

Entrepreneurs and new ideas

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Abstract: We take the view (advanced, among others, by Schumpeter) that new ideas are original combinations of existing elements. While many random combinations are useless, some represent combinations which "...t" together, aggregating diærent components in a novel and functional way. Thus, in order to appraise an innovative idea it is necessary to have specialized experts examine whether each of its diærent complementary dimensions ...ts; an innovative idea may be profitable only if, say, it is technically feasible, legally patentable and there is a su¢cient consumer demand for it. Thus, signals are complementary rather than additive (the usual assumption in ...nance for evaluating existing assets).

As a result, an entrepreneur must aggregate complementary expertises by forming a partnership in order to assess and implement an innovative idea. This process is very delicate, as experts observe privately their signals, and may steal a good idea. Strong complementarity of signals mitigates the risk of idea stealing because it incentivizes each expert to join the partnership, in order to benefit from the high marginal informativeness of the signal by the other partners. Interestingly, an entrepreneur may not be able to design a partnership if the idea is too good.

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1 Introduction

Innovative ideas are not easy to formulate in terms of existing notions, nor to evaluate and implement them; in fact, there is no fundamental definition of new ideas in economics. We take the view (advanced, among others, by Schumpeter) that ideas are essentially new combinations of existing elements, and that while many such new combinations are useless or nonviable, valuable new ideas represent combinations which "put" together, in the sense of aggregating the different components in a novel and functional way.¹

The focus of this paper is on the process of screening and implementation of novel ideas in the economy, and on the role of entrepreneurs, early partners and investors in the implementation process through which the initial vision is appraised, approved and the necessary resources are brought together for its realization.

It is clearly beyond the ability of the entrepreneur to complete this whole process alone. ² Very often, novel insights are of little use or value until they have been evaluated and operationalized by experts and embodied in scientific and technical teams (see e.g., Callon (1989) and Latour (1979)).

In this paper we model the process by which entrepreneurs with new ideas need the expertise from specialized individuals (or institutions) in order to screen their ideas and subsequently implement them. Elaborating the notion of ideas as novel combination of pre-existing elements, we model this appraisal process as requiring information along different dimensions. For instance, appraising new ventures requires assessing their technical feasibility, the extent of the potential market, the legal aspects of establishing the necessary property rights or its compliances with regulations, logistical and managerial skills for its implementation, and sometimes essential contacts to identify or access scarce resources. Some of these expertises may be both highly specialized; some of them may be critical, in the sense that the failure to clear a single one of these criteria may imply that the venture is worthless. Once the idea has been appraised, the venture also needs from such specialized experts the commitment of their key resources. Thus we view the process of formation of an innovative venture as the aggregation of the critical expertises and associated human and financial resources.

¹This approach that innovative ideas are novel combinations of different pre-existing elements is consistent with the combinatorial theory developed by Weitzman (1998).

²Recent research in the sociology of sciences has shown that the elaboration of knowledge does not derive just from individual thought, but rather from collective processes and interpersonal communication (see e.g. Dodgson, 1993). This may apply to the process of defining a new idea as well as the process of further elaboration that we describe in the paper.

There is much evidence that specialized individuals join new ventures early in its life. Business angels and venture capitalists play a crucial role in this process (see e.g. Casamatta, 2001). Along with experts in management and finance, new ventures often associate specialized advisors or companies in related fields. Computer specialists and logistic engineers are needed to assess the feasibility of an e-venture, and to implement it. Legal consultants are required to appreciate if a biotech innovation can give rise to enforceable – and thus profitable – intellectual property rights. For the innovative idea to be successful, it must be feasible along all the different dimensions on which expert advice is needed.

Arguably, a second dimension of new ideas is also significant in determining their appraisal and implementation; namely, that (good) ideas, once communicated to an expert for evaluation, may be stolen.³ In practice, innovating entrepreneurs are extremely concerned with confidentiality issues (Anton, and Yao, 1994; Ueda, 2000; for a model of appropriation of information within a firm, see Rajan and Zingales, 2001). 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.

The present model analyzes how and whether these difficulties can be circumvented by an entrepreneur. We study how she can aggregate critical expert's technical advice to sort out good ideas from those which, along at least one of the critical dimensions, are unfeasible or inconsistent, and incentivize them to commit their critical skills and resources to the venture, while at the same time protecting the intellectual property rights associated with the idea.

To study these issues we develop the following simple model. The entrepreneur has an innovative idea, which can be profitable or not. She contacts two advisors, who observe privately if, along their own line of expertise, the project is viable. For the venture to be surely profitable it must be feasible along the two dimensions. Thus the signals of the two experts are complements rather than substitutes. This differs from rational expectation models of information aggregation in financial markets, where all signals are drawn from the same distribution. As a result, the signals are additive, and the expected value of the asset is a weighted average of these signals.

We assume that associated to each dimension of expertise is a critical resource (human, physical or financial capital) which needs to be contributed

³Arrow (1962) first raised the paradox that information cannot be sold as a typical neoclassic good. Before the information is presented to the potential buyers, the latter would refuse to pay without knowing what they pay for. Yet, once the information is illustrated, there is no need any longer to pay for what they already know. This point is developed in the paradox of the impossibility of informative financial prices by Grossman and Stiglitz (1980).

for the implementation of the idea.⁴ We assume that such resources are contributed by the experts, if they agree to participate in the implementation phase, or may be bought on competitive markets.⁵ What cannot be bought are the signals themselves. For simplicity, we assume that the provision of these resources is observable, to abstract from moral hazard considerations, and focus on the adverse selection problems arising from privately observed expert signals.

