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Organization of Joint Research

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Moral Hazard and the Internal Organization of Joint Research*

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Abstract

We address the question of how the internal organization of partnerships can be affected by moral hazard behavior of their division(s)/agent(s). We explore cases where two entrepreneurs, each employing one agent subject to moral hazard, decide how to conduct a research project together. The project's success probability is affected by agent(s)' effort(s). A joint entity can take two configurations: either both, or only one agent is kept. If two agents are kept, all degrees of substitutability between agents' efforts are considered. We show that the privately optimal internal organization of the joint entity is also socially optimal, except when agents' efforts just start to duplicate each other. In this range, due to moral hazard, *too few partnerships keeping both agents* occur as compared to what would be socially optimal. A restriction on the number of agents to be kept in a partnership would induce *too few* of them leading to socially worse outcomes.

Keywords: internal organization of partnerships, moral hazard, efforts' interactions, cost functions.

JEL codes: D21, D23, L23

1 Introduction

Due to the increasing number of mergers, acquisitions, RJVs, bilateral agreements, and partnerships that have been recently formed, concerns arise about their formation mechanism, their rationale, their possible failures, their duration, and their impact on social welfare.

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There exists an extensive literature on mergers and acquisition, research joint ventures, research and development agreements, etc., which concentrates its attention on the underlying incentives to form a partnership, on the study - eventually - of its conditions for stability, and also on the change in market competitiveness it may induce. Most of the literature, typically, concentrates on the decision firms take to enter an alliance, a R&D agreement, a RJV, or a merger, as a decision that concerns only the owners involved in it. Therefore, issues such as the division of property rights, i.e. the way parties share the benefit of joining each other's forces, and the definition of the optimal contract that would guarantee the stability of the agreement itself.

In most of the contributions to this strand of literature, there is no conflict between the objective function of the firm, i.e. of the one deciding about whether to form a partnership at all, and the person that might affect the outcome of that decision if it is taken. In other words, there is no classical *principal-agent framework*.

For example, in Espinosa and Macho-Stadler (2003) an endogenous formation of partnerships is considered by firms having to decide to join each other in a double sided moral hazard context, i.e. each firm has to decide its level of production with which to contribute to the overall output of the merged entity. Incentives for partnerships have been justified by their ability to decrease or share the costs an individual firm would have to incur otherwise alone, i.e. R&D agreements might help in sharing research costs, saving on assets, avoiding to replicate laboratories, as it is argued in Harrigan (1986). In Pérez-Castrillo and Sandonís (1996) a study of the incentive contracts that make firms disclose and share their know-how within a research joint venture is analyzed. Banal-Estañol and Seldeslachts (2004) analyze merger failures due to the lack of integration efforts and uncertainty about post-merger synergies. Lastly, in Martínez-Giralt and Nicolini (2004) the duration of bilateral agreements for the development of new cost reducing technologies is explained through the description of the initial technological endowment of joining firms and their learning process while cooperating.

The purpose of this work is to investigate the effects of the presence of moral hazard on the decision of forming a partnership and on its *internal organization*. More than interested in whether and when parties agree on merging their assets, knowledge, etc. we want to explain *how* this partnership is organized once it is formed. This is because the organization of the partnership might be crucial in explaining why a partnership can be formed keeping or not the initial units/divisions each joining party was employing before. In reality many partnerships occur where units/divisions are fired after a research joint venture is formed. In other cases a different behavior might be observed. Is there a rationale for this? Which channel could explain this behavior? What is the privately optimal incentive contract to be offered to the members of the units/divisions under this assumption? Which are the

implications for social welfare for such an internal organization decision?

In order to do so, we build a model where - abstracting from market power considerations - we allow for joining parties to decide whether or not to keep their employees (units/divisions) once the partnership is formed. Furthermore, we do this in a context of moral hazard behavior on the employees' side. When considering this situation it becomes important to analyze possible degrees of employees' efforts interaction as they might affect the synergies and the scope for efficiency enhancement within the partnership. Technological efficiency, due to these efforts' interactions, is endogenized and it can capture then the scope for choosing one configuration or another one within the partnership. These different degrees of interactions are captured by what we will call the *technological parameter*: technological, as it relates to the technology/production of probability of success as a function of different possible substitutability, duplication or complementarity between efforts.

A closely related work from the team production literature is Itoh's (1991) paper on endogenous team production. In this work, he shows that inducing team production is optimal if own effort and helping effort are complementary. Contrary to his approach, we do not model complementarity/substitutability coming from the form of the agents' disutility of providing effort. In our model instead, efforts are substitutes to a varying degree and contribute to the overall probability of success of the research project to be undertaken jointly. Efforts interactions might also allow to reach potential synergies whenever the technological parameter is within a given range that we will discuss extensively in the paper. However, the decision to exploit these synergies fully will be the result of a trade-off between enhanced efficiency and increased cost of providing it due to the incentive compatible wage schedule to be offered to agents in these circumstances. The synergies arise as a result at equilibrium only under precise combinations of the parameters of the model. This is different from stating the scope for synergies as exogenous once the partnership is formed which is often argued in the literature related to mergers in particular (see Farrell-Shapiro, 1990).

The proposed model suits well situations where the parties join each other in order to pursue a project in common. The type of project we look at is characterized by an exogenous unit rate of return. This is a valid assumption, for example, for projects conducted by R&D joint-ventures that are formed between separate entities in order to share the benefits and costs of pursuing the research and/or development activities together. These activities may lead to the patenting of the invention/innovation to be sold to third parties who may use it in a separate market. The value of the patent, could be our unit rate of return of the investment. Another example, could be the one that concerns the acquisition of a biotech by a pharmaceutical firm for the development of a new compound or drug, which has to be commercialized by the pharmaceutical firm as a monopolist at least for a particular segment

of the market. One might think of the development of an orphan drug, used to cure a disease for which no other medicament already exists. We explicitly abstract in our model from changes in market configuration before and after the partnership is formed, and, thus from market power consideration, in order to concentrate instead on its internal organization driven by possible efficiency gains.

Our focus in the analysis is on *partnerships among equals*. This means that firms are able to stand-alone as each of them possesses the same assets of considering a research project, and employs, before any agreement is taken, an agent having embedded in him the capabilities/skills to conduct the project alone. It is not feasible for a firm to simply hire an additional employee (unit/division) to enjoy the same degree of synergies as the ones an employee might guarantee instead when coming from a similar firm. This is because the knowledge embedded in each employee is imagined to be the result of accumulated learning process within each firm and, therefore, within the potential partnership. This interpretation is quite realistic when focusing attention on high-tech partnerships, or biotech industries where the professionalism of the employees, is a direct function of their experience accumulated on a highly specialized field. It could be still possible to imagine a competition for specialized jobs between firms. However, we do not model this possibility in the present work. This is also done as firms even when able to "steal" the other's employee are still not able to duplicate the scale of their project alone: the project can be undertaken doubling its scale, only when joining another firm. This might be due to limits of financial resources, or, more realistically, in accessing easily assets specific to this research project. These assets can be only magnified when eventually joining another firm. Let us imagine that it would not be feasible to access these resources, other than getting them through a joint venture, or a merger, or an agreement that would guarantee their property rights and the appropriability of their consequent benefits.

