

# THE INNOVATION IMPACT OF THE ACQUISITION OF HIGH-TECH START-UPS: COMBINING THE INCENTIVE AND COMPETENCE- BASED PERSPECTIVES

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## **Abstract**

In this paper we consider the innovation impact of the acquisition of a high-tech start-up. In accordance with the extant acquisition literature, we claim that post-acquisition innovation performance closely depends on post-acquisition reorganization. This reorganization involves both structural and non-structural (i.e. behavioral) aspects. In particular, we focus on the delegation of decision authority to the acquired key inventors or its centralization within the acquiring firm. We develop a theoretical model that combines insights offered by the incentive and competence-based perspectives. The model leads to testable predictions relating to the influence on delegation of decision authority of the explorative or exploitative motives of the acquisition, the technological relatedness between the acquiring and acquired firms, the establishment of prior alliances between them, and the prior acquisition experience of the acquirer. It posits that while the motives of the acquisition have a direct effect on delegation, the effects of the remaining variables is moderated by the type of acquisition, be it explorative or exploitative.

**First draft. Preliminary and incomplete. Please, do not cite without permission from the authors.**

29<sup>st</sup> August 2008

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The support of the PICO project promoted by the European Commission is gratefully acknowledged.

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## 1. Introduction

In the last decade acquisitions of small, young high-technology firms have been increasingly used by large established companies like Cisco, Microsoft and big pharmaceutical companies as part of their external technology sourcing strategies, with the aim of obtaining new technologies and capabilities (see e.g. Blonigen and Taylor 2000, Kale and Puranam 2004, Higgins and Rodriguez 2006, Desyllas and Hughes 2008).

In spite of their increasing popularity and a few well advertized success stories, acquisition of high-tech start-ups often have dismal results. The empirical literature that will be reviewed in the next section, highlights that the impact of these acquisitions on innovation generally is weak or even negative. In particular, it is found that severe problems in the post-acquisition reorganization of the activity of the acquired start-up often lead to the rapid departure of the most productive acquired inventors and lower the motivations and performance of those that decide to stay with the company.

The aim of this paper is to provide a new conceptual framework so as to extend our understanding of this increasingly important type of acquisition. Since the seminal work of Jemison and Sitkin (1986) Haspeslagh and Jemison (1991), management scholars have emphasized the importance of the acquisition implementation process. Unfortunately, the extant empirical literature has focused almost exclusively on the dichotomy between structural separation and integration of the acquired start-up. Previous studies (Paruchuri, Hambrick and Nerkar 2006, Puranam, Singh and Zollo 2006, Puranam and Srikanth 2007, Kapoor and Lim 2007, Puranam, Singh and Chaudhuri 2008) have examined the antecedents and above all the consequences of the decision either to maintain the acquired firm separated from the other operations of the acquiring firm, as a subsidiary or a business unit, or to integrate it within the acquiring firm's organization. While this structural aspect is obviously important, we claim that other dimensions of the reorganization that occurs during the implementation of the acquisition of a high-tech start-up play an even more important role. Among these dimensions, the decision autonomy granted to key scientists and engineers of the acquired start-up (the "acquired key inventors") which is only weakly correlated with structural separation, figures quite prominently (Ranft and Lord 2000, 2002, Graebner 2004).

Our theoretical model predicts under which circumstances delegation to the acquired key inventors of decision authority over the post-acquisition innovation activity of the acquired start-up is more effective than centralization of this authority within the acquiring firm. For this purpose, we combine insights offered by recent developments in the incentive perspective (see Mookjerjee 2006 and Colombo and Delmastro 2008 for a survey of earlier work in this stream) with those provided by the competence-based perspective, a task that unfortunately has been rarely undertaken in the management literature (see e.g. Foss 1996). For an exception in the acquisition literature see Ka-

poor and Lim 2007). The model leads to a series of testable propositions that relate the impact on post-acquisition innovation of the delegation of decision authority to the acquired key inventors to a series of deal-specific and firm-specific characteristics: the explorative or exploitative motives of the acquisition, the technological relatedness between the acquiring and acquired firms, the prior alliances they have established with each other, and the prior acquisition experience accumulated by the acquirer. Moreover, the model suggests that the type of acquisition, either explorative or exploitative, crucially moderates the effect of the remaining variables. Lack of consideration of these moderating effects may explain why the empirical evidence provided by previous studies on the effect of these firm-specific variables on post-acquisition innovation is pretty weak.