The entrepreneur sets up the firm by designing a partnership proposal which maps the reports of the experts into the decision to undertake the project or not, and specifies the share of the cash flow to be allocated to each of the experts if the project is undertaken. The entrepreneur operates under the participation constraints of the two experts, and the incentive constraint that each expert prefers to join the venture rather than stealing the idea.

Suppose the first expert has observed a good signal. If he were to steal the idea, he could contact the other expert and offer him to engage in the venture together. By doing so, however, he would reveal that his signal was good. It would then be very tempting for the other expert to undertake the venture alone, free riding both on the idea generated by the entrepreneur, and on the evaluation of the first expert. We can show that if the first expert decides to steal the idea, he must undertake the venture alone. Thus he cannot benefit from the expertise of the other expert, and in particular he cannot find out if the idea is viable from the perspective of the other expert. This reduces the attractiveness of idea-stealing, particularly when the two signals are strongly complementary.

If the signals are not strongly complementary, each expert could profitably undertake the project alone, so the potential idea-stealing concern can in fact lead to a market break-down, in line with Arrow's paradox. This problem is particularly severe when the potential cash-flow from the project is very large, which makes it very tempting to steal the idea. On the other hand, if the potential cash flow from the project is not too high, or if there is a large gain in precision from adding a second expert, the entrepreneur can successfully implement a profitable idea via a partnership. In this case, the ability of the entrepreneur to bring the experts together and aggregate their complementary skills is enhanced by the fact that, when they commit to the venture (rather than stealing the idea), each of the experts can benefit from the evaluation offered by the other.

Our focus on private information held by the experts and contractible

⁴For example, venture capitalists and business angels may offer crucial managerial guidance and financial resources, a specialized engineer can run the hardware and software, a marketing partner offer an active sale effort, and a company specialized in the industry valuable equipment or distribution channels.

⁵Expertise and resources can also be provided by more mature industrial firms, potentially interested in the business applications of the new idea.

cash-flows differentiates our paper from Ambec and Poitevin (2001), who study the case where the innovator has private information, and Aghion and Tirole (1994) who analyze the situation where the output is not contractible. Our focus on complementary private information also differentiates our paper from Hellmann (2000), which studies the sequence of resource commitments in a bargaining setting.

In the next section we present our model, later we offer some extensions and conclusions.

2 Model

2.1 Technology

The entrepreneur has an idea, a novel combination of different elements. While the idea is clearly innovative, it remains to find out if it is practical, internally consistent, technically and legally feasible, and financially viable. If it is, then the project should be undertaken, otherwise its expected cash flows are too low and the project should not be undertaken.

We assume that no individual has all the critical expertises to assess the feasibility of the idea. The entrepreneur can identify the different experts who do have the necessary technical skills, each along a different dimension. While in principle there may be several dimensions to the appraisal, for simplicity we will consider only two dimensions of expertise. We hereafter denote them as: x and y . For example, x can be a venture capitalist or business angel, with management expertise, and the ability to assess if the logistic and marketing plan is realistic, while y may be an engineer, able to assess the technical characteristics of the project.

To model expertise, we assume that, once he has heard the description of the project, each expert costlessly observes a private signal. Denote these signals: X and 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 $\frac{1}{4}_x$ (resp. $\frac{1}{4}_y$) or a bad signal with the complementary probability. If both experts have received good signals, the cash flow to be generated by the project is:

$$H(X = 1; Y = 1) = H:$$

If one of the two signals is good and the other is bad, the two components of the idea "do not fit well together". Then the cash flow from the project is:

$$H(X = 1; Y = 0) = H(X = 0; Y = 1) = h:$$

Finally, if neither signals is good the project yields no cash flows:

$$H(X = 0; Y = 0) = 0:$$

Note that the two signals play symmetric roles in the cash flow function $H(·; ·)$. Hence that function can be rewritten as a function of the number of signals that are good (n): $H(n); n \in \{0; 1; 2\}$.

In our analysis, the degree to which the two signals are complementary is important. Complementarity reflects the notion that information on the project value comes from two different dimensions and both assessments need to be positive to appraise the overall coherence of the idea. To model the degree of complementarity, we assume that the cash flow function ($H(n)$) is convex, i.e.:

$$H(2) \geq H(1) + H(1) - H(0):$$

Thus, complementarity implies that the marginal increase in value implied by a positive signal is greater if the other signal is also positive. This amounts to assuming that:⁶

$$H \geq 2h$$

An extreme form of complementarity is when the project can generate positive cash flows only if both signals are good. For example, an 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.: $H(X; Y) = XYH$.⁷

In most financial models, signals on value are drawn from a single dimension; they cover the same dimension, and are therefore additive. In this case, the cash flow function ($H(n)$) is linear, and $H = 2h$. In the extreme case, a first positive signal is so informative that the second adds hardly any new information. In this case, the information content of both signals is almost identical.