Results of our model show that, when abstracting from market power considerations, and, in the presence of moral hazard behavior, partnerships are welfare enhancing. Within the partnerships we show which ones are less socially preferred as a function of the technological parameter mentioned above. It is shown that a conflict between the socially and privately preferred configuration for the final partnership may appear any time the employees' efforts are characterized by low degrees of duplication. In this case, private choice would ask for not keeping all the employees active, while keeping all of them would be socially preferred instead. The result is that *too few partnerships keeping all employees* would be observed and lower overall efficiency would be reached.

An intervention that would restrict the set of the possible configurations the partnership may take, is proved not to eliminate the problem, but, instead, to exacerbate it, leading

to worse social outcomes. This is the case, when legal constraints, or huge fixed costs of firing the agents, may oblige merging parties to keep their employees into the merged entity. When this happens, a welfare enhancing partnership may fail to exist at all. The option not to go together comes back as a valid one as parties may find more profitable to stay alone conducting the project any time they are not allowed to fire their employees while going together. Given this, the final outcome would be that *too few partnerships* are observed compared to the ones that would have been socially desirable. This leads in turn to an even lower overall social welfare than the one obtained in the absence of such a constraint.

The work is organized as follows. In section 2 we describe the setup of the model. Section 3 is devoted to the characterization of the first best solution, i.e. the socially and privately optimal one in the absence of asymmetric information. In section 4, we analyze the second best solutions for respectively the stand-alone, the partnership keeping one agent and the one keeping two agents instead. We also compare the different outcomes in terms of expected social welfare, profit and probability of success. Comparisons are made in order to establish the privately optimal organizational form and the one that would be socially desirable. Section 5 is devoted to an analysis of the costs principals face for implementing a given probability of success associated with each type of contract, i.e. the first and the second best ones. In section 6 we propose an interpretation of the probability of success as *productive efficiency*. We finally conclude with section 7, offering possible ideas for extensions of the present work.

2 The Model

Entrepreneurs' side We consider two entrepreneurs/principals. Each of them has one unit of assets to be invested into a project. Agents have the ability to affect the probability of success or failure of the project they conduct. The project's constant unit return to investment, \tilde{R} , is stochastic. There exist two different states of nature which determine the realization of \tilde{R} . We may observe either 0 in the bad state of nature (*failure*) or Δ in the good state of nature (*success*).

Projects may be conducted by each entrepreneur alone, or together with another entrepreneur. Each entrepreneur initially employs one agent i , with $i = 1, 2$. We assume that each agent has embedded the knowledge/capability to conduct the project alone. Each entrepreneur can thus decide whether to join another entrepreneur and, eventually, whether to keep his own agent in this joint project.

If entrepreneurs conduct the project separately, each of them employs one agent and this agent is devoted to the project alone. We will refer to this case as the *stand-alone* one (S).

If the entrepreneurs combine their assets for a joint project, they further have to decide whether to keep both their agents to conduct it, or only one of them. If only one agent is kept, we will refer to the *joint/one-agent* case, (*J1*). If both agents are kept instead, we will refer to the *joint/two-agents* case, (*J2*). Any time the project is conducted jointly, we assume that a new entity is founded. We refer to this entity as the *joint entity*. The unit rate of return to the joint investment stays the same, however having doubled the scale of the investment by putting together the assets of two entrepreneurs makes the overall joint project return associated to each state of nature twice as big as before. We further assume that owners share equally the costs and the benefits of conducting the joint project. In our work, we abstract from asymmetric sharing of the project and from optimal investment level considerations. This is done, in order to focus our analysis on the pure organizational choice entrepreneurs have when dealing with agents that are subject to moral hazard behavior.

Agents' side The source of moral hazard comes from the ability agents have to affect the probability of success or failure of the project they conduct through their chosen effort. The agents, when devoted to the project, exert a non observable, therefore not-contractable, effort e_i which is a continuous choice from the interval $[0, 1]$. Exerting this effort e_i implies a disutility for the agent that is equal to $c_i(e_i) = \frac{1}{2}e_i^2$. Agents receive a transfer t_i from their respective entrepreneur in the stand-alone case or from the joint entity. They are risk neutral and their utility is additively separable between effort and money, $U_i = u_i(t_i) - c_i(e_i) = t_i - \frac{1}{2}e_i^2$. However, we assume that agents have limited liability so that for any state of nature they have to receive a non-negative transfer.

A contract cannot be written contingent on the efforts exerted, but only on the observable and verifiable return to investment \tilde{R} . We assume the transfer agents receive from their respective owner to be a function:

$$t_i(\tilde{R}) = \begin{cases} w_i + b_i & \text{if success} \\ w_i & \text{if failure} \end{cases}$$

In the joint cases (*J1*, *J2*) we will again drop the index i while referring to the transfer agent(s) receive from the joint entity. If two agents are kept, we impose equal transfer to both agents. This may be due to legal constraints which oblige owners to pay comparable wages/transfers for comparable jobs. It could also be of the interest of the owners to let their agents follow the project jointly in order not to lose part of the tacit knowledge that agents may acquire during the development of the project itself. Furthermore, giving an incentive contract to only one of the two agents will reduce this case to the *J1* case. In our model, giving equal wages for equal jobs, will come out at equilibrium as the result of the minimization of the cost of implementing a given probability of success. We will discuss

more extensively the nature of this result in a separate section, while introducing the notion of cost function within our model.

Probability of success As already mentioned, agents may affect the success of the project selecting a certain level of effort. We define this probability as:

$$\Pr(\text{success}) = \left(\sum_i e_i^{1-\varepsilon} \right)^{\frac{1}{1-\varepsilon}} \leq 1.$$

In order for this probability to never exceed one, we impose the restriction¹ $\Delta \leq \min \left\{ 2^{-\frac{2}{1-\varepsilon}}, 2^{-1} \right\}$.

Whenever only one agent is devoted to the project, this success probability collapses to either $\Pr(\text{success} | S)_i \equiv p(S)_i = e_i$ if each agent is employed by stand-alone entrepreneurs, or $\Pr(\text{success} | J1) \equiv p(J1) = e$ if the agent is employed by the joint entity. If both agents are kept in it, we have that $\Pr(\text{success} | J2) \equiv p(J2) = (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{1}{1-\varepsilon}}$. In any case, the success probability is an increasing function of the agent(s)' exerted effort(s). The probability of success will be taken as a measure of *technical* or *productive efficiency*. This is because any time the probability is increased, the overall pie to be shared in the economy - gross of the agent(s)'s disutility - becomes bigger.

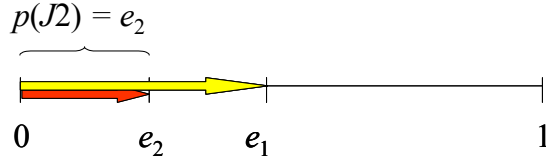
The parameter $\varepsilon \in [\underline{\varepsilon}, \bar{\varepsilon}]$ determines the way agents' efforts interact with each other depending on the technology possibilities attached to a given project². A project can be such that it is possible to subdivide it into several tasks, which may require each to succeed or not; or it is possible to be run in parallel by each agent to whom the whole project is assigned. Depending on these technological possibilities attached to the project we allow for different degrees of substitutability, complementarity and duplication between agents' efforts.

