represented in Figure 1. (Note that the sequence of signals does not matter).

To assess the effect of changes in the degree of complementarity, it is convenient to consider a change in h compensated by a change in H, such that the expected cash–flow from the project when the two signals are positive remains constant. Denote ϵ this change in h (i.e., h goes to $h-\epsilon$). The corresponding change in H is $\frac{1-m}{m}\epsilon$ (i.e., H goes $H+\frac{1-m}{m}\epsilon$). The greater ϵ, the more convex the resulting function, the more complementary the signals.

2.1.5 Net Present Value

If the project is undertaken without any advice from either expert, its expected net present value is:

$$\begin{aligned} & E(H(\tilde{X},\tilde{Y}))-2c \\ = \; & [p_x p_y(mH+(1-m)h)+(p_x(1-p_y)+p_y(1-p_x))h]-2c. \end{aligned}$$

We assume that this ex–ante net value is negative.

On the other hand, if both experts have observed good signals, the expected net present value of the project is positive:

$$E(H(\tilde{X},\tilde{Y})|X=1,Y=1)-2c=mH+(1-m)h-2c>0.$$

In the case where one of the two signals is positive and the other negative, we assume that the net value of the project is negative, i.e.:

$$h<2c.$$

This assumption is in line with our focus on the complementary case, and obviously holds in the multiplicative case (where $h=0$). To allow for positive net value conditional on two signals in the additive case (i.e. when the function $H(n)$ is linear), we also assume that $h>c$.

2.2 Designing the partnership

The task of the entrepreneur can be analyzed as a mechanism design problem, where the principal is the entrepreneur, and the experts are agents. The entrepreneur presents her idea and offers the mechanism to the experts, separately and simultaneously. The experts answer with announcements about their types, i.e., their private signals. We apply the revelation principle.

The direct mechanism involves a decision rule mapping the announcements of the experts into the choice whether to engage in the project or not. If the project is undertaken, the experts must commit their resources, at cost c. The mechanism also specifies a transfer to the experts, in the case

[10] In this additive case, a second positive signals adds just as much as the first.

where the project is undertaken. The transfer function is contingent on the final realization of the cash flow: H, h or 0, and could also depend on the announced signals. The total transfer is between 0 and the realized cash flow (H, h, or 0). For simplicity, this cash flow is assumed to be observable and contractible. Since the project has positive net present value only if both signals are positive, the decision rule is simply to undertake the project if and only if the two announcements are good. Thus, the transfer function needs only to be contingent on the final cash flow.

To implement this direct mechanism, the entrepreneur offers the experts a contract to join her venture. The contract describes the project, the compensation of the experts contingent on joining, their resource commitments, and no–compete clauses for all.[11] The entrepreneur signs this contract before offering it to the experts, thus she can commit to the mechanism she offers.[12] The contract specifies that the partnership is formed if and only if both experts accept to join. When they do so, they have to commit their specialized resources to the venture (at cost c), and in exchange receive financial claims on the cash flows it will generate. In the next section we show that these claims are increasing in the cash flow generated by the project, and that they can be implemented by equity stakes. Thus we can interpret the contract as a partnership.[13]

Strictly speaking, the principal in our model is privately informed, since she privately observes the combination of productive factors which is in the set of promising ideas (O^*). We assume, however, that when the principal describes her idea to the experts, the latter observe the corresponding proposed combination of productive factors, and can check (at zero or negligible cost) that the idea is indeed promising. Thus, once the experts have heard of the idea, we are in the standard situation where the principal is uninformed and the agents are informed.[14]

The program of the entrepreneur Denote by $\varphi_i(.), i \in \{x, y\}$ the compensation of expert i as a function of the payoff of the venture. The program of the entrepreneur is to choose the two functions $\varphi_x(.)$ and $\varphi_y(.)$ to maximize her expected gains:

$$p_y p_x[m(H - \varphi_x(H) - \varphi_y(H)) + (1 - m)(h - \varphi_x(h) - \varphi_y(h))],$$

subject to:

[11] In our context, the idea can be described in a contract, since if it can be communicated in words it must be possible to describe it in written form. However, it is assumed to be still to general (ahead of further implementation) to be patentable.

[12] Also, by signing a no–compete clause, the entrepreneur commits not to expropriate the experts by stealing their signals and undertaking the project without them.

[13] The claims may be also implemented via options or convertible debt.

[14] In contrast with Anton and Yao (2002), in our model the entrepreneur does not signal her own type. Consequently, we do not have to deal with the difficulties associated with signalling through the choice of a mechanism (see Maskin and Tirole, 1990 and 1992).

1. the participation constraints of the experts, requiring that their expected compensation be at least as large as the development cost they incur:
$$m\varphi_i(H) + (1-m)\varphi_i(h) \geq c \quad for\ i \in \{x, y\},$$

2. the condition that the experts truthfully report their type.

A crucial assumption is that, after being told the idea, each expert can refuse to join the partnership and steal the idea to implement it on his own. In this case, the expert can simply report a bad signal, so the project is not undertaken by the entrepreneur. The ability for the expert to steal the idea stems from the assumption that ideas cannot be patented. Indeed, the idea is too preliminary to benefit from intellectual property rights protection. This is in line with the evidence, surveyed in Besen and Raskind (1991), on the difficulty to protect intellectual property rights.[15]

The risk of idea stealing could be mitigated if the experts could sign a no-compete clause before hearing the idea. Signing such a clause related to the specific idea without learning the idea itself is logically impossible. This leaves open the issue whether the experts could sign a broader clause, committing them not to start any project in the general line of business. In the first part of the paper (Section 3), we simply assume this is not possible. While this assumption is in line with the difficulty to enforce no compete clauses in practice (see, e.g., Besen and Rasking (1991), in Section 4 we also analyze the case where no compete clauses can be enforced. In that section, we assume that, while some of the potential entrepreneurs really have observed promising ideas, others in fact have observed worthless ideas. Until they have inspected the idea, the experts cannot tell if the entrepreneur is really serious. Thus they do not want to restrict their future options and be at risk of being blackmailed (see Anton and Yao, 2003). This limits their willingness to sign broad no–compete clauses ex–ante.

2.3 The extensive form of the game

To conclude the presentation of our model, and clarify the timing of the moves, we briefly present the extensive form of the game.

At time 1:

1. The entrepreneur obtains the idea, i.e., observes that (ω_x^*, ω_y^*) is in O^*.

2. The entrepreneur can contact the experts, and separately and simultaneously present them her idea and the mechanism she offers.

3. The experts privately observe their signals.

[15] See also the recent paper by Anton and Yao (2003).

4. The experts separately and simultaneously report their type to the entrepreneur.

   - If both experts report a good signal, they join the partnership, and contribute the resource necessary to the development of the project (at cost c). In this case, all the parties are bound by a no–compete clause.
   - Instead of joining the partnership, each expert can steal the idea. In that case, he can then implement the idea alone, or contact another expert, in order to obtain information relevant along the complementary dimension of the idea.

At time 2, if the project has been undertaken, it generates cash flow H, h or 0. If the partnership has been formed, the transfers conditional on these cash flows are distributed.

3 New ideas in equilibrium

In this section we study when the formation of the partnership and the implementation of the new idea are feasible.