The cash flow as a function of n is graphically represented in Figure 1. Here h parametrizes (for a given H) the degree of complementarity. As h decrease, the function becomes more convex, and the complementarity between the two signals is enhanced.

Associated to each dimension of expertise is a critical resource (reflecting human, physical or financial capital) which needs to be contributed for the implementation of the idea.⁸ We assume that such resources are contributed by the experts, if they agree to participate in the implementation phase,

⁶Note that while it matters for the impact of a positive signal whether the other signal has already been found to be positive, the ex ante sequence does not matter in this case.

⁷Arguably, this case probably describes particularly complex ideas, in which each dimension of the idea needs to "fit exactly".

⁸For example, venture capitalists and business angels may offer crucial managerial guidance and financial resources, a specialized engineer can run the hardware and software, a marketing partner offer an active sale effort, and a company specialized in the industry valuable equipment or distribution channels.

or may be bought on competitive markets. What cannot be bought are the signals themselves.

The cost of the complementary resources committed by the specialists, denoted c , can be thought as the implementation cost of the project. For simplicity, we describe this resource contribution as observable and contractible effort, thus ruling out any moral hazard. Thus we focus only on the adverse selection problem in aggregating complementary information which arise because the experts privately observe their signals.

Normalizing discount rates to 1, if the project is undertaken without taking advice from the experts, its ex-ante expected net value of the project is:

$$E(H(X; Y)) - 2c = [\frac{1}{4}x\frac{1}{4}yH + (\frac{1}{4}x(1 - \frac{1}{4}y) + \frac{1}{4}y(1 - \frac{1}{4}x))h] - 2c:$$

We assume that the project is very risky ex-ante so that this net value is negative. On the other hand, if both experts have observed good signals, the net value of the project is:

$$E(H(X; Y)|X = 1; Y = 1) - 2c = H - 2c:$$

Obviously, we assume that this net value is positive, i.e., $H > 2c$. Now turn to the case where one of the two signals is positive and the other is negative. In this case, 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 linear additive case, we also assume that: $h > c$.

2.2 Contracts and incentives

The problem of aggregation of expertises outlined above can be solved as a mechanism design problem. The entrepreneur must elicit truthful reporting of private signals by the experts and compensate them for the development cost. To do so, she allocates them a share of the cash-flow generated by the idea if the project is undertaken, so that the experts become partners in the firm if they choose to contribute to it. The mechanism maps the reports of the experts into the decision to undertake the project or not, and the share of the cash flows allocated to all partners.⁹

Given our hypotheses, under truth-telling, the entrepreneur does not undertake the project if one of the experts reports he observed a bad signal.

⁹We assume that only share contracts are available. It is possible to rationalize equity claims under moral hazard, but it would not add much to the argument.

We assume that if both experts report good signals, the project has positive net present value and it is undertaken. In this case, denote θ_x (resp. θ_y) the share of the cash-flow allocated to expert x (resp. y).

The entrepreneur designs the mechanism so as to maximize her revenue, subject to truthful revelation by the experts. They have no incentive to falsely report good signals, as they know for sure that the project has negative net value in that case.

The risk of idea-stealing arises when either signals are good. An expert with good signals could steal the idea, and undertake the project for their own account.

Suppose the entrepreneur goes to specialist x to present her the project, and the expert has a positive evaluation. Instead of telling the truth, and joining the entrepreneur in the venture, in exchange of a share θ_x of the potential cash-flow, he could decide to report a bad signal and then undertake the project on his own account. He could do so 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 effort corresponding to the complementary dimension of expertise, at price c . (Our assumption that this effort can be obtained from a competitive market is in line with our assumption that it is observable and contractible.) In that case, the expected profit of the expert would be:

$$E(H(X; Y) | X = 1) - 2c = \frac{1}{4}H + (1 - \frac{1}{4}\theta_y)h - 2c:$$

Alternatively, he could go the other expert (y), describe the idea and offer him to set up a partnership together. The latter can either accept the offer or reject it. But at this stage y can also decide to undertake the project himself, if he feels it profitable.

Proceeding by backward induction, first analyze the reaction of y to x 's offer. y realizes that if x had observed a bad signal, it would be a dominated strategy for him to undertake the venture, even with the collaboration of y . Indeed, if x 's signal is bad, he knows that the net value of the project is negative, so that the development cost $2c$ can never be recouped, and the whole affair results in losses. Therefore, by elimination of dominated strategies, y can infer from x 's offer that x 's signal is good. But once he has inferred x 's signal, then y does not need him any longer. Hence, he is better off reporting to x that he observed a bad signal, implement the project himself, and earn the entire value of the project: $H - 2c$.

Anticipating this reaction, x never finds it attractive to offer y to undertake the venture with him. Hence we can state the following lemma:

Lemma 1 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.

We can see here already a potential impact of the risk of idea-stealing, namely that it may lead to insufficient information aggregation.