The technology parameter can be positive but not too big as we want to keep the assumption that the project can be carried out by one agent alone. A value of ε which would tend to infinity would imply that agents' efforts are perfect complements, i.e. both agents' efforts would be needed to bring the project to a success. For this reason, we assume an upper bound for ε equal to $\bar{\varepsilon}$, with $0 < \bar{\varepsilon} \ll +\infty$. Allowing instead for positive values of this parameter we can still consider situations where some projects may require agents to tightly work together for the project to succeed. We can think about a project that let the agents acquire information while exerting an effort together. This information needs to be shared between the two agents and it is crucial for making the project successful. Given this situation, a part of effort of the agent working more than the other would be lost and

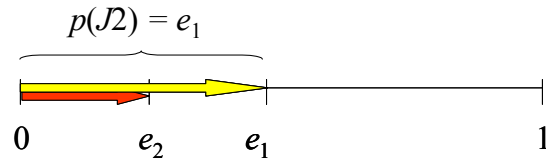
¹This constraint can be derived from the optimally implemented probabilities of success.

²The reason for the restriction of the technological parameters are explained in the next two paragraphs.

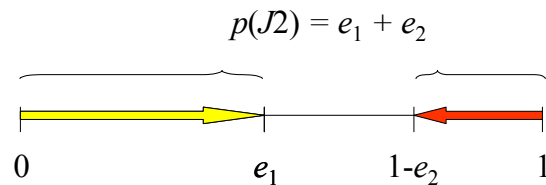
would not contribute to the overall success of the project. To give a graphical intuition for the extreme case where ε would tend to infinity, even if we do not consider it in our analysis for the reasons just mentioned, we can draw the following figure:



The technology parameter can also be negative, but not too negative. We assume the lower bound $\underline{\varepsilon}$ with $-\infty \ll \underline{\varepsilon} < 0$ in order to fulfill the second order conditions for the optimally implemented contracts. A negative ε accounts for the degree to which the agents' efforts are duplicates. If $\varepsilon \rightarrow -\infty$, even though we do not look at this extreme value, we would have perfect duplication of agents' efforts: only the maximum level of effort exerted by either one or the other agent determines the level of the success probability of the joint project. An illustration of that case is a project whose probability of success strongly depends on the fact that one and the same agent has conducted it in a continuous way. The following figure gives a graphical interpretation of this case:



Finally, if $\varepsilon = 0$, agents' efforts are perfect substitutes. An example for this case is a project, which can be divided into two parts that may each partially contribute to the overall success of the project and which are assigned each to a different agent. Here no agent's effort overlaps the one of the other and the probability of success is determined by the overall amount of effort exerted by the two agents. Finally, we can provide a graphical interpretation of this case:



Timing The timing of the model is the following:

1. Owners decide on whether they want to invest in a joint or in a stand-alone project.

2. Owners offer a contract to the agents involved in the project.
3. Agent(s) accept(s) or reject(s) the contract(s).
4. Agent(s) decide(s) on an effort level to be exerted.
5. The outcome is realized and the transfers are executed.

3 Benchmark: First best

The goal of this section is to describe the socially (and privately, as they coincide) optimal organizational structures (S), ($J1$), and ($J2$) in a world without informational asymmetries. This means that, contrary to our original assumption from the model setup, we assume here the efforts to be observable. This analysis will represent the benchmark to be compared to the second best outcome that would derive from introducing the moral hazard behavior on the agents' side.

In a first best world, it is always possible for the principals to implement an effort level that they would have chosen to exert themselves, only having to let the agent(s) accept the contract, i.e. let him/them break even, (*individual rationality constraint* = IR) as well as to give him/them a non-negative transfer for each state of nature (*limited liability* = LL).

We derive the socially optimal contracts for each of the different organizational structures. We then compute the expected welfare/profits for each of them. We further discuss which organizational structure would lead to the highest welfare/profits level.

3.1 Stand-alone (S)

In this section we take the assumption that each entrepreneur conducts the project alone employing one agent each. Here only the effort of their own manager will determine the probability of success of their respective project, i.e. $p_i(S) = e_i$.

Therefore, each entrepreneur solves:

$$\begin{aligned} \max_{e_i} \Pi_i(S) &= \max_{e_i} [e_i \Delta - t_i] \\ \text{s.t.} \quad t_i - \frac{1}{2} e_i^2 &\geq 0 && (IR) \\ t_i &\geq 0 && (LL) \end{aligned}$$

It is straightforward to notice that the (IR) constraint when satisfied, implies that the (LL) constraint is satisfied too. Therefore, it is easy to show that the solution to this problem

gives:

$$\begin{aligned} [p_i(S)]^{FB} &= [p(S)]^{FB} = \Delta \\ [t_i(S)]^{FB} &= [t(S)]^{FB} = \frac{\Delta^2}{2} \end{aligned}$$

The expected welfare, as well as the sum of the profits as they coincide, associated with the first best probability of success and, therefore, with the transfer to be paid to each agent is:

$$\begin{aligned} [EW(S)]^{FB} &= 2 \left([p(S)]^{FB} \Delta - [t(S)]^{FB} \right) \\ &= \Delta^2. \end{aligned}$$

Each entrepreneur realizes an expected profit equal to:

$$\frac{[E\Pi(S)]^{FB}}{2} = \frac{\Delta^2}{2}.$$

3.2 Joint-one agent (*J1*)

When two entrepreneurs invest into a joint project they form a new entity. Doing so, they might choose to let one agent run the project alone. In this case, as already discussed, we assume that the joint entity offers a transfer to this agent, and the entrepreneurs share equally the cost of the transfer as well as the revenues of the project. Again, only the effort of one agent will determine the probability of success of the joint project so that $p(J1) = e$.

Therefore, the joint entity's maximization problem is:

$$\begin{aligned} \max_e \Pi(J1) &= \max_e [e2\Delta - t] \\ s.t. \quad t - \frac{1}{2}e^2 &\geq 0 && (IR) \\ t &\geq 0 && (LL) \end{aligned}$$

As in the previous subsection we can derive the following solution to this problem:

$$\begin{aligned} [p(J1)]^{FB} &= 2\Delta, \\ [t(J1)]^{FB} &= 2\Delta^2. \end{aligned}$$

The expected welfare associated with this case is:

$$\begin{aligned} [EW(J1)]^{FB} &= [p(J1)]^{FB} 2\Delta - [t(J1)]^{FB} \\ &= 2\Delta^2. \end{aligned}$$

Therefore, each entrepreneur/principal realizes an expected profit equal to:

$$\frac{[E\Pi(J1)]^{FB}}{2} = \Delta^2.$$

3.3 Joint-two agents ($J2$)

When entrepreneurs go together keeping two agents, we still assume that they share equally the costs of employing these agents and the revenues that come from the joint project.

The probability of success in this case becomes a function of both agents' efforts so that $p(J2) = (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{1}{1-\varepsilon}}$. In the first best world, the joint entity proposes to each agent exactly the same optimal contract, i.e. the same transfer and the same level of effort to be exerted by both the agents employed.