The paper is organized as follows. In the following section we review the extant empirical literature so as to illustrate the “stylized facts” on the innovation impact of acquisitions of small (generally young) high-tech firms, and we highlight what in our opinion, are the key weaknesses of the extant literature. The subsequent section is the core of the paper; it presents the theoretical model based on a fusion of the incentives and competence-based perspectives.

## **2. What do we know about the effects on innovation of the acquisition of high-tech startups?**

### **2.1. Results of prior studies**

In spite of the increasing popularity of acquisitions of young high-technology firms, there is no robust evidence documenting their alleged beneficial effects on innovation. Conversely, the few large scale empirical studies on this issue revealed a rather disappointing outcome.

Kapoor and Lim (2007) analyzed the post-acquisition innovation output of a large sample of inventors of 50 semiconductor firms that were acquired in the period 1991-1998 and had been granted one or more patents before the acquisition. Innovation output was measured by the number of patents in the five years subsequent to the acquisition. The sample of acquired inventors was compared with two matched samples composed of i) 287 inventors of otherwise similar but non-acquired firms and ii) 259 inventors in acquiring firms.<sup>1</sup> The innovation output of the acquired inventors exhibited a substantial decline in the first year after the acquisition and then leveled off. This result was in line with previous evidence produced by Ernst and Vitt (2000) on the post-

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<sup>1</sup> Matching at individual level was based on pre-acquisition innovation productivity measured by the number of granted patents, the years from the assignment to the inventor of the first patent, and the technological field in which she received patents.

acquisition patenting activity of 42 “key inventors” of acquired German firms.<sup>2</sup> More interestingly, in the post-acquisition period the acquired inventors were found to be far less productive than their non-acquired twins. In the first year after the acquisition they were also less innovative than matched inventors of acquiring firms, while from the second year this difference vanished.

Note that acquired inventors who patented with other firms within five years after the focal acquisition were excluded from the analysis. So the detected decline in the productivity of the research personnel comes on top of the negative effects on post-acquisition innovation output that may arise from the fact that scientists with high innovation productivity may leave the acquired firm after the acquisition. In fact, Ernst and Vitt (2000) study showed that a considerable number of key inventors (47%) left the R&D departments of the acquired firms by the third year after the acquisition.<sup>3</sup>

Previous studies also analyzed several moderating factors of the post-acquisition innovation output of acquired firms. Kapoor and Lim (2007) detected a lower productivity decrease of acquired inventors if the acquired and acquiring firms had similar organizational routines, proxied by the type of core activity, and shared a similar knowledge base, up to a (rather high) threshold beyond which the moderating effect of this variable turned negative. Conversely, the negative impact on innovation was larger for younger acquired firms and for acquired firms that were of smaller size relative to the size of the acquirer (see also Paruchuri et al. 2006); however these latter results were not replicated by other studies (Puranam et al. 2006, Puranam and Srikanth 2007).

Among the factors that moderate the effects of acquisitions on innovation, the choice between the *structural separation* and *integration* of the acquired firm has received considerable attention in the empirical literature. This choice is a crucial aspect of acquisition implementation, which in turn allegedly plays a key role in favoring or hampering post-acquisition innovation activity (Jemison and Sitkin 1986, Haspeslagh and Jemison 1991). In this respect, the acquisition implementation literature claims that acquiring firms face a fundamental dilemma. On the one hand, structural integration is necessary to assure close coordination between the operations of the two previously independent firms and efficient transfer of knowledge. On the other hand, the alleged loss of autonomy of the acquired unit creates disruption of its organizational routines and hampers its capacity to continue to innovate after the acquisition (Pablo 1994, Larsson and Finkelstein 1999, Ranft and Lord 2002, Schweizer 2005, Puranam et al. 2006, Puranam and Srikanth 2007, Puranam

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<sup>2</sup> “Key inventors” were defined as individuals with both high patenting activity and high quality patents (see Ernst and Vitt 2000, p. 107).