3.1 Preventing gambling

The entrepreneur must prevent the expert with a bad signal from reporting a good signal. Since even after a bad signal there is a chance that the project will produce a value h, the expert might claim a positive signal to "gamble" on a positive signal by the other expert. Since when he truthfully reports a bad signal he gets 0, the expert has no incentive to falsely pretend he had a good signal if:

$$p_i(\varphi_j(h) - c) \leq 0, (i, j) \in \{(x, y), (y, x)\}.$$

This condition implies that the entrepreneur must promise only limited cash flow to the experts in the bad state h, i.e., cash flow lower than the cost of the resource c. Hence, the structure of the claim held by the experts has to be payoff-contingent to ensure reliability. Furthermore, since the expert has to receive less than c in the low state to avoid gambling, he must be receiving more than c in the high state to break even. Thus we can state our first proposition:

Proposition 1 *The compensation of the expert is strictly increasing in the payoff of the venture.*

This result suggests that the contract involves a sort a partnership, as we show more precisely later.

3.2 Preventing idea stealing

Suppose that expert x has a positive evaluation of the project. Instead of reporting this positive signal and joining the entrepreneur in the venture in exchange for a share φ_x of the cash–flow, he could decide to report a bad signal and then undertake the project on his own account. This would amount to stealing the entrepreneur's idea.

Should the expert decide to steal the idea, he could use it in two different ways. First, he could set up the firm and exploit the idea without involving another expert for further appraisal. In this case he would supply his own effort (at cost c), and he could acquire the complementary resource at the market price c.[16] In that case, the expected profit of the expert would be:

$$E(H(\tilde{X}, \tilde{Y})|X = 1) - 2c = p_y(mH + (1 - m)h) + (1 - p_y)h - 2c.$$

Alternatively, the expert (say x) could go to an expert competent relative to dimension $\mathcal{Y}$, describe her the idea and offer her to set up a partnership together.[17] The latter can either accept the offer or reject it. But at this stage, the expert from dimension $\mathcal{Y}$ can also decide to undertake the project herself, if she feels it profitable. Thus expert x also faces the risk of idea stealing. As stated in the next proposition, this risk prevents the expert from successfully stealing the idea and implementing it in collaboration with another expert.

Proposition 2 *There is no equilibrium where expert x, after hearing the idea from the entrepreneur, and observing his own signal, would be able to successfully contact expert y and undertake the project with her.*

The intuition of this result is the following. Suppose expert x steals the idea, contacts another expert, tells her the idea and offers her to form a partnership. If this reveals x's signal (as would be the case if x stole the idea only after observing a good signal), then once she has been contacted and told the idea, the second expert does not need x any longer. Hence if the idea is profitable, she is better off implementing it alone rather than sharing its profit with x. Consider the alternative case where x's offer does not reveal his own signal, i.e., a candidate pooling equilibrium. Then the second expert is willing to accept x's offer only if, conditional on her own

[16] Our assumption that this effort can be purchased is in line with our assumption that it is observable and contractible.

[17] We assume that the entrepreneur contacts the two experts separately and they do not know the identity of the other expert. Hence they cannot get together to form a coalition and design a collusion mechanism a la Laffont and Martimort (2000). Expert x, if he decides to contact a complementary expert, draws randomly from a continuum of agents with this expertise.

signal, the venture is expected to be profitable. However, in this case, she prefers to implement the idea alone rather than to share its profits with x.

The previous proposition directly implies the following:

Proposition 3 *Should one of the experts decide to conceal from the entrepreneur that he had a good signal, the best he could do would be to undertake the project alone.*

This is our first important result. After stealing the idea, the expert himself faces the risk of idea stealing, and in fact more so than the entrepreneur, since the incentive to steal the idea from an informed thief is even greater than from an uninformed entrepreneur. Thus an expert who steals the idea can only undertake the project alone. This limits the profitability of idea stealing, and increases the ability of an entrepreneur to reliably aggregate the signals of the experts.

Building on the results above, we can state the next proposition:

Proposition 4 *The condition under which, after observing a good signal, the expert does not steal the idea is:*

$$\begin{aligned} &\pi_j[\mu\varphi_i(H) + (1-\mu)\varphi_i(h) - c] \\ \geq\ &\pi_j[\mu H + (1-\mu)h] + (1-\pi_j)h - 2c, (i,j) \in \{(x,y),(y,x)\}. \end{aligned}$$

The left hand side of the inequality is the expected profit of the expert if he truthfully reports a good signal and joins the project. The right–hand side of the inequality is his expected profit if he undertakes the project alone. This expected profit determines the level of the informational rent which the entrepreneur must leave to the expert to prevent idea–stealing. If it is non positive, then the experts do not obtain rents.

3.3 The determinants of the informational rents of the experts

We consider next the comparative statics of the economic variables determining the rents of the experts.

The greater the development cost, the less demanding the condition under which the partnership is viable (i.e., neither expert steals the idea). We can then state the following:

Proposition 5 *The greater the development cost c, the more attractive it is for the experts to join the venture rather than undertaking it alone and the lower their informational rents.*

For each expert, the advantage of joining the venture or partnership is that it enables him to incur the development cost only when the signal of the other expert is also good. This is especially attractive when the development cost is large.

The condition under which expert x does not steal the idea can be rewritten as:

$$\begin{aligned} & \frac{2c-(1-p_y)h}{p_y} \\ \geq \quad & m(H-\varphi_x(H))+(1-m)(h-\varphi_y(h))+c. \end{aligned}$$

The left-hand side is decreasing in p_y. Hence the condition is more demanding if the probability that the other expert observes a good signal is large. The lower is this probability, the more likely it is that ex ante the project has negative net value, and thus the more crucial it is to rely on the expertise of y to avoid engaging in a loss–making venture. We refer to $1-p_y$ (resp. $1-p_x$) as the information criticality of the signal of expert y (resp. x). Thus, we can state the following result:

Proposition 6 *The less likely it is that the signal of expert y is positive (i.e. the greater is his information criticality), the less attractive it is for expert x to engage in the venture alone, and the lower the rent that expert x can obtain.*

A high information criticality corresponds to more "daring" ideas, which are ex–ante less likely to be viable and for which a complete appraisal is more critical. In this case, the entrepreneur manages to capture a greater fraction of value because she is essential in aggregating the critical signals.

Correspondingly, there is a threshold level of information criticality for each expert beyond which the other expert cannot undertake the project alone:

Proposition 7 *If the probability of a positive signal by expert y is sufficiently low, in the sense that $\pi_y < \frac{2c-h}{\mu(H-h)}$, then it never pays for agent x to go ahead alone. In this case, we define agent y as critical.*

Hereafter, this threshold level of criticality will be denoted β, i.e.:

$$\beta = \frac{2c-h}{m(H-h)}. \tag{1}$$

A direct implication is the following:

Proposition 8 *The condition under which expert x does not steal the idea when his signal is good is binding, and he earns a rent, if and only if expert y is not critical.*

3.4 The role of information criticality

We now examine under what conditions the venture is viable, in the sense that it is possible for the entrepreneur to reliably aggregate the experts' signals. We established that the entrepreneur must concede expert x an informational rent to avoid idea–stealing when y is not critical, i.e. when obtaining a reliable report on the signal of the other expert is not too important. We will see that when the criticality of both experts is too low, the project is already so attractive to an expert with a good signal that no reliable aggregation of expert signals is possible. In this case the partnership is not viable.

Without loss of generality consider the case where: $p_x \geq p_y$, i.e., the informational criticality of expert y is greater than that of x. The following propositions spell out the three types of equilibria which can arise when one expert, both or none are critical.

We consider first the case where both experts are critical. This corresponds to the situation where the ex–ante expected value of the project is low (as the ex–ante probability of success is low). In this case the entrepreneur does not need to leave rents to the experts, since none of them can undertake the project alone. Thus, when both experts have critical signals, information aggregation by the entrepreneur is facilitated. In a sense, both experts need each other, and only the entrepreneur can arrange for them to commit to a partnership.