Let us show this as an endogenous result which derives from the joint entity's maximization problem:

$$\begin{aligned} \max_{t_1, t_2} \Pi(J2) &= \max_{t_1, t_2} \left[(e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{1}{1-\varepsilon}} 2\Delta - t_1 - t_2 \right] \\ \text{s.t.} \quad t_i - \frac{1}{2}e_i^2 &\geq 0 \quad \forall i && (IR) \\ t_i &\geq 0 \quad \forall i && (LL) \end{aligned}$$

This problem leads to the following result:

$$\begin{aligned} [e_i(J2)]^{FB} &= [e(J2)]^{FB} = 2^{\frac{1}{1-\varepsilon}} \Delta, \\ [p(J2)]^{FB} &= 2^{\frac{2}{1-\varepsilon}} \Delta, \\ [t(J2)]^{FB} &= 2^{\frac{1+\varepsilon}{1-\varepsilon}} \Delta^2. \end{aligned}$$

For the $J2$ case, we get an expected welfare equal to:

$$\begin{aligned} [EW(J2)]^{FB} &= [p(J2)]^{FB} 2\Delta - 2[t(J2)]^{FB} \\ &= 2^{\frac{2}{1-\varepsilon}} \Delta^2, \end{aligned}$$

and, therefore, a per entrepreneur/principal expected profit of:

$$\frac{[E\Pi(J2)]^{FB}}{2} = 2^{\frac{1+\varepsilon}{1-\varepsilon}} \Delta^2.$$

3.4 First best optimal organizational form

We are now able to draw some conclusions about which organizational structure would have been selected both socially and privately. To summarize the results found for the first best world, we can use the following table:

	S	$J1$	$J2$
$[E\Pi(\cdot)]^{FB} = \frac{1}{2}[EW(\cdot)]^{FB}$	$\frac{\Delta^2}{2}$	Δ^2	$2^{\frac{1+\varepsilon}{1-\varepsilon}}\Delta^2$
$[p(\cdot)]^{FB}$	Δ	2Δ	$2^{\frac{2}{1-\varepsilon}}\Delta$

Given that the S -structure is always dominated by the $J1$ in terms of welfare and probability of success, the only meaningful comparison is the one between the $J1$ and the $J2$ structure when entrepreneurs decide for a joint project. Therefore, we will limit our comparison to the welfare and probabilities of success associated with $J1$ and $J2$.

Keeping two agents in the joint entity is socially and privately preferred to keeping only one agent, whenever the technological parameter $\varepsilon \in]-1, 1[$. Outside this interval, the reverse is true. The same conclusion applies when comparing the probabilities of success under each case. This is due to the fact that in the absence of asymmetric information, entrepreneurs can always let the agent(s) implement their preferred level of effort with the only limitation that their cost of doing so has to be compensated to let them accept the contract. Profitability, enhanced social welfare and probabilities of success are all aligned.

We can summarize the benchmark results in the following proposition:

Proposition 1 *In a first best world,*

- i) S is always dominated by $J1$, from the profitability, social welfare and probability of success points of view;*
- ii) $J2$ is socially and privately preferred to $J1$, and leads to a higher probability of success, than the $J1$ iff $\varepsilon \in]-1, 1[$.*

4 Second best

In this section we go back to our original assumption of unobservable agents' efforts. In this case, contracts cannot be written on the actual level of effort chosen by the agent(s), but only on the realization of the project instead. When the project succeeds, principals give a bonus to their agent(s) in order to incentivate them to exert higher level of efforts, while when it fails they will not.

Within this context, we replicate the analysis made in the previous section in order to derive the second best optimal contracts and the organizational structure that would prevail privately. We then compute the expected welfare and the success probability induced by each organizational structure. Furthermore, we provide an analysis of the entrepreneurs' cost functions associated with the implementation of a given probability of success (function of the implemented agents' efforts).

4.1 Stand-alone (S)

If entrepreneurs decide to invest in a stand-alone project, its probability of success would be, again, equal to $p_i(S) = e_i$. However, the level of effort to be exerted by the respective agent involved into each project will have to satisfy the additional constraint that results from the agent's maximization program, the (IC) one.

Agent's problem Each agent i selects the effort that maximizes his expected utility which is given by his expected wage net of the disutility of exerting an effort e_i , i.e.:

$$\max_{e_i} U_i = \max_{e_i} \left[w_i + e_i b_i - \frac{1}{2} e_i^2 \right]$$

The solution to this problem gives us the (IC) constraint we will need to add to the principals problem when deciding the optimal wage contract to be offered to their respective agents:

$$e_i = b_i.$$

Entrepreneurs' problem Each principal solves for the following problem now:

$$\max_{w_i, b_i} \Pi_i(S) = \max_{w_i, b_i} [e_i(\Delta - b_i) - w_i]$$

$$s.t. \quad e_i = b_i \tag{IC}$$

$$w_i + e_i b_i - \frac{1}{2} e_i^2 \geq 0 \tag{IR}$$

$$w_i \geq 0 \tag{LL}$$

As a solution to the above problem, both entrepreneurs will offer the same base wages and bonuses to their respective agent,

$$[t_i(S)]^{SB} = [t(S)]^{SB} = \begin{cases} [b(S)]^{SB} = \frac{\Delta}{2} & \text{if success} \\ [w(S)]^{SB} = 0 & \text{if failure} \end{cases}$$

and, therefore, the implemented probability of success for each project will be the same as well,

$$[p_i(S)]^{SB} = [p(S)]^{SB} = \frac{\Delta}{2} = \frac{[p(S)]^{FB}}{2}.$$

The induced probability of effort is half the one that an entrepreneur/social planner would have chosen in a first best world. Furthermore, given the incentive compatibility constraint together with the agents' limited liability constraint, each entrepreneur expected profit becomes:

$$\begin{aligned} [E\Pi(S)]^{SB} &= [p(S)]^{SB} \left(\Delta - [b(S)]^{SB} \right) - [w(S)]^{SB} \\ &= \frac{\Delta^2}{4}. \end{aligned}$$

The expected welfare that results from the implementation of this contract is the following one:

$$\begin{aligned} [EW(S)]^{SB} &= 2 \left([p(S)]^{SB} \Delta - \frac{1}{2} \left([p(S)]^{SB} \right)^2 \right) \\ &= \frac{3}{4} \Delta^2. \end{aligned}$$

4.2 Joint-one agent ($J1$)

If entrepreneurs decide to invest in a joint-one agent project, its success probability would be function, again, of one agent's effort only, so that $p(J1) = e$. Entrepreneurs will face the (IC) constraint that comes from their agent's utility maximization problem, they will share the cost of the transfer to be paid to the agent and also the revenues coming from the joint project, i.e. the one that gives twice \tilde{R} .

Agent's problem The agent's program corresponds to the one of the stand-alone case, only difference being that now there is one agent who conducts a double scale project and only one receives a transfer. We therefore drop the i index from the solution to the one-agent's problem already found, obtaining:

$$e = b.$$

Joint entity's problem The joint entity solves, therefore, for:

$$\begin{aligned} \max_{w,b} \Pi(J1) &= \max_{w,b} [e(2\Delta - b) - w] \\ \text{s.t. } e &= b && (IC) \\ w + eb - \frac{1}{2}e^2 &\geq 0 && (IR) \\ w &\geq 0 && (LL) \end{aligned}$$

This problem gives us the following results:

$$[t(J1)]^{SB} = \begin{cases} [b(J1)]^{SB} = \Delta & \text{if success} \\ [w(J1)]^{SB} = 0 & \text{if failure} \end{cases}$$

and, therefore, the induced probability of success for the joint project is,

$$[p(J1)]^{SB} = \Delta = \frac{[p(J1)]^{FB}}{2}.$$

Again, the induced probability of effort is half of the one that an entrepreneur/social planner would have chosen in a first best world for the correspondent case.