<sup>3</sup> Nonetheless, Kapoor and Lim (2007) failed to show any difference between the propensity to leave the combined entity of acquired inventors that were productive in the post-acquisition period and those of the control groups.

et al. 2008). The empirical literature generally show that structural integration *on average* damages the post-acquisition patenting activity of the target firms. For instance, Paruchuri et al. (2006) and Kapoor and Lim (2007) detected a bigger drop in the innovation productivity of acquired inventors if the acquiring firm was integrated into the organization of the acquirer as opposed to being kept independent as a separate subsidiary or business unit (see also Ranft and Lord 2000). Nevertheless, it has also been suggested that these negative effects on innovation of structural integration depend on several contingencies relating to both the characteristics of the acquired firm and those of individual inventors.

As to the former aspect, it was argued that structural integration is most beneficial in situations where i) coordination is most useful, and ii) it cannot be achieved by other allegedly less disruptive means. In accordance with this view, Puranam et al. (2008) claimed that the benefits of structural integration, and thus the likelihood of its occurrence, are highest when there is a high level of interdependence between the activities of the acquirer and those of the target, and use of informal coordination mechanisms is prevented because of lack of common ground between the two organizations. They analyzed a sample of 207 technological acquisitions of small firms by 49 large acquiring firms in the IT hardware sector. They showed that the likelihood of structural integration is higher when the acquisition is motivated by access to a component technology rather than to a stand-alone product. However, with component technology acquisitions, as the level of common ground<sup>4</sup> increases the likelihood of structural integration rapidly decreases. No such effect is detected for stand-alone product acquisitions.

In a similar vein, Puranam et al. (2006) and Puranam and Srikanth (2007) argued that structural integration favors use of the existing technological knowledge of the acquired firm in the innovation activity of the combined entity. On the contrary, organizational autonomy through structural separation favors continuous use of the technological capabilities of the acquired firm. Accordingly, structural integration is more beneficial when the main objective of the acquiring firm is the commercial exploitation of the technological artifacts developed by the acquired firm. Structural separation plays a crucial role in stages when exploration of new technological opportunities prevails over exploitation. Accordingly, Puranam et al. (2006) found that in a sample of 207 technological acquisitions of small firms in the information and communication technology hardware industry, the post-acquisition hazard rate of the introduction of new products that incorporate the technologies of the acquired firm declined substantially with integration if the acquired firm had not introduced any new product before the acquisition. The largest decrease was observed in the period

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<sup>4</sup> Common ground is operationalized by the existence of pre-acquisition patenting activity by the target and the acquirer in the same technological classes; so it captures proximity of the knowledge base of the two firms.

from the acquisition date up to the first post-acquisition product launch. These results proved to be robust while controlling for the endogenous nature of structural integration. They confirm that integration badly hurts post-acquisition innovation activity in exploration stages. However, no evidence was provided in favor of the argument that integration positively affects innovation output in exploitation periods. Moreover, Puranam and Srikanth (2007) found that the negative effects of structural integration on explorative technological activities are alleviated when the acquiring firms have considerable acquisition experience as learning by doing helps acquiring firms face the organizational problems engendered by integration.