Proposition 9 *If $\beta > \pi_x \geq \pi_y$, both experts are critical and they earn no rents. In this case the entrepreneur contacts the experts, the partnership is formed and the project is implemented when both experts observe good signals. The entrepreneur captures the entire ex–ante expected net present value of the project:*

$$\pi_x \pi_y [\mu H + (1-\mu)h - 2c].$$

Next we consider the case when only one agent is critical.

Proposition 10 *If only expert y is critical, he must be left an information rent to discourage idea-stealing; in contrast, expert x obtains no rent. In this case, the partnership is viable. Furthermore, the ex–ante expected profit of the entrepreneur equals:*

$$(1-\pi_x)\pi_y[2c-h] > 0$$

When one of the agents is critical and the other is not, the latter can be held down to his outside option, while the former will earn an information rent. In that case, the expected profit of the entrepreneur is independent of

H. Indeed, an increase in H has two countervailing effects. On the one hand it increases the expected cash–flow from the project; on the other hand it increases the rent which must be left to the critical expert. The proposition shows that the two effect exactly offset each other. The result also implies that, when only one of the experts earn rents, the residual expected profit left to the entrepreneur is sufficiently large to undertake the project.

Next we consider the case when neither signal is critical. This case turns out to be the most challenging for the aggregation of signals.

Proposition 11 *When none of the experts is critical, then if:*

$$\pi_y > \frac{\pi_x}{\pi_x(1+\frac{1}{\beta})-1},$$

the rents which must be left to the experts are so large that it is no longer profitable for the entrepreneur to hire the experts to evaluate her idea. Otherwise, the entrepreneur will hire the two experts, and her ex-ante expected profit is:

$$\begin{aligned} & 2c(\pi_y + \pi_x - \pi_y\pi_x) \\ -[(1-\pi_y)\pi_x + (1-\pi_x)\pi_y]h - {} & \pi_x\pi_y(\mu H + (1-\mu)h). \end{aligned}$$

When the criticality of the experts is too low, idea stealing is too attractive and the entrepreneur cannot retain any share of the surplus after contacting the experts. Thus there is a market breakdown: the innovative idea is not implemented, even when its net present value is positive. This is in the line of the Arrow's (1962) paradox.

Somewhat paradoxically, the expected profit of the entrepreneur in that case is decreasing in H. This is because large cash–flows increase the attractiveness of idea stealing for the experts and increase the required information rents. When none of the two experts is critical they both earn an information rent which is increasing in H.

The different equilibrium outcomes for different values of the parameters are graphically represented in Figure 2. The figure illustrates that, when p_x and p_y are low, and the experts are critical, the project can be undertaken and the entrepreneur can profitably exploit her innovative idea. In contrast, when p_x and p_y are high, there is a market breakdown.

The key parameter of the equilibrium regions in Figure 2 is β. The smaller β, the lower the no–rent region, and the greater the market breakdown region. Note further that β is decreasing in the possible cash flow from the project: H and h. This is in line with our above remark that large cash–flows make idea stealing more attractive and thus exacerbate the problem faced by the entrepreneur.

Relying on the three propositions above, we can characterize the evolution of the profit of the entrepreneur as H varies, as illustrated in Figure 3 and presented in the next proposition:[18]

Proposition 12 *The expected profit of the entrepreneur is not monotonic in the high realization of the cash flow, H.*

Similarly, it is straightforward to show that the expected profit of the entrepreneur is not monotonic in the a priori probabilities that the signals of the experts will be good: On the one hand, when these probabilities are low, both experts are critical, and the entrepreneur captures the entire value of the project. In that region, the expected profit of the entrepreneur is increasing in p_x and p_y. On the other hand, when these probabilities are large, the experts are not critical. When p_x and p_y are too large, we are in the market breakdown region and the expected profit of the entrepreneur is zero.

Putting together the counter–intuitive results we obtained relative to i) the ex–ante probability of success ($p_x p_y$) and ii) the level of payoffs, our model shows that the best ideas cannot be implemented – because it is too tempting to steal them.

How does complementarity affect the ability of the entrepreneur to profitably undertake the project? Recall that complementarity is related to the convexity of the payoff function $H(.,.)$. Consider an increase in its degree of convexity, corresponding to a decrease of h to $h-\epsilon$, compensated by an increase of H to $H+\frac{1-m}{m}\epsilon$. In this case, β changes to:

$$\frac{2c-h+\epsilon}{m(H-h)+(1-m)\epsilon},$$

It is easy to see that this is increasing in ϵ. Hence, we can state the next proposition:

Proposition 13 *The more complementary the signals the smaller the region in the parameter space for which there is a market breakdown.*

So complementarity helps the entrepreneur to cope with the market breakdown problem. The intuition is the following: The greater complementarity of the signals, the more attractive it is for each expert to join the venture to benefit from the value added by the signal of the other expert.

What happens when the informational rents are so large that the entrepreneur cannot profitably hire the two experts? In that case, since we

[18] The upper and lower bounds on H in the figure reflect our assumptions that the project has negative net present value a priori, and positive net present value conditionally on two good signals, respectively.

assume that the ex–ante expected cash flow from the project is below $2c$, it would not be optimal for the entrepreneur to undertake the project alone, without the advice of the experts (in the next section we discuss what happens if we relax this assumption).

Could the entrepreneur choose to go to only one expert, say x? Obviously this can lead to undertaking the project only if it has positive net expected value when the expert has observed a positive signal, that is: $p_y[mH + (1 - m)h] + (1 - p_y)h > 0$. In that case, consider the reaction of the expert after being presented the idea. If she observes a bad signal, then she has no incentive to lie. But if she observes a good signal and joins the venture, her expected gain is:

$$\alpha_x(p_y[mH + (1 - m)h] + (1 - p_y)h) - c,$$

while if she steals the idea and implement it alone, her expected profit is:

$$p_y[mH + (1 - m)h] + (1 - p_y)h - 2c.$$

The former is greater than the latter if and only if:

$$\alpha_x > 1 - \frac{c}{p_y[mH + (1 - m)h] + (1 - p_y)h}.$$

The participation constraint of the entrepreneur is:

$$(1 - \alpha_x)(p_y[mH + (1 - m)h] + (1 - p_y)h) - c > 0.$$

Comparing the two conditions shows that satisfying the incentive compatibility condition prevents from leaving the entrepreneur (strictly) positive profits. Thus, going to one expert only is not an attractive course of action for the entrepreneur.

The interpretation is simple. It is advantageous for an expert to join the venture only if by doing so he can benefit from the advice of the other expert, and thus avoid to incur the development cost when the idea is bad. This benefit cannot be obtained when the entrepreneur goes to see only one expert.

3.5 Implementing the direct mechanism with financial contracts

Proposition 1 stated that the compensation of the experts had to be increasing in the cash–flows from the project. We now characterize this compensation more precisely. For simplicity focus on the case where the two experts have identically critical signals ($p_x = p_y = p$). In that case, we obtain the following proposition:

Proposition 14 *The optimal direct mechanism can be implemented by offering the experts equity or convertible debt.*

Implementing the optimal mechanism with equity is consistent with interpreting it as a partnership. That the mechanism can be implemented equivalently with equity or convertible debt underscores that, in our simple model, the precise allocation of cash flows across states does not play a central role. All that is required is that the claims' payoff in the low state be sufficiently low to deter gambling, and the total expected payoff be large enough to avoid idea stealing and enable the experts to break even. Enriching the model could lead to sharper implications for financial contracts. For example, if the implementation cost was (at least partly) unobservable, this would raise moral hazard issues. Cash–flow sensitive claims, such as equity or options, would cope with these problems more effectively that insensitive claims such as debt.