Given the equal sharing rule between entrepreneurs after joining forces, each of them will expect to receive the following profit:

$$\begin{aligned} [E\Pi(J1)]^{SB} &= [p(J1)]^{SB} \left(\Delta - \frac{[b(J1)]^{SB}}{2} \right) - \frac{[w(J1)]^{SB}}{2} \\ &= \frac{\Delta^2}{2}. \end{aligned}$$

The expected welfare that results from the implementation of this contract is the following one:

$$\begin{aligned} [EW(J1)]^{SB} &= 2 \left([p(J1)]^{SB} \Delta \right) - \frac{1}{2} \left([p(J1)]^{SB} \right)^2 \\ &= \frac{3}{2} \Delta^2. \end{aligned}$$

4.3 Joint-two agents ($J2$)

If entrepreneurs decide to invest in a joint-two agents project, its probability becomes function of both agents' effort, so that $p(J2) = (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{1}{1-\varepsilon}}$. Entrepreneurs will face one (IC) constraint for each of their employed agents and, again, they will share the cost of the transfer to be paid to them - remember that here we maintain the assumption that agents obtain comparable contracts for comparable jobs - as well as revenues coming from the joint project, i.e. twice \tilde{R} .³

Agents' problem Whenever two agents are involved in a joint project, each of them will maximize his own utility w.r.t. his own effort taking as given the one of the other agent. The first order conditions of each of these problems give us their respective reaction functions. The two reaction functions taken together will lead to the (IC) constraints that the joint entity will have to satisfy when proposing a given contract to these two agents.

The two agents' maximization problems are:

$$\begin{aligned} \max_{e_1} U_1 &= \max_{e_1} \left[w + (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{1}{1-\varepsilon}} b - \frac{1}{2} e_1^2 \right] \\ \max_{e_2} U_2 &= \max_{e_2} \left[w + (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{1}{1-\varepsilon}} b - \frac{1}{2} e_2^2 \right] \end{aligned}$$

The first order conditions associated with these problems are:

³In section 5.2.3 we will prove that this is not an assumption that is imposed for tractability reasons, but instead a result of the cost minimization entrepreneurs face when employing two agents in a second best world.

$$\begin{aligned} e_1^{-\varepsilon} (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{\varepsilon}{1-\varepsilon}} b - e_1 &= 0 \\ e_2^{-\varepsilon} (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{\varepsilon}{1-\varepsilon}} b - e_2 &= 0 \end{aligned}$$

The solution to the Nash behavior of the two agents will lead to the following (*IC*) constraint:

$$e_1(J2) = e_2(J2) = e(J2) = 2^{\frac{\varepsilon}{1-\varepsilon}} b.$$

This leads to a probability of success:

$$p(J2) = 2^{\frac{1+\varepsilon}{1-\varepsilon}} b.$$

Each agent's i will accept the contract the joint entity will propose as long as:

$$w + p(J2)b - \frac{1}{2} [e(J2)]^2 \geq 0.$$

Joint entity's problem The joint entity solves, therefore, for:

$$\begin{aligned} \max_{w,b} \Pi(J2) &= \max_{w,b} [p(J2)(2\Delta - 2b) - 2w] \\ \text{s.t. } e(J2) &= 2^{\frac{\varepsilon}{1-\varepsilon}} b \quad \forall i && (IC) \\ w + p(J2)b - \frac{1}{2} [e(J2)]^2 &\geq 0 \quad \forall i && (IR) \\ w &\geq 0 \quad \forall i && (LL) \end{aligned}$$

Each agent receives the following transfer:

$$[t(J2)]^{SB} = \begin{cases} [b(J2)]^{SB} = \frac{\Delta}{2} & \text{if success} \\ [w(J2)]^{SB} = 0 & \text{if failure} \end{cases}$$

and, as a consequence, we will get that the probability of success of the joint project corresponds to:

$$\begin{aligned} [e(J2)]^{SB} &= 2^{\frac{2\varepsilon-1}{1-\varepsilon}} \Delta \\ [p(J2)]^{SB} &= 2^{\frac{2\varepsilon}{1-\varepsilon}} \Delta = \frac{[p(J2)]^{FB}}{4}. \end{aligned}$$

This time, the probability induced by keeping two agents in the second best world does not correspond to half the one of the first best world as before. Instead, the implemented probability is equal to one fourth of the first best one.

Each entrepreneurs' expected profit is:

$$\begin{aligned} [E\Pi(J2)]^{SB} &= [p(J2)]^{SB} \left(\Delta - [b(J2)]^{SB} \right) - [w(J2)]^{SB} \\ &= 2^{\frac{3\varepsilon-1}{1-\varepsilon}} \Delta^2. \end{aligned}$$

The implemented probability of success will lead to an expected welfare equal to:

$$\begin{aligned} [EW(J2)]^{SB} &= 2 \left([p(J2)]^{SB} \Delta - \frac{1}{2} \left([e(J2)]^{SB} \right)^2 \right) \\ &= 7\Delta^2 2^{\frac{4\varepsilon-2}{1-\varepsilon}}. \end{aligned}$$

4.4 Second best optimal organizational form

We are now able to draw some conclusions about which organizational structure would have been selected privately and which welfare level this choice would lead to. To summarize the results found for the second best world, we can use the following table:

	S	$J1$	$J2$
$[E\Pi(\cdot)]^{SB}$	$\frac{\Delta^2}{4}$	$\frac{\Delta^2}{2}$	$2^{\frac{3\varepsilon-1}{1-\varepsilon}} \Delta^2$
$[EW(\cdot)]^{SB}$	$\frac{3}{4}\Delta^2$	$\frac{3}{2}\Delta^2$	$7\Delta^2 2^{\frac{4\varepsilon-2}{1-\varepsilon}}$
$[p(\cdot)]^{SB}$	$\frac{\Delta}{2}$	Δ	$2^{\frac{2\varepsilon}{1-\varepsilon}} \Delta$

Again, the S -structure is always dominated by the $J1$ in terms of induced welfare, profitability and probability of success. Given this, as before, entrepreneurs, when free to fire one of their agents, will always prefer to join each other and the only decision they will have to take is about which type of internal organization the joint entity will have, i.e. with one or two agents devoted to the joint project.

Once more, if no restriction exists on the freedom of entrepreneurs of firing their agents, having ruled out the interest of staying alone, we can limit our comparison to the welfare, profitability and probabilities of success associated with $J1$ and $J2$.

The following proposition summarizes the results:

Proposition 2 *In a second best world,*

- i) S is always dominated by $J1$, from the profitability, social welfare and probability of success point of views;*
- ii) $J2$ is more profitable, and leads to a higher probability of success, than the $J1$ iff $\varepsilon \in]0, 1[$;*
- iii) $J2$ is socially preferable to $J1$ iff $\varepsilon \in]-0.125, 1[$.*

The first part of our results, point (i) of proposition 2, shows that a privately formed joint entity enhances social welfare. This result has been obtained under the assumption of the exogenous constant unit rate of return of the project to be chosen by entrepreneurs. The return of the investment does not affect other players in the economy. If this was the case, instead, further effects - not explicitly accounted for in our analysis so far - would have to be taken into consideration. For example, if the joint entity was a merger, then the impact of a change in the market power as opposed to the increase of the productive efficiency the merger itself leads to, had to be taken into consideration as well. In our analysis we abstract from any consideration as this one. Therefore, our results do not contradict a possible need of fighting mergers any time the negative welfare effect coming eventually from an increased market power would be proven to be bigger than the productive efficiency gains generated from joining the forces of two entrepreneurs.

To better understand how an increase in the productive efficiency may lead to an overall increase in the social welfare, we will provide a possible interpretation for it in section 6.