3 Analysis

3.1 Incentive and participation constraints

When the entrepreneur contacts expert x , if the latter finds the idea good, i.e., observes a good signal, his expected profit if he truthfully reports his signal and joins the venture is:

$$\frac{1}{4}y(\theta_x H - c);$$

while if he lies and undertakes the project alone, his expected gain is:

$$(\frac{1}{4}y H + (1 - \frac{1}{4}y)h) - 2c;$$

which is the present value of the project conditional on a single positive signal. Comparing the two payoffs we can state our next result:

Lemma 2 The incentive compatibility condition under which expert x does not steal the idea when he has observed a good signal is that he obtains a sufficiently large share of the cash flow of the project:

$$\theta_x \geq 1 - \frac{c}{H} \left(\frac{2}{\frac{1}{4}y} - 1 \right) + \frac{1 - \frac{1}{4}y}{\frac{1}{4}y} \frac{h}{H};$$

To incentivize experts to participate in the project rather than stealing the idea, the entrepreneur must promise them a sufficiently large share of the cash flow. This scheme is reminiscent of a partnership agreement. Note that, to the extent that the share of the cash flow which must be promised to the experts to prevent idea-stealing is greater than what is necessary for them to recoup the development cost c , they earn rents.

This condition is essential for an entrepreneur to be able to aggregate information and resources reliably enough to form a venture. We can now investigate some comparative statics.

For expert x , the advantage of joining the venture or partnership is that it enables to incur the development cost only when the signal of the other expert is good also. Hence, we can state the following lemma:

Lemma 3 The greater the resource opportunity cost c , the more attractive it is for the experts to join the venture, the less demanding their incentive compatibility conditions and the lower their information rents.

The cost of joining the venture for the expert is that he only gets a fraction of the cash flow. This cost is particularly high when H is very large, so that it is very tempting to undertake the project alone. Indeed, it is easy to check that, under our assumptions, the right hand-side of the incentive compatibility condition is increasing in H . Hence, we can state our next lemma:

Lemma 4 The greater the high realization of the cash flow (H), the more demanding the incentive compatibility condition of the experts and the greater their rent.

Note further that the right-hand side of the incentive compatibility condition is increasing in the intermediary cash flow realization (h). Since this cash flow realization parametrizes the convexity of the cash flow function we can state the next lemma:

Lemma 5 The more convex is the production function, i.e., the more complementary the two signals, the less demanding are the incentive compatibility condition of the experts, and the lower is the rent they must be left to preclude idea-stealing.

This lemma emphasizes the important role played by the complementarity of the two signals to prevent idea stealing. This is an intriguing idea. If appraising and implementing an idea requires more strongly "interdependent" information and resources, it is easier to create a reliable partnership arrangement.

Finally note that the right-hand side of the incentive compatibility condition of expert x is decreasing in the probability that the other expert observes a good signal: $\frac{1}{4}y$. The lower this probability, the more likely it is that the project has negative net value overall, the more crucial it is to rely on the expertise of y to avoid engaging in a loss-making venture. Correspondingly, we refer to $1 - \frac{1}{4}y$ (resp. $1 - \frac{1}{4}x$) as the informational criticality of expert y (resp. x). Thus we can state the next lemma:

Lemma 6 The greater the information criticality of one expert, the less attractive it is for the other to engage in the venture alone, and the lower the rent the latter expert can obtain.

This result is also intriguing, especially if a high information criticality reflects a more "daring" idea which is 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, and so does the expert with the higher information criticality.

Having characterized the incentive compatibility conditions, we now turn to the participation constraint, or individual rationality condition:

$$\frac{1}{4}y(\theta_x H - c) \geq 0:$$

Putting together the incentive compatibility condition and participation constraints of expert x we obtain the following lemma:

Lemma 7 The minimum share of the cash-flow the entrepreneur must promise to expert x to convince him to join the venture is:

$$\theta_x \geq \text{Max}\left[1 - \frac{c}{H}\left(\frac{2}{\frac{1}{4}y} - 1\right) + \frac{1 - \frac{1}{4}y}{\frac{1}{4}y} \frac{h}{H}; \frac{c}{H}\right]:$$

The first term in the maximum reflects the incentive compatibility condition, while the latter reflects the participation constraint. The former binds when the project would be feasible by the expert alone (i.e., when $\frac{1}{4}yH + (1 - \frac{1}{4}y)h > 2c$). In that case, the entrepreneur must promise the expert expected cash flows which more than compensate the development cost. Thus the expert obtains an informational rent. On the other hand, when $\frac{1}{4}yH + (1 - \frac{1}{4}y)h \leq 2c$, since the expert cannot undertake the project alone, there is no need to incentivize him not to steal the idea. In that case, the participation constraint is the only binding condition, and the expert obtains no rent. Once again, ideas whose components are highly complementary are more easily supported.

Notice that this critical condition concerns the value of a single positive signal. Since a project with two positive signals is certainly valuable, this condition indicates how critical it is to add expertise on the second dimension. We consider first the case when it not very critical, then when it is.