4 Robustness and discussion

4.1 Would the experts sign a no compete agreement before seeing the idea ?

Could the entrepreneur ask the experts to sign a broad no–compete agreement before showing them the idea? This would prevent them from stealing the idea. As discussed above, such no–compete clauses are difficult to enforce (see Besen and Raskind, 1991, for example). We now show that, even if they were perfectly enforceable, they could be ineffective to solve the idea stealing problem, in case of *a priori* uncertainty about the quality of the entrepreneur's idea.

Extending the model analyzed above, consider the case where with probability δ the idea of the entrepreneur is promising, while with the complementary probability it is worthless. The potential entrepreneur does not know if her idea is promising, but the experts, after being told the idea, immediately find out if the idea is valueless. This is in line with the discrimination process followed by venture capitalists (see e.g. Fenn, Liang and Prowse, 1995). Approximately 90% of the enterprise projects they receive are immediately rejected. The remaining 10% are then inspected carefully (which corresponds in our model to the evaluation of the project by the experts).

Suppose the entrepreneur contacts experts x and y, and asks them to sign a broad no–compete clause before being presented the idea. Denote K the opportunity cost for the experts of the no–compete clause. This is the opportunity cost of passing up all the other interesting projects they might encounter later in this line of business. For simplicity, consider the case where the criticality of the two experts is the same, i.e., $p = p_x, p_y$. Since the no–compete clause prevents idea stealing, the entrepreneur can actually sell her idea to the two experts, at price $P \geq 0$, and allocate to each of them half of the its cash flows if:

$$\delta p^2[\frac{mH + (1-m)h}{2} - c] > P + K.$$

The left–hand-side is the expected net present value of the cash–flows to be received by the expert, while the right–hand–side is the cost borne by the expert. There is no positive price at which this transaction can take place if:

$$\delta < \frac{K}{p^2[\frac{mH+(1-m)h}{2} - c]}.$$

Thus the experts will not agree to sign a no–compete clause before seeing the idea if the *a priori* probability that the entrepreneur's idea is promising is small relative to the ratio of the opportunity cost of this clause for the experts to the net present value of promising ideas.

4.2 Endogenous number of experts

To discuss the process by which the entrepreneur chooses the number of experts she contacts, we slightly extend our model by assuming ideas are combinations of productive factors from 3 sets: $\mathcal{X}, \mathcal{Y}$ and $\mathcal{Z}$. Experts skilled along these three dimensions can evaluate the idea, based on the signals they receive: $\tilde{X}, \tilde{Y}$ and $\tilde{Z}$. Each signal can be good and take the value 1 with probability $p_s, s \in \{x, y, z\}$, or bad and take the value 0 with the complementary probability. Correspondingly, the expected cash flow from the project conditional on the realization of the signals is: $H(X, Y, Z)$. For example, a simple generalization of the framework presented in the previous section is: $H(X = 1, Y = 1, Z = 1) = H$ with probability m and h with the complementary probability, while:

$$H(X = 1, Y = 1, Z = 0) = H(X = 1, Y = 0, Z = 1) = H(X = 0, Y = 1, Z = 1) = h,$$

and:

$$H(X = 1, Y = 0, Z = 0) = H(X = 0, Y = 0, Z = 1) = H(X = 0, Y = 1, Z = 0) = 0,$$

Remember that a dimension is critical if the project has negative expected net present value when the signal corresponding to that dimension has not yet been observed, even if all other signals have been observed to be positive. It is plausible that there is only a limited number of critical dimensions. Hereafter we consider the case when only two dimensions, say x and y, are critical, while the third is not. That does not mean that expert z is irrelevant. Observing his signal does lead to a revision in the expectation of the value of the project. But the project, has positive net present value when the two first signals have been observed to be positive while the third has not been disclosed yet. Formally, we assume that:

$$E[H(X, Y, Z)|X = 1, Z = 1] = p_y(mH + (1-m)h) + (1-p_y)h < 3c,$$

$$E[H(X,Y,Z)|Y=1,Z=1] = p_x(mH+(1-m)h)+(1-p_x)h < 3c,$$

and:

$$E[H(X,Y,Z)|X=1,Y=1] = p_z(mH+(1-m)h)+(1-p_z)h > 3c.$$

Note that, when $p_z = 1$, this framework simplifies to the case studied in the previous sections.

Since both x and y are critical, it is not possible to undertake the venture without consulting them. What happens if the entrepreneur contacts x and y, but not z? She would undertake the project when both experts would report good signals. Limiting the payoff to the experts when the cash flow is h deters them from falsely reporting a good signal. As discussed in the previous section, since each of the two experts is critical, none can steal the idea. Hence each can be held down to his reservation utility, and the entrepreneur captures all the social value generated by the project:

$$\begin{aligned} p_x p_y [p_z H(X &= 1, Y=1, Z=1) + (1-p_z)H(X=1, Y=1, Z=0) - 3c] = \\ & p_x p_y [p_z(mH+(1-m)h)+(1-p_z)h - 3c]. \end{aligned}$$

Instead of consulting only x and y, should the entrepreneur also consult z, to benefit from his advice also? How would expert z react, if he was consulted? Clearly, he could not undertake the venture alone, since the signals of the two other experts are critical. However, after being told the idea and observing a good signal, z could contact experts from the two other dimensions: $x^{'}$ and $y^{'}$. Could any of these experts steal the idea from z? No, since signals relative to dimensions $\mathcal{X}$ and $\mathcal{Z}$ are both critical. For example, even after inferring that the signal of z was good and observing that his own signal was good, $x^{'}$could not undertake the project without $y^{'}$, since: $E[H(X,Y,Z)|X=1,Z=1] < 3c$. Could $x^{'}$ contact $y^{'}$, disclose the idea, tell her that the signals relative to dimensions $\mathcal{X}$ and $\mathcal{Z}$ are good, and offer her to undertake the venture with him? No, because if $z^{'}$ observed that her own signal was good, she would steal the idea and undertake the project alone.

Thus, while the entrepreneur can undertake the project after consulting only the two critical experts, she cannot associate the third, non critical, expert to the venture. Indeed, the latter would be in a position to steal the idea, and then secure the advice of two other experts. In other words, bringing in a third, non critical, expert would destabilize the partnership.

4.3 Arbitrary division of the development cost

So far, we assumed that, in the context of the partnership, each experts incurred the development cost (c) in his or her dimension. In this subsection, we show that our results are unchanged if, instead, the cost is arbitrarily split between the entrepreneur, who pays I_E, expert x, who pays I_x, and expert y, who pays I_y, such that:

$$I_E + I_x + I_y = 2c.$$

In this case, the program of the entrepreneur is to choose $\varphi_x(.)$ and $\varphi_y(.)$ to maximize:

$$p_y p_x[m(H - \varphi_x(H) - \varphi_y(H)) + (1-m)(h - \varphi_x(h) - \varphi_y(h)) - I_E],$$

subject to:

1. the participation constraints of the experts:

$$m\varphi_i(H) + (1-m)\varphi_i(h) \geq I_i \quad for\ i \in \{x, y\},$$

2. the no–gambling condition:

$$p_i(\varphi_j(h) - I_j) \leq 0, (i, j) \in \{(x, y), (y, x)\},$$

1. and the no–stealing condition:

$$\begin{aligned} & p_j[m\varphi_i(H) + (1-m)\varphi_i(h) - I_i] \\ \geq\ & p_j[mH + (1-m)h] + (1-p_j)h - 2c, (i, j) \in \{(x, y), (y, x)\}. \end{aligned}$$

Note that the right–hand–side of the no–stealing condition is the same as in the previous case. Here again, what matters is whether expert i can undertake the project alone after observing a good signal. If he can, then i earns rents, otherwise the entrepreneur can hold him down to his participation constraint. Thus, as in the previous case, we must consider three cases: i) no expert earns rents, ii) only one expert earns rents, iii) both experts earn rents. In the first case, the participation constraints of the experts hold as equalities, the entrepreneur undertakes the venture and extracts all the surplus, as in Proposition 9. In the second case, the participation constraint of one expert holds as an equality, while the no–stealing constraint of the other is binding. Substituting these conditions in the objective of the entrepreneur, the expected profit of the latter is found to be exactly the same as in Proposition 10. Similarly, in the third case, both no–stealing conditions bind. Substituting these conditions in the objective of the entrepreneur we find exactly the same equations for the market breakdown region and the expected profit of the entrepreneur as in Proposition 11. Thus, the allocation of the initial cost $(2c)$ between the members of the partnership does not interfere with the ability of the entrepreneur to aggregate the private signals of the experts while avoiding idea–stealing.