The second and third part of our proposition 2, tell that private and social interests are aligned except when $\varepsilon \in]-0.125, 0[$. Within this region socially optimal consideration would prefer the joint entity to keep both agents in conducting the project, whereas entrepreneurs would prefer to fire one of them. This is because entrepreneurs, in a second best world, take their decision having to face two sources of costs: the disutility of agent(s)'s effort(s) and the additional informational rent that did not appear in the first best world. Whenever entrepreneurs cannot contract upon the effort(s) their agent(s) have to exert, the privately taken decision departs from the one that would have induced a higher social welfare. In this region, entrepreneurs to enjoy higher rents at the expenses of agents.

It has to be noticed also that the difference between privately and socially preferred configurations arises for values of the technological parameter which belong to the interval $]-0.125, 0[$. If a constraint existed that limits the configuration of the joint entity to be of $J2$ type, the choice of entrepreneurs would have been different. Suppose that by law when entrepreneurs have to guarantee to keep their own agents in the joint entity, or that to fire part of their previously employed agents induces a prohibitively high fixed cost due for example to the opposition made by strong unions. If this happens, then their choice will be between staying alone, each with their agent, and going together bringing each this same agent, i.e. between S and $J2$ so that:

Proposition 3 *In a second best world, if firing one of the two agents is not feasible,*

i) $J2$ is more profitable, and leads to a higher probability of success, than the S iff $\varepsilon \in]-1, 1[$;

ii) $J2$ is socially preferable to S iff $\varepsilon \in]-1.572, 1[$.

There exists, again, a possible conflict between the profitable and socially desirable outcome. This conflict occurs for a larger range of values of the technological parameter. Moreover, the imposed restriction makes the stand-alone outcome occur, even though it would have not been privately and socially preferred to the $J1$. In this world, unless a high value is attached to employing per se all the agents in the economy, restricting ex-ante the choice of the joining parties with respect to their possible internal configuration, may more often lead to welfare losses.

5 Cost functions

This section is entirely devoted to an analysis of the *cost functions* entrepreneurs face under each regime. Doing so, we will clarify where the discrepancies between the privately chosen and the socially preferred organizational structures come from.

We first provide a formal analysis of them and we then compare and discuss their role in explaining the entrepreneurs' chosen configuration for a given merger.

5.1 First best cost functions

We here compute the per-entrepreneur cost functions of implementing a certain probability level, $[C(p)]^{FB}$, for the (S), ($J1$) and ($J2$) cases under the assumption that efforts are observable. Entrepreneurs employ one or more agents to whom a contract, that specifies an effort level and transfer(s), is proposed. Each agent then has the choice to accept or reject this contract. Thus, entrepreneurs maximize their profits subject only to their respective (IR) constraint(s). In this case, the cost of implementing a certain probability level is exactly equal to the real cost of the efforts exerted to achieve the probability level itself.

5.1.1 Stand-alone (S)

In this case, $p_i(S) = e_i$. Given that only the (IR) constraint has to be satisfied in this regime, the transfer agents receive simply compensates them for their disutilities of exerting the prescribed level of effort. Therefore, given the results obtained in section 3.1, each entrepreneur's cost of implementing a given probability level coincides with its associated agent's disutility, i.e.:

$$[C(p|S)]^{FB} \equiv \frac{1}{2}p^2$$

5.1.2 Joint-one agent ($J1$)

Now, $p(J1) = e$. The rest of the comments of the previous subsection apply, so that, again:

$$[C(p|J1)]^{FB} \equiv \frac{1}{2}p^2$$

and, each entrepreneur's cost is equal to:

$$\frac{[C(p|J1)]^{FB}}{2} \equiv \frac{1}{4}p^2$$

5.1.3 Joint-two agents ($J2$)

In this case, the probability of success depends on two agents' efforts, i.e. $p(J2) = (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{1}{1-\varepsilon}}$. We can write the cost function as the one that derives from the following minimization problem:

$$\begin{aligned} \min_{t_1, t_2} C(J2) &= \min_{t_1, t_2} [t_1 + t_2] \\ \text{s.t. } t_i - \frac{1}{2}e_i^2 &\geq 0 \quad \forall i && (IR_i) \\ p(J2) &= (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{1}{1-\varepsilon}} \end{aligned}$$

The result of this minimization problem gives us:

$$e_1 = e_2 = e.$$

So that the overall probability of success that comes out from this minimization problem can also be written as:

$$p = 2^{\frac{1}{1-\varepsilon}} e \quad \Rightarrow \quad e = 2^{-\frac{1}{1-\varepsilon}} p.$$

The overall cost of implementing a given level of effort is, therefore:

$$[C(p|J2)]^{FB} = 2 \left(\frac{1}{2} e^2 \right) = 2^{-\frac{2}{1-\varepsilon}} p^2.$$

Each entrepreneurs faces only half of it, i.e.:

$$\frac{[C(p|J2)]^{FB}}{2} = \frac{1}{2} e^2 = 2^{-\frac{3-\varepsilon}{1-\varepsilon}} p^2$$

5.2 Second best cost functions

Replicating the same analysis for the second best world, requires to consider that now entrepreneurs have to offer contracts specifying the transfer to be paid to their agent(s) depending on each state of nature. Since efforts are not contractable here, entrepreneurs have to give incentives, (*IC*) constraint(s), through transfers, while satisfying at once the (*IR*) and the (*LL*) constraints.

5.2.1 Stand-alone (*S*)

As before, $p_i(S) = e_i$. We know from section 4.1 that the (*IC*) is:

$$e = b.$$

We can rewrite this constraint, as before, as $b = ce = cp$. The general cost function of employing one agent performing a given level of effort is:

$$[C(p|S)]^{SB} = w + pb$$

when minimizing this function under the (*IC*), (*IR*) and (*LL*) constraints, we would get that $w = 0$. Given the previous relationship mentioned above and this result, we can write the second best cost function associated with employing one agent as:

$$[C(p|S)]^{SB} = p^2.$$

5.2.2 Joint-one agent (*J1*)

When $p(J1) = e$ we can say that:

$$e = b.$$

Given $b = e = p$ and, for the same logic as above, $w = 0$. The overall cost associated with employing one agent in the joint project corresponds to:

$$[C(p|J1)]^{SB} = w + pb = p^2.$$

Each entrepreneurs' cost is, thus equal to:

$$\frac{[C(p|J1)]^{SB}}{2} = \frac{1}{2}p^2.$$

5.2.3 Joint-two agents ($J2$)

When two agents are employed by the joint entity, the probability of success is defined as $p(J2) = (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{1}{1-\varepsilon}}$.

Up to now, we have assumed that when the joint entity was employing both agents, these agents would have received comparable transfers for comparable jobs. We drop here this assumption and we show that instead it comes out endogenously from the entrepreneurs' minimization cost problem.