The virtue of a “contingent” or “mixed” integration approach had been emphasized by early qualitative work. For instance, while analyzing five acquisitions of biotechnology companies by big pharmaceutical firms, Schweizer (2005) suggested that a “hybrid” organizational arrangement which relied on structural integration or separation according to the nature of the focal activities, was associated with the best results. In all successful acquisitions examined in this study clinical trials, regulatory approval, marketing and sales operations – that is, exploitation oriented activities, were absorbed in the acquiring firm. Conversely, the acquired biotech units which allegedly were involved in explorative technological activities, were given wide autonomy in R&D and were transformed in “centers of excellence”. Other authors focused attention on implementation speed, claiming that initial separation followed by integration – an approach labeled “symbiosis” by Haspeslagh and Jemison (1991), provides an efficient organizational solution. In fact, slow acquisition implementation allegedly allows an extended period of learning, during which the two previously separated firms begin to work together and progressively get acquainted with each other’s operations, organizational routines and distinctive capabilities; this in turn makes subsequent structural integration less disruptive (Ranft and Lord 2002).

Lastly, the negative effects of structural integration on innovation output are not uniform across individual inventors, and depend on their personal characteristics. Paruchuri et al. (2006) analyzed the post-acquisition patenting activity of 3,933 inventors in 62 pharmaceutical companies that were acquired in the 1979-1994 period. They considered i) the likelihood of an inventor continuing to patent with the newly combined company in the first five years following the acquisition (i.e. the inventor is a “known survivor”), and ii) the post-deal patent productivity of known survivors. They found that when the target unit is integrated in the acquiring firm’s organization, the inventors who have divergent technological expertise from that of the acquirer and have greater social embeddedness measured by the extent of co-authorship, are those that experience the most negative effects.

## **2.2. The effects on innovation of the acquisition of high-tech startups: Open research questions**

The results illustrated above provide interesting evidence on factors that influence post-deal innovation, and notably on the consequences of the structural integration of acquired high-tech start-ups the acquisition implementation process. However, several research questions remain open.

First, in the acquisition literature the term “integration” refers to all the means through which coordination of the activities of the acquired and acquiring firms is achieved (see e.g. Haspeslagh and Jemison 1991, Pablo 1994, Larsson and Finkelstein 1999, Ranft and Lord 2002, Zollo and Singh 2004). These means go beyond structural integration and include also non-structural aspects. The different dimensions of the organizational reconfiguration of the acquiring and acquired firms that occurs during the acquisition implementation process need to be examined carefully. Some of these dimensions may be complementary, others may be substitutive. For instance, management practices that assure rich and frequent communications between the personnel of the two entities may substitute for structural integration as an effective coordination and knowledge sharing mechanism; these practices include the creation of work teams composed of personnel from the two firms for specific tasks or projects, joint meetings and attendance of common social events (Ranft and Lord 2002, p. 431). A similar effect may be obtained through the appointment of managers previously employed by one organization in the managerial ranks of the other one or through the assignment to managers of cross-organizational responsibilities (Graebner 2004, pp. 767-768).

Second, as was mentioned in the previous section, the extant literature highlights a fundamental paradox in post-acquisition reorganization. Studies inspired by the competence-based perspective claim that in order to realize the synergistic potential of an acquisition, the skills, competencies and resources of the acquired and acquiring firms need to be combined, shared or redeployed. This process is favored by closer integration (see e.g. Datta and Grant 1990, Datta 1991, Capron and Mitchell 1998, Capron 1999, Larsson and Finkelstein 1999, Zollo and Singh 2004). However, autonomy is needed to preserve the distinctive skills and capabilities of the acquired firm. A high level of integration may destroy those same skills and capabilities that are the basis of the synergistic gains that could be engendered by the acquisition and finally be detrimental to post-acquisition innovation (Haspeslagh and Jemison 1991, p. 142. See also Chaudhuri and Tabrizi 1999, Larsson and Finkelstein 1999, Birkinshaw, Bresman and Hakanson 2000, Ranft and Lord 2000, 2002, Graebner 2004). The key managerial challenge allegedly faced by the acquiring firm allegedly is to choose the “right” level of integration, that is the one that optimizes the coordination-autonomy trade-off. Nonetheless, one may wonder whether autonomy and coordination are necessarily incompatible. For instance, key individuals (or groups of individuals) in the acquired organization