4.4 What if the project has positive net present value before observing signals?

The expected profit from the project before observing the signals from the experts is:

$$\begin{aligned} & E(H(\tilde{X},\tilde{Y})) - 2c \\ = \; & [p_x p_y (mH + (1-m)h) + (p_x(1-p_y) + p_y(1-p_x))h] - 2c. \end{aligned}$$

In the previous sections, we assumed that this ex–ante net value was negative, so that the entrepreneur could not undertake the venture alone. In this subsection, we modify this assumption, to consider a population of heterogeneous entrepreneurs, $i = 1, ..., N$, who differ (only) in terms of the cash obtained in case of success: H_i. For simplicity, assume $p_x = p_y$. In this case, the condition under which the entrepreneur can associate the experts to the partnership while avoiding idea stealing is:

$$H < h + (\frac{2}{p} - 1)(2c - h)/m,$$

which we denote: $\underline{H}$, while the condition under which the entrepreneur can undertake the project alone is:

$$H > \frac{2c - (p_x(1-p_y) + p_y(1-p_x))h}{m p_x p_y} - \frac{1-m}{m} h,$$

which we denote: $\bar{H}$. Equilibrium in this context is as follows:

- Entrepreneurs with $H_i <\underline{H}$, contact experts and undertake the only if both have positive signals about the venture. In this case, when it is undertaken, the project yields cash–flow H_i with probability m and h with the complementary probability.

- Entrepreneurs with $\underline{H}< H < \bar{H}$ cannot undertake the project.

- Entrepreneurs with $H > \bar{H}$ undertake the project alone (we assume they can fund the development cost $2c$). In this case, the project yields cash–flow H_i with probability $p^2 m$, h with probability $[p^2(1-m) + 2p(1-p)]$ and 0 with the complementary probability.

This yields an empirical implication: projects undertaken in collaboration with expert partners are more often successful, while projects undertaken alone are more often failures, and have a more skewed distributions (many failures, some rare great successes).

5 Conclusion

Following Schumpeter, we have modelled new ideas as novel combinations of existing productive factors. Evaluating such new ideas is quite different from valuing an existing assets, whose use is already observable. A new idea has by definition never been implemented, so its features cannot be compared with previous experiences.[19] One crucial question is whether the different aspects of the proposed new combination can be functionally combined. Evaluating this internal consistency requires experts drawn from the distinct dimensions of the project, whose signals are complementary rather than additive.

To screen good ideas, the innovative entrepreneur must first identify the critical ingredients of her business concept. Then, she must aggregate privately observed expert opinions along each complementary dimension of the idea, while controlling the incentives experts have to steal the idea. To do so, she offers them to join a venture which resembles a partnership.

We identify a potential market breakdown, in which a partnership is not viable because stealing the idea is too tempting for the experts. The entrepreneur can successfully avoid such opportunistic actions if each expert is better off joining the partnership to benefit from the advice of the other expert, rather than undertaking the venture on his own. This requires that at least one of the expert signals be critical for the success of the venture or that the degree of complementarity in the two dimensions of the project be very high. Both conditions relate to the size of the gain in cooperating with other experts.

The possibility of a market breakdown when the idea is too good begs the question which mechanism could be implemented to solve this problem. Personal links, or hierarchies (as analyzed by Rajan and Zingales, 2001) could play this role. The threat of competition has also been explored by several authors. Another mechanism is reputation. Suppose the population of potential entrepreneurs and experts observe idea stealing when it occurs, so that they can black list idea stealers. This reaction would naturally reflect their reluctance to deal with agents likely to deprive them from potential rents. The threat of blacklisting would reduce the attractiveness of idea stealing. This would improve the ability of entrepreneurs to contact experts and form partnerships to implement innovative ideas. By construction it takes time and experience to build reputation. Thus, reputation effects in a dynamic extension of our model could generate a virtuous innovation cycle: Initially reputational capital is limited, the market breakdown problem identified in the present paper is severe, and this limits innovation. As time goes by, more and more innovative projects are undertaken and experts ac-

[19] In the words of Schumpeter (1926, Chapter 2, Part III) "Outside the usual path, economic agents cannot rely on the data which are available for routine decisions... They can and should forecast and assess ... but in many respects things are quite uncertain."

quire reputation. This enhances the ability to undertake further innovative projects. We leave the analysis of such dynamics to further research.

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Appendix: proofs

Proof of Proposition 2:

There are three candidate equilibria where x would contact y and offer her a share α of the venture:[20]

First, consider a candidate separating equilibrium where x would offer y a share α_G after observing good news and a share α_B after bad news: In that case, when she is offered α_G, y realizes that x has observed a good signal. Would she be interested in collaborating with x when she has observed a good signal ? No. After observing a good signal, y would be better off reporting a bad signal to walk away from x, implement the project by herself, and earn the entire value of the project: $mH + (1 - m)h - 2c$. Anticipating this reaction, x does not find it attractive to share the idea with y after observing a good signal.

Now consider the case where x would offer α_B to y. After observing a bad signal, y would reject this offer because she would know the project cannot yield any cash flow. After observing a good signal, she could accept x's offer only if: $\alpha_B h - c > 0$, that is: $\alpha_B > \frac{c}{h}$. On the other hand, x's rationality condition requires that:

$$(1 - \alpha_B)h - c > 0 \Leftrightarrow 1 - \alpha_B > \frac{c}{h} \Leftrightarrow 1 - \frac{c}{h} > \alpha_B.$$

Together, the two conditions imply that:

$$1 - \frac{c}{h} > \frac{c}{h} \Leftrightarrow 1 > 2\frac{c}{h} \Leftrightarrow h > 2c,$$

which contradicts our assumptions.

Hence, there is no separating equilibrium where x could collaborate with y by offering her a share α_G after observing good news and a share α_B after bad news.

Second, consider a candidate equilibrium where the expert would steal the idea and contact another expert only after observing a good signal.[21] In that case, the second expert infers the signal of the first expert from the mere fact that she is contacted. Following the same logic as in the first candidate equilibrium, in this context the first expert cannot avoid idea stealing.

[20] For simplicity we consider only the case where the first expert offers the other expert a share of the project, i.e., an equity stake. In our simple model, allowing for more general contracts would not alter the result. Also for simplicity we focus on pure strategies equilibria.

[21] Stealing the idea to undertake it only after observing a bad signal is obviously not a profitable strategy.