3.2 If both experts can profitably implement the idea based on their signal alone

We first consider the case where: $\frac{1}{4}iH + (1 - \frac{1}{4}i)h > 2c$; $i = x, y$, so that both experts could undertake the project alone. In that case, if the entrepreneur wants to secure the collaboration of the experts, she must leave them informational rents. The best she can do is to set θ_x and θ_y , so that the incentive compatibility conditions of the two experts hold as equality. Correspondingly, her expected profit is:

$$\begin{aligned} & \frac{1}{4}x\frac{1}{4}y(1 - \theta_x - \theta_y)H \\ &= 2c(\frac{1}{4}x + \frac{1}{4}y - \frac{1}{4}x\frac{1}{4}y) - \frac{1}{4}x\frac{1}{4}yH - h[(1 - \frac{1}{4}x)\frac{1}{4}y - (1 - \frac{1}{4}y)\frac{1}{4}x]: \end{aligned}$$

Note that this expected profit is decreasing in H . This may seem paradoxical and contrasts with the case where there would be no adverse selection problem, where the return to the entrepreneur would increase with the profitability of her project. In the second best world we analyze, the entrepreneur

must leave informational rents to the strategic, privately informed experts. The greater the profitability of the project, the greater these rents. This implies that the residual cash flow left for the entrepreneur after these rents are paid is decreasing in the profitability of the project.

Building on the discussion above we can state our next lemma:

Lemma 8 Consider the case where both experts may undertake the project based on their signal alone, after being told the idea, i.e.,:

$$H > \frac{2c + (1 - \frac{1}{4}i)h}{\frac{1}{4}i}; i = x, y:$$

In that situation, the entrepreneur can profitably associate the experts to her innovative project without them stealing the idea if and only if the high realization of the profit (H) is not too large, in the sense that:

$$H < \frac{2c(\frac{1}{4}x + \frac{1}{4}y + \frac{1}{4}x\frac{1}{4}y) + h(2 - \frac{1}{4}x - \frac{1}{4}y)}{\frac{1}{4}x\frac{1}{4}y}.$$

The lemma reflects the fact that, as discussed above, really good projects (i.e., projects with high values of H) are so attractive that, to deter the experts from stealing the idea, the entrepreneur must leave each of them such a large share of the cash flows that her residual profits are negative.

What happens when:

$$H > \frac{2c(\frac{1}{4}x + \frac{1}{4}y + \frac{1}{4}x\frac{1}{4}y) + h(2 - \frac{1}{4}x - \frac{1}{4}y)}{\frac{1}{4}x\frac{1}{4}y},$$

so that the informational rents are so large that the entrepreneur cannot profitably hire the experts? In that case, since we assume that

$$E(H(X; Y)) < 2c;$$

it would not be optimal for the entrepreneur to undertake the project alone, without the advice of the experts, even if she was not wealth constrained and could pay the development costs $2c$.

Could the entrepreneur choose to go to only one expert, say x ? Consider the reaction of the expert in that case. If he observes a bad signal, then he has not incentive to lie. But if he observes a good signal and joins the venture, his expected gain is:

$$\frac{1}{4}yH + (1 - \frac{1}{4}y)h - c;$$

while if he steals the idea and implement it alone, his expected profit is:

$$\frac{1}{4}yH + (1 - \frac{1}{4}y)h - 2c;$$

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

$$\theta_x > 1 - \frac{c}{\frac{1}{4}yH + (1 - \frac{1}{4}y)h}:$$

The participation constraint of the entrepreneur is:

$$(1 - \theta_x)(\frac{1}{4}yH + (1 - \frac{1}{4}y)h) - c > 0:$$

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. Once the expert has heard of the idea, it is advantageous for him 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.

The results presented above can be summarized in the next proposition:

Proposition 9 Consider the case where both experts could undertake the project alone, after being told the idea, i.e.,:

$$H > \frac{2c - (1 - \frac{1}{4}i)h}{\frac{1}{4}i}; i = x, y:$$

Then, the entrepreneur can hire the two experts and retain positive profits if the profitability of the project is relatively low, i.e., if:

$$H < \frac{2c(\frac{1}{4}x + \frac{1}{4}y - \frac{1}{4}x\frac{1}{4}y)}{\frac{1}{4}x\frac{1}{4}y},$$

while if the high cash flow is above that threshold then the entrepreneur does not undertake the project, neither alone, nor with one or two experts.

The proposition emphasizes the consequences of the difficulty to establish property rights on ideas, and shows that these negative consequences can be quite severe for rather good ideas. These ideas are so tempting that it is not possible to secure the help of experts. The informational rents the entrepreneur would need to leave to the experts, to avert their temptation to steal the idea, would be too large. Thus the possibility to steal ideas leads to a market break down, in line with the Arrow's paradox.

Note, however, that the problem is less severe even if H is high, if either h or $\frac{1}{4}y$ are small enough. In either case, the second expert has a resource that is quite critical for the additional increase in precision in the valuation of the venture. Especially when c is large enough, it is then attractive for an expert to join the venture to gain the considerable gain in resource cost saving by eliminating type 2 errors.