Let us determine the cost function that corresponds to the solution of the following minimization problem:

$$\begin{aligned} \min_{w_1, w_2, b_1, b_2} C(J2) &= \min_{w_1, w_2, b_1, b_2} [w_1 + w_2 + p(J2)(b_1 + b_2)] \\ \text{s.t. } p(J2) &= (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{1}{1-\varepsilon}} \\ e_i^{-\varepsilon} (e_1^{1-\varepsilon} + e_2^{1-\varepsilon})^{\frac{\varepsilon}{1-\varepsilon}} b_i &= e_i \quad \forall i && (IC_i) \\ w_i &\geq 0 \quad \forall i && (LL_i) \end{aligned}$$

It is easy to notice that the fixed component of the wages to be paid to both agents is minimized for $w_1 = w_2 = 0$, therefore what is left in the minimization problem is to account for the transfers to be paid in the good state of nature, the incentive compatible bonuses, that have to be overall as low as possible. Solving for this problem, leads to the following result⁴:

$$e_1 = e_2 = e \quad \Rightarrow \quad b_1 = b_2 = b.$$

When plugging this result into the probability of success function, the following is true:

$$p = e 2^{\frac{1}{1-\varepsilon}} \quad \Rightarrow \quad e = 2^{-\frac{1}{1-\varepsilon}} p.$$

We can now use the result that tells us that transfers have to be symmetric and also that equal levels of efforts are chosen by each agent in a ($J2$) case. Using this symmetry, we can describe the relationship between e and p compatible with all the mentioned constraints, taking the results of our section 4.3 obtained under the symmetry assumption as valid ones, so that:

$$e = 2^{\frac{\varepsilon}{1-\varepsilon}} b \quad \Rightarrow \quad b = 2^{-\frac{\varepsilon}{1-\varepsilon}} e$$

⁴It has to be said that the second order condition for this problem may not be satisfied for the entire possible range of values of ε . However, it can be proved that for these values the problem would give a solution that is not preferred to the joint-one agent case and therefore can be ruled out at this stage already.

Incorporating all into the minimum cost function associated to the second best agents' efforts leads to:

$$[C(p|J2)]^{SB} = 2w + 2pb = 2^{\frac{-2\varepsilon}{1-\varepsilon}} p^2.$$

Therefore, each entrepreneur's cost of employing two agents for conducting the joint project is:

$$\frac{[C(p|J2)]^{SB}}{2} = 2^{-\frac{1+\varepsilon}{1-\varepsilon}} p^2.$$

5.2.4 Comparisons

The following table summarizes the results just gotten.

	<i>FB</i>	<i>SB</i>
<i>S</i>	$\frac{1}{2}p^2$	p^2
<i>J1</i>	$\frac{1}{4}p^2$	$\frac{1}{2}p^2$
<i>J2</i>	$2^{-\frac{3-\varepsilon}{1-\varepsilon}} p^2$	$2^{-\frac{1+\varepsilon}{1-\varepsilon}} p^2$

We can now show how entrepreneurs decide their internal organization once the merger occurs on the basis of their cost functions.

In particular, *J1* always dominates *S* as:

$$[C(p|J1)]^{FB} = \frac{1}{4}p^2 < \frac{1}{2}p^2 = [C(p|S)]^{FB} \quad \forall \varepsilon$$

and,

$$[C(p|J1)]^{SB} = \frac{1}{2}p^2 < p^2 = [C(p|S)]^{SB} \quad \forall \varepsilon.$$

We can also show when *J2* is preferred to *J1*:

$$[C(p|J2)]^{FB} = 2^{-\frac{3-\varepsilon}{1-\varepsilon}} p^2 < \frac{1}{4}p^2 = [C(p|J1)]^{FB} \quad \text{iff} \quad \varepsilon \in]-1, 1[$$

and,

$$[C(p|J2)]^{SB} = 2^{-\frac{1+\varepsilon}{1-\varepsilon}} p^2 < \frac{1}{2}p^2 = [C(p|J1)]^{SB} \quad \text{iff} \quad \varepsilon \in]0, 1[.$$

It is possible to conclude again that when looking at the cost functions each entrepreneur faces, a discrepancy between the socially and privately taken decisions may only occur in the second best world, when comparing the (*J1*) and (*J2*) configurations. The private decision would recommend (*J2*) for $\varepsilon \in]0, 1[$ while – as we know from the previous section – (*J2*)

would be socially preferred to ($J1$) for a larger range of values of the technological parameter, namely for $\varepsilon \in]-0.125, 1[$.

Where does this discrepancy come from? Entrepreneurs face the following problem: in the second best world, the probability that has to be implemented, compatible with the (IC), (IR) and (LL) constraints for either one or both agents (depending on which structure they look at), has to lead to the lowest overall cost of implementing it. This can be translated in the following statement: ($J2$) is preferred by them to ($J1$), iff the value of the cost function associated to ($J2$), i.e. the one that corresponds to the implemented probability under ($J2$), is lower than the one associated to ($J1$), i.e. again the one that corresponds to the implemented probability under ($J1$). In general, the cost function can be decomposed into two components such that:

$$[C(p|\cdot)]^{SB} = \text{informational rent}(s) + \text{agent}(s)' \text{ disutility}$$

Let us take the point where $\varepsilon = 0$. In this point, which represents the switching point between the privately taken and socially preferred configuration in a second best world, we have that:

$$\begin{aligned} [p(J1)]^{SB} |_{\varepsilon=0} &= [p(J2)]^{SB} |_{\varepsilon=0} \\ &\& \\ [C([p(J1)]^{SB})]^{SB} |_{\varepsilon=0} &= [C(p|J1)]^{SB} |_{\varepsilon=0} \end{aligned}$$

This implies that, at $\varepsilon = 0$, the per entrepreneur expected profits are the same so that:

$$E\Pi([p(J1)]^{SB}) |_{\varepsilon=0} = E\Pi([p(J2)]^{SB}) |_{\varepsilon=0}$$

However, for this same point, the following is true:

$$\text{disutility associated to } [p(J1)]^{SB} |_{\varepsilon=0} > \text{disutility associated to } [p(J2)]^{SB} |_{\varepsilon=0}$$

which then implies that:

$$\text{informational rent } [p(J1)]^{SB} |_{\varepsilon=0} < \text{informational rent } [p(J2)]^{SB} |_{\varepsilon=0} .$$

When decreasing ε starting from $\varepsilon = 0$, the increase in the informational rents entrepreneurs have to pay is so high that it cannot counterbalance anymore the lower level of the disutility to be compensated to the agents when choosing ($J2$) instead of ($J1$). The

(J2) option would be privately preferred to (J1) if the agents' disutility was the only cost entrepreneurs would have to face. However, for negative but small levels of the technological parameter, the gain in the lower agents' disutility to be compensated is overcome by the loss due to the cost of paying for a higher informational rent.

6 'Productive efficiency'

From the analyses made up to this point, we know that there may exist a discrepancy between productive efficient outcomes and more efficient ones. However, these two notions of efficiencies may converge whenever the productive efficiency translates into components of the welfare we did not explicitly take into account in our analysis. For example, when productive efficiency would increase consumers' surplus, the gains of a higher productive efficiency - induced by the private choice of entrepreneurs - may reduce the conflict between the privately decided and the socially preferred configuration.