Third consider a candidate pooling equilibrium where x would contact y and offer her a share irrespective of his own signal. Could expert y accept this offer after observing a negative signal? In that case, her individual rationality condition would imply:

$$\begin{aligned} \alpha p_x h &> c \\ &\Leftrightarrow \alpha > \frac{c}{p_x h}. \end{aligned}$$

On the other hand, the individual rationality condition of expert x after observing a bad signal would imply:

$$(1-\alpha)p_y h > c \Leftrightarrow 1-\alpha > \frac{c}{p_y h} \Leftrightarrow 1 - \frac{c}{p_y h} > \alpha.$$

The two conditions together imply:

$$1 - \frac{c}{p_x h} > \frac{c}{p_y h} \Leftrightarrow 1 > \frac{c}{p_y h} + \frac{c}{p_x h}.$$

In turn this implies:

$$1 > \frac{2c}{h},$$

which contradicts our assumptions.

Hence, there is no pooling equilibrium where y accepts the offer when she has observed a bad signal. Could there be an equilibrium where she would accept the offer only after observing a good signal? This would require that she prefers to accept the offer than to undertake the project alone, i.e.:

$$\begin{aligned} & \alpha[p_x(mH + (1-m)h) + (1-p_x)h] - c \\ > \; & p_x(mH + (1-m)h) + (1-p_x)h - 2c. \end{aligned}$$

This is equivalent to:

$$\frac{c}{[p_x(mH + (1-m)h) + (1-p_x)h]} > 1 - \alpha.$$

On the other hand, the individual rationality of expert x, if he has observed a bad signal, is:

$$\begin{aligned} p_y[(1-\alpha)h - c] &> 0 \\ &\Leftrightarrow 1 - \alpha > \frac{c}{h}. \end{aligned}$$

The two conditions imply that:

$$\frac{c}{p_x(mH+(1-m)h)+(1-p_x)h} > \frac{c}{h},$$

that is:

$$p_y h > p_x(mH+(1-m)h)+(1-p_x)h \Leftrightarrow h > H,$$

a contradiction.

QED

Proof of Proposition 9:

Since none of the experts can undertake the project alone, their incentive compatibility condition in the good state does not bind. Hence, the program of the entrepreneur is to maximize:

$$p_y p_x[m(H-\varphi_x(H)-\varphi_y(H))+(1-m)(h-\varphi_x(h)-\varphi_y(h))],$$

under the incentive compatibility condition of the experts in the bad state:

$$\varphi_k(h) < c, k \in \{i,j\},$$

and the rationality conditions of the experts:

$$m\varphi_i(H)+(1-m)\varphi_i(h) \geq c \qquad for\ i \in \{x,y\}.$$

Saturating the rationality condition, and substituting it in the objective of the entrepreneur, the latter becomes:

$$p_y p_x[mH+(1-m)h-2c],$$

i.e., the command variables cancel out, and the entrepreneur earns positive profits.

Hence, any transfer function satisfying the rationality conditions is an optimum. For example, set:

$$\varphi_k(h) = h/2, k \in \{i,j\}.$$

Thus, the incentive compatibility condition in the bad state holds, and the rationality condition becomes:

$$m\varphi_i(H)+(1-m)\frac{h}{2} = c \qquad for\ i \in \{x,y\},$$

that is:[22]

$$\varphi_i(H) = \frac{c-\frac{1-m}{2}h}{m} \qquad for\ i \in \{x,y\}.$$

[22] Note that this is consistent with limited liability since, with $\varphi_k(h)=h/2, k \in \{i,j\}$, the expected profit of the entrepreneur is: $\pi_y\pi_x[\mu(H-\varphi_x(H)-\varphi_y(H))]$. That this profit is positive implies that: $H > \varphi_x(H)-\varphi_y(H)$.

QED

Proof of Proposition 10 :
Since only expert y is critical, her incentive compatibility condition in the good state binds, while for expert x, we only need to impose the rationality condition. Hence, the program of the entrepreneur is to maximize:

$$p_y p_x[m(H - \varphi_x(H) - \varphi_y(H)) + (1-m)(h - \varphi_x(h) - \varphi_y(h))],$$

under the incentive compatibility condition of the experts in the bad state:

$$\varphi_k(h) < c, k \in \{i, j\},$$

the rationality condition of the expert x:

$$m\varphi_x(H) + (1-m)\varphi_x(h) \geq c,$$

and y's incentive compatibility condition in the good state:

$$\begin{aligned} & p_x[m\varphi_y(H) + (1-m)\varphi_y(h) - c] \\ \geq \ & p_x[mH + (1-m)h] + (1-p_x)h - 2c. \end{aligned}$$

Saturate the two latter conditions:

$$m\varphi_x(H) + (1-m)\varphi_x(h) = c,$$

$$m\varphi_y(H) + (1-m)\varphi_y(h) = [mH + (1-m)h] + \frac{1-p_x}{p_x}h - c(\frac{2}{p_x} - 1).$$

Substituting these equalities in the objective of the entrepreneur, the latter simplifies to:

$$p_y(1-p_x)(2c-h).$$

Here also the command variables cancel out, and the entrepreneur earns positive profits.

Hence, any transfer function satisfying the rationality condition of x, and the incentive compatibility condition of y is an optimum. For example, set:

$$\varphi_k(h) = h/2, k \in \{i, j\}.$$

Thus, the incentive compatibility condition in the bad state holds, and the rationality condition of x becomes:

$$\varphi_x(H) = \frac{c - \frac{1-m}{2}h}{m}.$$

The incentive compatibility condition of y in the good state becomes:

$$\varphi_y(H) = H + \frac{1-m}{m}h/2 + \frac{1-p_x}{mp_x}h - \frac{c}{m}(\frac{2}{p_x} - 1),$$

which pins down the value of the transfer to y in that state.[23]

QED

Proof of Proposition 11 :

Since none of the experts is critical, their incentive compatibility conditions in the good state bind. Hence, the program of the entrepreneur is to maximize:

$$p_y p_x[m(H - \varphi_x(H) - \varphi_y(H)) + (1-m)(h - \varphi_x(h) - \varphi_y(h))],$$

under the incentive compatibility condition of the experts in the bad state:

$$\varphi_k(h) < c, k \in \{i, j\},$$

and their incentive compatibility condition in the good state:

$$\begin{aligned} & p_i[m\varphi_j(H) + (1-m)\varphi_j(h) - c] \\ \geq \; & p_i[mH + (1-m)h] + (1-p_i)h - 2c, (i,j) \in \{(x,y),(y,x)\}. \end{aligned}$$

Saturate the latter:

$$m\varphi_y(H) + (1-m)\varphi_y(h) = [mH + (1-m)h] + \frac{1-p_x}{p_x}h - c(\frac{2}{p_x} - 1),$$

$$m\varphi_x(H) + (1-m)\varphi_x(h) = [mH + (1-m)h] + \frac{1-p_y}{p_y}h - c(\frac{2}{p_y} - 1),$$

Substituting these equalities in the objective of the entrepreneur, the latter becomes:

$$p_y p_x[-[mH + (1-m)h] - \frac{1-p_x}{p_x}h + c(\frac{2}{p_x} - 1) - \frac{1-p_y}{p_y}h + c(\frac{2}{p_y} - 1)],$$

This is negative if:

$$mH + (1-m)h + \frac{1-p_x}{p_x}h + \frac{1-p_y}{p_y}h > 2c(\frac{1}{p_x} + \frac{1}{p_y} - 1),$$

or:

$$p_x p_y[m(H-h)] > (2c - h)(p_y + p_x - p_x p_y).$$

[23] Again, note that these transfers are consistent with limited liability.

That is:

$$p_x p_y > \beta(p_y + p_x - p_x p_y),$$

or:

$$p_y > \frac{p_x}{p_x(1+\frac{1}{\beta}) - 1},$$

which is the condition stated in the proposition.