3.3 If only one of the two experts can profitably implement the idea alone

Suppose, expert x could profitably implement the idea alone, i.e.,:

$$\frac{1}{4}y H + (1 - \frac{1}{4}y)h > 2c;$$

but expert y could not:

$$\frac{1}{4}x H + (1 - \frac{1}{4}x)h < 2c;$$

This corresponds to the case where the criticality of the information of x is high while that of y is low. In that case, θ_x must be set such that the incentive compatibility condition of x holds:

$$\theta_x = 1 - \frac{c}{H} \left[\frac{2}{\frac{1}{4}y} - 1 \right] + \frac{1 - \frac{1}{4}y}{\frac{1}{4}y} \frac{h}{H};$$

while θ_y is set so that the participation constraint of y holds:

$$\theta_y = \frac{c}{H};$$

The expected profit of the entrepreneur is:

$$\frac{1}{4}x \frac{1}{4}y (1 - \theta_x - \theta_y) H = (2c - h) [1 - \frac{1}{4}y] \frac{1}{4}x;$$

In contrast with the case analyzed in the previous subsection, this expected profit cannot be negative. Hence there is no market break down. Note also that this expected profit is independent of H. This is because the two effects of an increase in H: an increase in the total size of the pie, and an increase in the share of the pie that must be left to expert x, exactly offset each other.

3.4 If none of the two experts can profitably implement the idea alone

Suppose,

$$\frac{1}{4}y H + (1 - \frac{1}{4}y)h < 2c;$$

and,

$$\frac{1}{4}x H + (1 - \frac{1}{4}x)h < 2c;$$

In that case, θ_x and θ_y are set so that the participation constraints of x and y hold as equality:

$$\theta_x = \theta_y = \frac{c}{H};$$

It is not necessary to leave informational rents to the experts. This is because the profitability of the project is relatively low, so that it is not very tempting for the experts to steal the idea, and the possibility to benefit from each other's expertise is sufficient to keep them in the venture. The expected profit of the entrepreneur is:

$$\frac{1}{4}x\frac{1}{4}y(1 - \theta_x - \theta_y)H = \frac{1}{4}x\frac{1}{4}y(H - 2c);$$

as in the first best situation where property rights on ideas are perfectly enforceable. In that case, the Arrow's paradox has no bite.

3.5 The case where the informational criticality of the two experts is the same

To illustrate and discuss our results, consider the case where $\frac{1}{4}x = \frac{1}{4}y$: Denote their identical informational criticality $\frac{1}{4}$. Then one can distinguish three regions as H varies from its lowest possible level ($2c$), at which the net value of the project conditional on two good signals is 0, and its highest possible level denoted $\hat{H}$ (and equal to: $\frac{2c - (1 - \frac{1}{4})h}{\frac{1}{4}}$), at which the net expected value of the project conditional on no signal is 0.

In the first region, corresponding to:

$$H < \frac{2c - (1 - \frac{1}{4})h}{\frac{1}{4}};$$

none of the two experts can undertake the project alone. Both of them need the information of the other, to decide whether to engage in the venture. Then it is easy for the entrepreneur to elicit their advice, while retaining the entire expected net value of the project:

$$\frac{1}{4}^2(H - 2c);$$

In that region, the expected profit of the entrepreneur is increasing in H , as the expected social net value of the project.

In the second region, corresponding to:

$$\frac{2c - (1 - \frac{1}{4})h}{\frac{1}{4}} < H < \frac{2c - (1 - \frac{1}{4})h}{\frac{1}{4}} + \frac{1 - \frac{1}{4}}{\frac{1}{4}}(2c - h);$$

both of the experts could undertake the project alone. Yet, because each expert reckons that the criticality of the information of the other is high, and because the complementarity of the two signals is relatively large, it is possible for the entrepreneur to elicit their advice, while retaining positive profits for herself. In that case, her expected profit is:

$$\frac{1}{4}^2(1 - 2\theta)H = 2c\frac{1}{4} + 2\frac{1}{4}(c - h)(1 - \frac{1}{4}) - \frac{1}{4}^2H;$$

Finally, in the third region, the entrepreneur does not engage in the venture, because that would imply leaving excessive rents to the experts. Hence her expected profit is 0.

Figure 2 depicts graphically the evolution of the expected profits of the entrepreneur over these three regions. It illustrates that the expected profit of the entrepreneur is not monotonic in the a priori profitability of her idea (H).

This non-monotonicity illustrates that, because of the risk that idea can be stolen, the optimal level of the high cash flow (H) for the entrepreneur:

$$H^* = \frac{2c + (1 - \frac{1}{4})h}{\frac{1}{4}},$$

is below the socially optimal value of this cash flow: $\bar{H}$.

3.6 The supply of new ideas and innovative ventures

Consider the following extension of our model where there is a continuum of potential entrepreneurs, indexed by $i \in [0; 1]$. Each entrepreneur is endowed with an innovative idea, which can generate cash flow H_i with probability $\frac{1}{4}$; or h with probability $\frac{3}{4}(1 - \frac{1}{4})$; or 0 with the complementary probability. Each entrepreneur can contact two experts, and contract with them as analyzed above. Ex ante, the entrepreneurs differ only in terms of their potential high cash flow (H_i), drawn from a continuous distribution over $[2c; \bar{H}]$, with c.d.f denoted F .¹⁰

In the first best, where property rights would be so strong that ideas could not be stolen, all entrepreneurs would contact the experts, and a proportion $\frac{1}{4}$ of them would engage in the venture. In this context, the expected social welfare would be:

$$\frac{1}{4} \int_{2c}^{\bar{H}} t dF(t);$$

In the second best situation we analyze, where ideas can be stolen, only entrepreneurs with potential high cash flow below H^* would contact experts. In this context, expected social welfare is:

$$\frac{1}{4} \int_{2c}^{H^*} t dF(t);$$

which is below the first best, since: $H^* < \bar{H}$.