Let us take the following example. There are two monopolists (parallel to our entrepreneurs) operating in two separate markets (e.g. one for each domestic market, one for each segment of an overall market, etc.) producing a good which demand in each market $j = 1, 2$ is:

$$Q_j = 1 - p_j$$

Each monopolist/entrepreneur faces a unit production cost that depends on the realization of a state of nature, either good or bad, which occurs with a given probability function of agent(s)' efforts devoted to the project. Let the project consist in having the agent(s) affect the unit production cost in the sense that the higher the effort the higher the probability of cost reduction would be. The unit production cost are defined as:

$$c_j = \begin{cases} c_l & \text{if success} \\ c_h & \text{if failure} \end{cases}$$

The gross profit each monopolist will be able to get is, therefore:

$$\Pi_j = \begin{cases} \frac{(1-c_l)^2}{4} \equiv R + \Delta & \text{if success} \\ \frac{(1-c_h)^2}{4} \equiv R & \text{if failure} \end{cases}$$

Having written the gross profit in this way, allows us to create a parallel with the unit return of investment we analyzed in the previous sections. Basically, our Δ becomes a deterministic value which derives from a possible success in decreasing costs, therefore increasing monopolistic profits over the level without such a cost reduction R , associated with

exchanging a good in the economy afterwards. We get that:

$$\begin{aligned}\Delta &= \frac{(1 - c_l)^2}{4} - \frac{(1 - c_h)^2}{4} \\ &= \frac{1}{4}(c_h - c_l)(2 - c_l - c_h).\end{aligned}$$

Anything else having been kept equal to the previous analyses, this allows us to interpret the probability of success as a measure of productive efficiency.

All results related to profitability and probability of success derived in the previous sections are valid here as well. However, the conflict we underlined for welfare could be decreased. The interest of a competition authority that has to decide upon a merger would incorporate the gains of enhanced consumers' surplus, thanks to decreased expected production costs and, therefore, expected prices in the economy.

It would be interesting and natural to extend our analysis to these alternative situations where the effects coming from increased market power due to the merger may play a role in determining the overall decision of accepting or refusing a proposed merger⁵.

7 Conclusion

We have shown that, when abstracting from any market power consideration, private parties always decide to go for a joint project. However, even though partnerships are both privately and socially preferred to a stand-alone situation, private and social interests with respect to configurations of the joint entity do not necessarily coincide. The reason for this conflict lies in a discrepancy between welfare enhancement and productive efficiency gains caused by informational rents appropriated by the agents in a second best world. There exists a region of the substitution parameter where a partnership keeping only one agent is privately preferred, whereas social preferences still ask for keeping both agents. This region is characterized by a low degree of duplication of efforts. *Too few partnerships keeping both agents* are therefore observed.

We have also shown that the moral hazard plays a crucial role in determining which configuration is preferred privately, but not socially. The way employees interact with each other and the consequent wage contract to be proposed to these agents may determine the decision to fire one of them whenever their efforts just start to duplicate. This is the case, any time that employing both agents and having to pay informational rent to both of them becomes too expensive as compared to the situation where only one agent is kept, which would guarantee to obtain higher levels of productive efficiency from one side and overall

⁵We do this in Fabrizi and Lippert (2004).

lower informational rent to be paid from the other side. When this occurs, the parties opt for the joint-one agent case while the joint-two agents would still be socially preferred.

Restricting the freedom of the parties – by law or with a high fixed cost of firing agents – to opt for the joint-one agent case would induce even worse outcomes as parties will start preferring not to go together at all for larger ranges of the technological parameter leading to overall lower expected social welfare. *Too few partnerships* would be observed at all.

Our results have been obtained looking at the *2-entrepreneurs/2-agents* case, which fits bilateral agreements or partnerships. However, for different situations one might want to investigate further which organizational structure would be chosen by *m-entrepreneurs* who would like to associate with each other for a given project keeping *n* of their *m* initial agents. Doing so, our model could be used to explain internal organization decisions of *associations/partnerships*, like law firms or consultancies, with respect to their number of active *partners/entrepreneurs* and *associates/agents* as a result of the underlying incentives partners from one side and agents from the other one have.

A further possible extension is to integrate a competition stage into the model. Results of the present work have stressed the role of productive efficiency as opposed to allocative efficiency as the only determinant of the discrepancy between privately and socially taken decision about the merger. However, if the rate of return to the investment that is eventually made jointly is not exogenous anymore and it becomes function of the pre- and post-merger competition environment principals/firms face, then decisions will change as market power considerations are added. Different optimal contracts are the result, and different discrepancies between privately chosen and socially preferred mergers and merger configurations are described. This is the avenue we take in a related work (Fabrizi and Lippert, 2004). In this paper, we are able to give policy recommendations for a competition authority with respect to a design of an efficiency defense that would not overestimate the impact of the efficiency gains of merging while not discouraging potentially "good" mergers from being proposed by the merging parties.

Our current model could be taken as a corner stone in the analysis of pure internal decisions about the sharing of the work attached to a given production process and/or project. Remember that the joint two-agents case was leading us to a result such that the final per agent working load was lower than the one induced in the joint one-agent case. One might interpret the effort variable as hours worked so that our joint two-agents case versus joint-one agent case can be reinterpreted as a principal's/firm's decision on whether to offer part-time or full-time jobs. A suitably adapted labor model might analyze the existence of part time work and describe the circumstances under which part time work is more likely to be observed. Using this model, one might be able to give policy recommendations to labor

market institutions as the "Bundesanstalt für Arbeit" on where to sensibly support part time work.

References

- [1] Alchian and Demsetz (1972), "Production, Information Costs, and Economic Organization", *The American Economic Review*, 62, 5, 777-795.
- [2] Banal-Estañol, A. and J. Seldeslachts (2004), "Merger Failures", University of Western Ontario and Universitat Autònoma de Barcelona, mimeo.
- [3] d'Aspremont, C. and A. Jacquemin (1988), "Cooperative and Noncooperative R & D in Duopoly with Spillovers", *The American Economic Review*, 78, 5, 1133-1137.
- [4] Espinosa, M.P. and I. Macho-Stadler (2003), "Endogenous formation of partnership with moral hazard", *Games and Economic Behavior*, 44, 172-183.
- [5] Fabrizi, S. and S. Lippert (2004), "Is the Efficiency Defense a Good Ingredient in the Cooking Recipe for Judging Merger Cases?", Universidad del País Vasco, Bilbao and Université Toulouse 1, mimeo.
- [6] Farrell, J. and C. Shapiro (1990), "Horizontal Mergers: An Equilibrium Analysis", *The American Economic Review*, 80, 1, 107-126.
- [7] Farrell, J. and C. Shapiro (2001), "Scale Economies and Synergies in Horizontal Merger Analysis", *Antitrust Law Journal*, 68, 3, 685-710.
- [8] Harrigan, K.R. (1986), "Managing for Joint Venture Success", Lexington Books.
- [9] Holmström (1982), "Moral Hazard in Teams", *The Bell Journal of Economics*, 13, 2, 324-340.
- [10] Itoh, H. (1991), "Incentives to Help in Multi-Agent Situations", *Econometrica*, 59, 3, 611-636.
- [11] Kamien, M.I., E. Muller and I. Zang (1992), "Research Joint Ventures and R&D Cartels", *The American Economic Review*, 82, 5, 1293-1306.
- [12] Laffont, J.J. and P. Rey (2001), "Collusion and Group Lending with Moral Hazard", IDEI Université de Toulouse 1.

- [13] Martínez-Giralt, X. and R. Nicolini (2004), "On Bilateral Agreements: the Importance of Technological Endowments in Presence of a Learning Process", Universitat Autònoma de Barcelona, Barcelona Economics WP No. 101.
- [14] Pérez-Castrillo, D. and J. Sandonís (1996), "Disclosure of Know-how in Research Joint Ventures", *International Journal of Industrial Organization*, 15, 51-75.
- [15] Rogerson, W.P. (1985), "The First-Order Approach to Principal-Agent Problems", *Econometrica*, 53, 6, 1357-1368.