It only remains to propose a transfer function. Set:

$$\varphi_k(h) = h/2, k \in \{i, j\}.$$

The incentive compatibility condition becomes:

$$\varphi_y(H) = [H + \frac{1-m}{m}\frac{h}{2}] + \frac{1-p_x}{p_x}\frac{h}{m} - \frac{c}{m}(\frac{2}{p_x} - 1),$$

$$\varphi_x(H) = [H + \frac{1-m}{m}\frac{h}{2}] + \frac{1-p_y}{p_y}\frac{h}{m} - \frac{c}{m}(\frac{2}{p_y} - 1),$$

which pins down the value of the transfers.[24]

QED

Proof of Proposition 14:

First consider the case of equity financing:

The entrepreneur offers each of the experts a fraction α of the revenues of the project.

First consider the case where the experts are critical ($p < \beta$). Their participation constraint binds. Hence:

$$\alpha = \frac{c}{mH + (1-m)h}.$$

Our positive NPV assumption implies that $\alpha < 1/2$.

It only remains to check that this is consistent with the no gambling condition:

$$\alpha h < c.$$

Substituting the value of α obtained from the break even constraint, the no gambling condition holds iff:

$$\frac{ch}{mH + (1-m)h} < c.$$

That is:

$$h < mH + (1-m)h \Leftrightarrow h < H,$$

[24] Again, note that this is consistent with limited liability.

which obviously holds.

Second consider the case where the experts are not critical ($p > \beta$). Their no stealing condition is:

$$\begin{aligned} & p[\alpha(mH + (1-m)h) - c] \\ \geq \; & p[mH + (1-m)h] + (1-p)h - 2c. \end{aligned}$$

That is:

$$\begin{aligned} & \alpha(mH + (1-m)h) \\ \geq \; & [mH + (1-m)h] + \frac{1-p}{p}h - \frac{2-p}{p}c, \end{aligned}$$

or:

$$\alpha \geq 1 - \frac{\frac{2-p}{p}c - \frac{1-p}{p}h}{(mH + (1-m)h)}.$$

By construction, when there is no market breakdown, the right hand side is lower than one half. Thus the no stealing condition is is consistent with the no gambling condition iff:

$$\frac{c}{h} \geq 1 - \frac{\frac{2-p}{p}c - \frac{1-p}{p}h}{(mH + (1-m)h)},$$

which holds since the right–hand side is lower than 1 and $c > h$.

Second turn to the case of convertible bonds. The details of the face value of the bond, the conversion rate and the exercise strategies are as follows: As shown in the proofs of Propositions 9, 10, and 11, the transfer to the experts when the cash flow is low can be set to:

$$\varphi_k(h) = h/2, k \in \{i, j\}.$$

The transfer to the experts when the cash flow is high is: $\varphi_k(H), k \in \{i, j\}$. Set the conversion rate of the bond to: $\gamma_k = \varphi_k(H)/H$. Each of the two experts rationally expects the other expert to convert his (or her) bond in the high cash flow state. Thus, each expert expects to obtain: $\gamma_k H = \varphi_k(H)$ if he (or she) converts. Since, as stated in the previous proposition, the transfer function is increasing in the cash flow from the project, the payoff obtained in state H by each expert if he (or she) converts: $\gamma_k H = \varphi_k(H)$, is greater than what he (or she) obtains when not converting: $\varphi_k(h) = \frac{h}{2}$. Thus, both experts indeed prefer to convert in state H.