¹⁰Considering only cash flows above $2c$ does not alter qualitatively our results, since projects cash flows below this level would not be undertaken, in the second best as in the first best.

Thus, our analysis shows that because ideas can be stolen, the supply of innovative ideas and ventures will be lower than required by social optimality. This is a form of underinvestment.

Note that, such insufficient supply of innovative ideas would also arise if the entrepreneurs could choose their optimal level of potential high cash flow $H_i \in [2c; H^*]$, at some cost $k(H_i)$; increasing in H_i or if agents could initially choose between becoming entrepreneurs or workers.

4 Conclusion

Schumpeter (1942) wrote that “the role of the entrepreneur consists in reforming or revolutionizing routines of production through taking advantage of an invention or, more generally, hitherto unknown or unused techniques.” In this paper we have proposed a description the nature of truly innovative ideas, as novel combinations of exiting notions whose internal congruence or viability can be assessed only by using specific skills along the different dimensions. In addition to the specific difficulty in appraising them, novel ideas also have a particular vulnerability to theft (following Arrow’s intuition on the unique nature of information as a nonstandard good). We discuss the resulting obstacles to the implementation of novel ideas in the economy, hopefully contributing to knowledge on the information and resource aggregation process through which they are turned from visions into profitable businesses.

References

- Aghion, P. and J. Tirole, 1994, On the management of innovation, *Quarterly Journal of Economics*, 1185–207.
- Ambec, S. and M. Poitevin, 2001, Organizational design of R&D activities, Working paper, University of Salerno and University of Montreal.
- Anton, and Yao, "Expropriation and Inventions", *American Economic Review*, 1994
- Arrow, K., (1962)
- Callon, M., 1989, *La science et ses réseaux*, La Découverte, Paris.
- Casamatta, C., 2001, Financing innovation, working paper, Toulouse University.
- Cheung, "Property Rights in Trade Secrets", *Economic Inquiry*, 1992
- Dodgson, M., 1993, "Learning, trust and technological collaboration", *Human Relations*, 46, 77–94.
- Latour, B., and S. Woolgar, 1979, *Labora*
- Rajan, R. and L. Zingales, "The Firm as a Dedicated Hierarchy", *Quarterly Journal of Economics*, 2001
- Schumpeter, J., 1942, *Capitalism, Socialism and Democracy*, George Allen and Unwin, London.
- Weitzman, M., 1998, Recombinant growth, *Quarterly Journal of Economics*, 331–360.