QED

Figure 1: The expected cash flow function

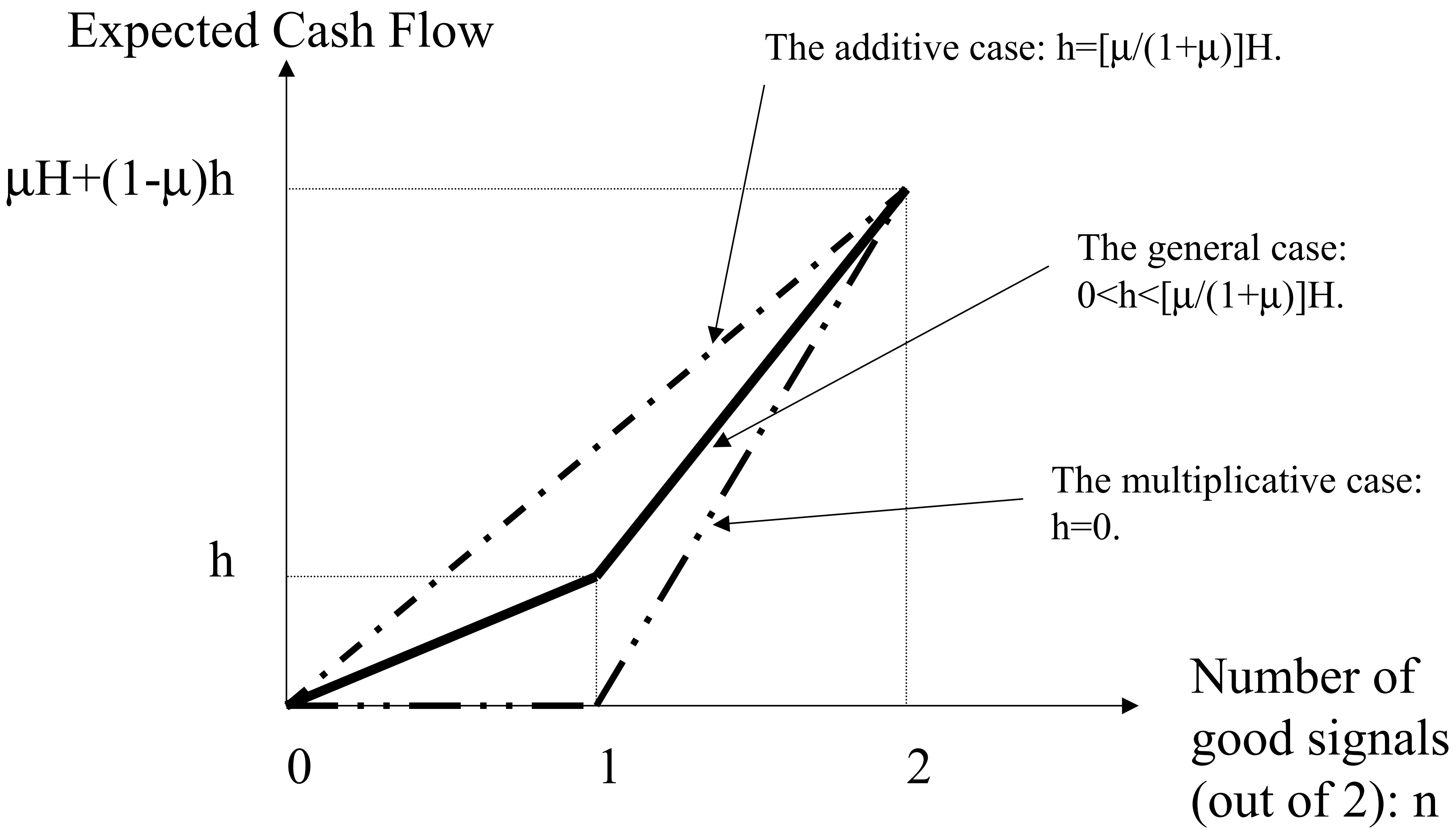

Figure 2: Criticality and feasibility of the partnership

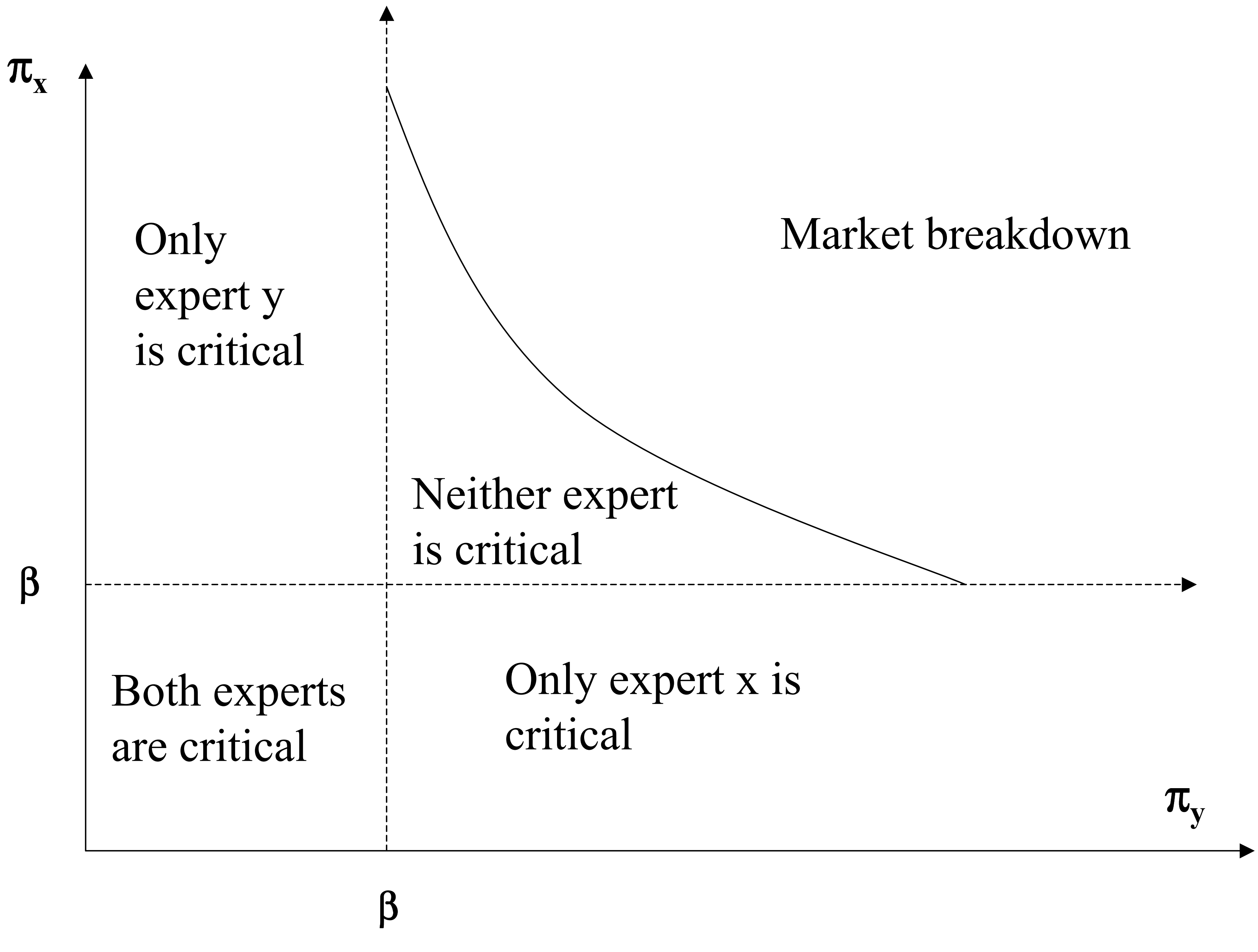

Figure 2b Impact of complementarity

Increase convexity of H(n) leads to an increase in β

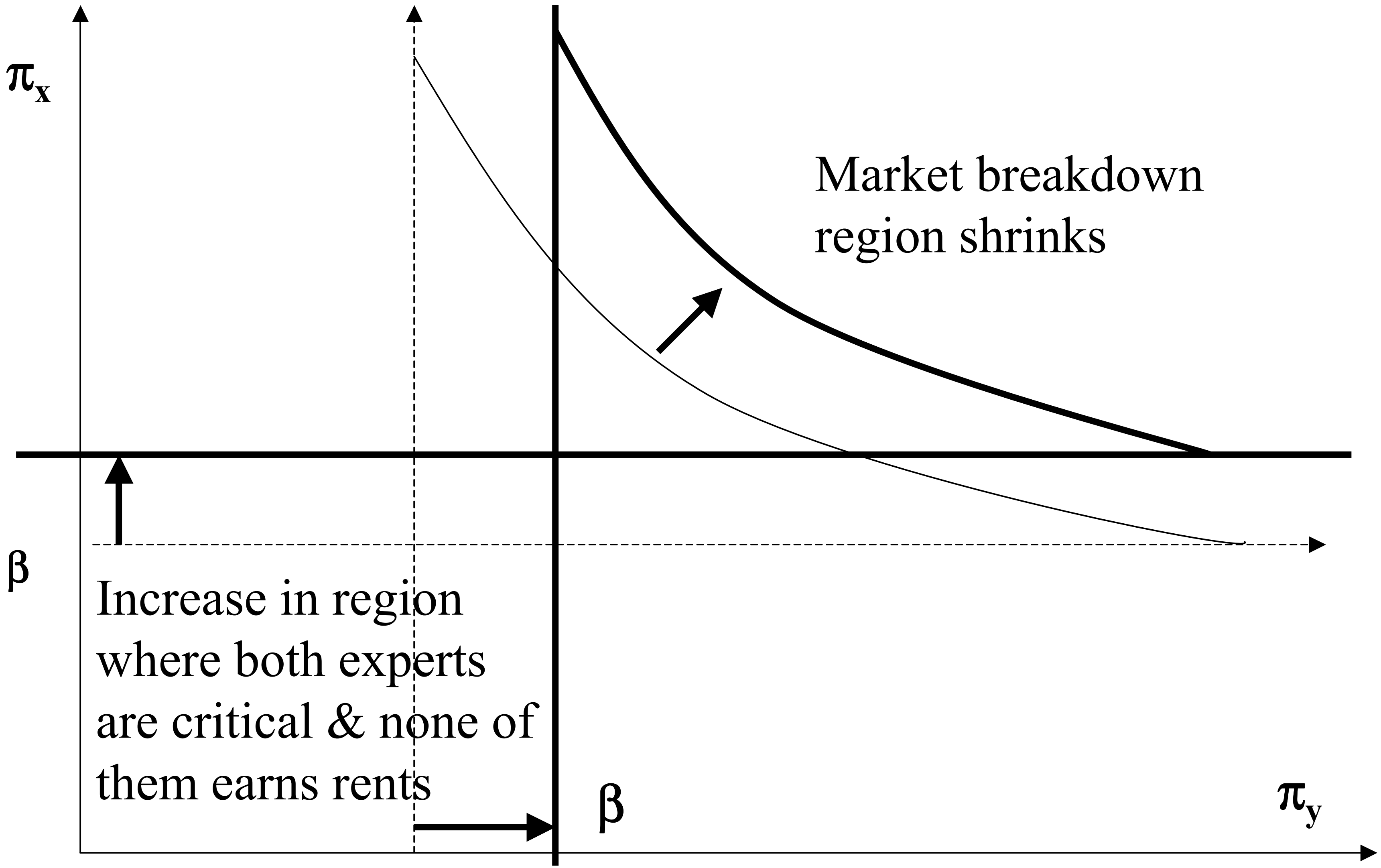

Figure 3 Expected payoff for the entrepreneur