Figure 1.A: The distribution of the cash flows

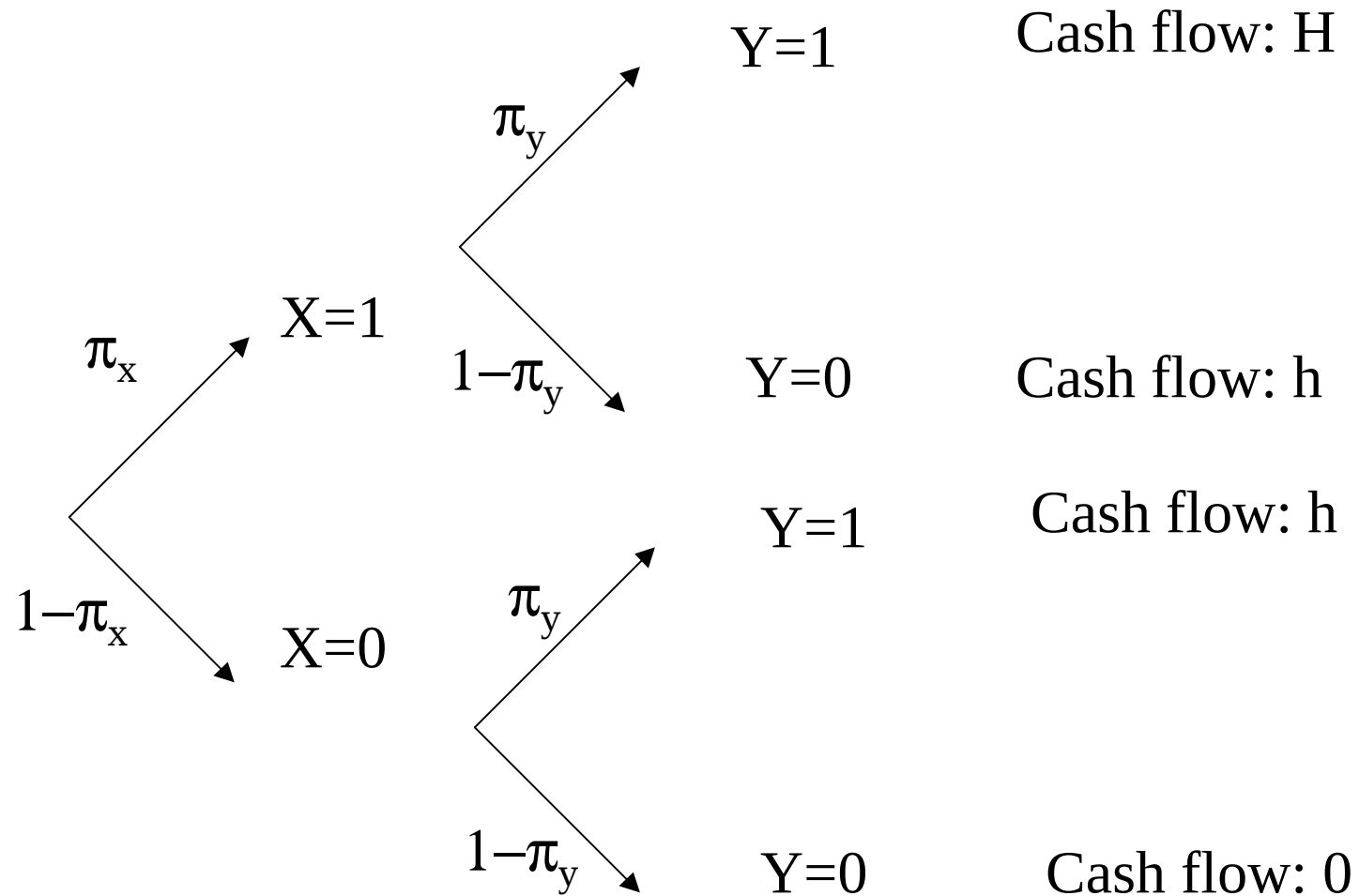


Figure 1.B: The cash flow function

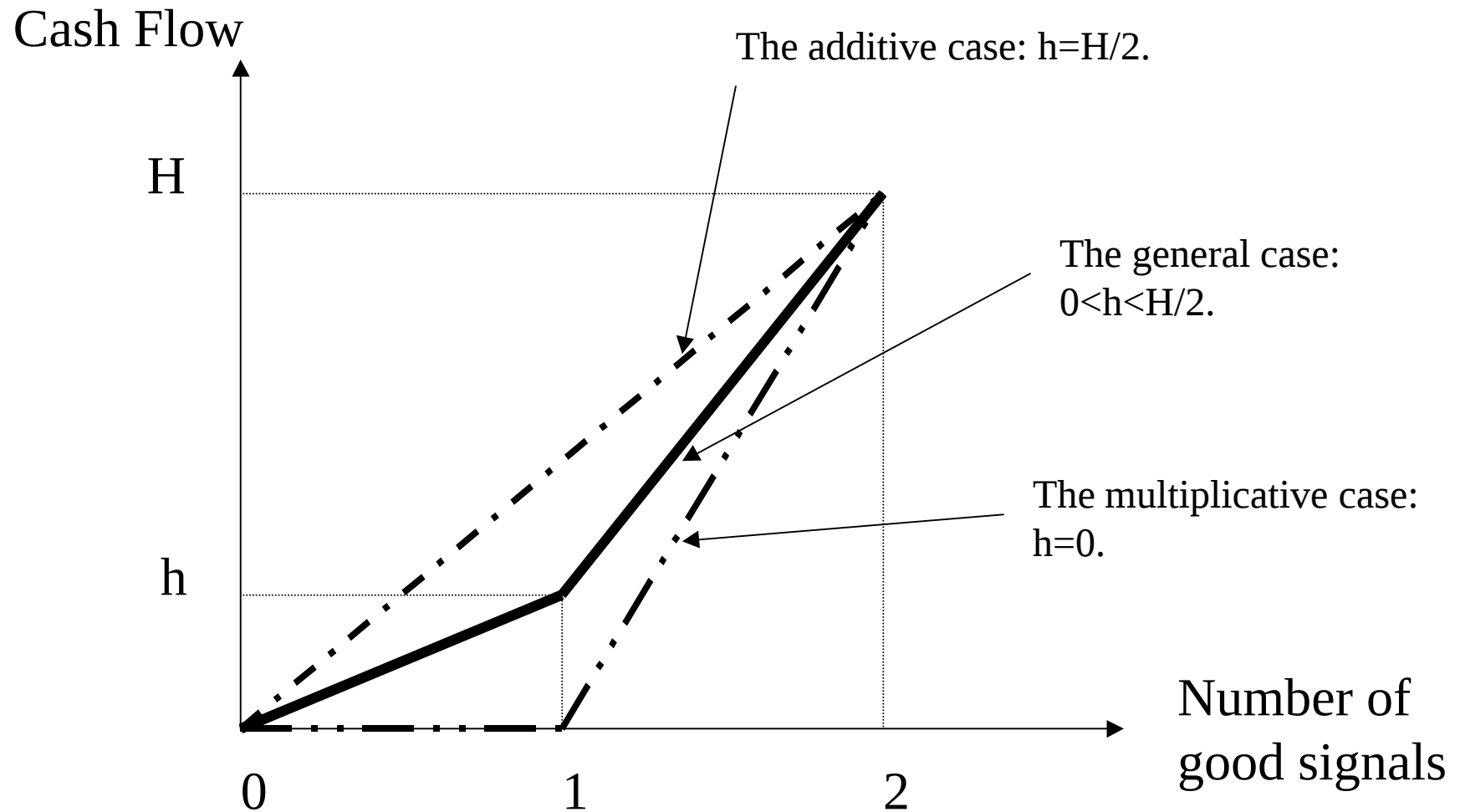


Figure 2: The expected profit of the entrepreneur