may be assigned substantial decision autonomy in spite of the structural integration of the acquired firm.<sup>5</sup> Similarly, in spite of structural separation, the autonomy of the personnel of the acquired firm may be substantially reduced if a new top management team dominated by managers from the acquiring firm is installed in the acquired firms after the acquisition and decision authority is largely centralized in the new team.<sup>6</sup> What we need is a fine-grained analysis that considers the implications of post-acquisition reorganization for the behavior of acquired key individuals (see Graebner 2004 for a similar contention). In particular, the extent of the *decision autonomy* granted to the acquired key inventors and the *design of effective incentives* aimed at aligning their objectives with those of the acquiring firm, play a crucial role.

Third, the acquisition literature inspired by the competence-based view has highlighted that the technology relatedness between the acquired and acquiring firms and the experience accumulated by the latter firm in managing acquisitions moderate the effect of structural integration on post-acquisition innovation. The existence of considerable overlap between the knowledge base of the combining firms allows the use of informal coordination mechanisms, thus reducing the benefits of structural integration (Puranam et al. 2008). In a similar vein, the acquisition experience of acquirers helps mitigate the disruptive consequences of structural integration on the acquired firm (Puranam and Srikanth 2007).<sup>7</sup> Nonetheless, the interaction effects between competence-based and organizational variables again deserve a closer examination. We claim that these interaction effects extend to other relevant, though quite underresearched aspects of post-acquisition reorganization, notably the delegation (or centralization) of decision authority and the design of incentives for the acquired personnel.

Lastly, the *longitudinal* aspect of post-acquisition reorganization has not been given sufficient attention. Some authors have emphasized the role of the pace of the acquisition implementation (Haspeslagh and Jemison 1991, Ranft and Lord 2002), others have highlighted that the effects on innovation of the structural integration of the acquired firm depend on the stage of the technolo-

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<sup>5</sup> For instance, in three of the seven acquisition cases examined by Ranft and Lord (2002), key subunits of the acquired firms were allowed substantial decision-making autonomy in their functional domains, in spite of lack of formal independence.

<sup>6</sup> In the detailed case studies of eight technological acquisitions illustrated by Graebner (2004), failure to assign to acquired firms' leaders a proactive role in the acquisition implementation was found to negatively influence acquisition performance independently of structural integration or separation.

<sup>7</sup> On the direct effects of technological relatedness on post-acquisition innovation see Ahuya and Katila (2001), Cassiman, Colombo, Garrone and Veugelers (2005), Puranam et al. 2006, Cloudt, Hagedoorn and Van Kranenburg (2007), Kapoor and Lim (2007). Several studies have analyzed the direct effects of acquirer's acquisition experience on the financial and economic performances of acquisitions, providing mixed evidence (see e.g. Haleblian and Finkelstein 1999, Vermeulen and Barkema 2001, Hayward 2002, Zollo and Singh 2004). Studies that have examined the influence of this variable on post-acquisition innovation are almost non-existent (see Puranam et al. 2006 and Puranam and Srikanth 2007 for exceptions).

gy development process (Puranam et al. 2006). Again one has to move a step forward and recognize that i) reorganization decisions can be implemented immediately after an acquisition or be postponed, ii) the benefits and costs of post-acquisition organizational changes vary over time as they depend on other critical time-varying dimensions of the acquisition (e.g. the relative importance of exploration as opposed to exploitation objectives, the knowledge the acquirer has of the operations of the acquired firm), and iii) these organizational changes involve sunk costs (like the ones that arise from structural integration of the acquired firm), are partially irreversible and path-dependent.<sup>8</sup>

In the remaining of the present work we contribute to the exploration of these open issues. For this purpose, we develop a theoretical model that predicts under what circumstances delegation of decisions authority to the acquired key inventors is more effective than centralization of this authority within the acquiring firm. In so doing, we call in favor of the advantages that arise in the examination of post-acquisition reorganization from the combination of the incentives and competence-based perspectives.

### **3. Further insights into post-acquisition reorganization: combining the incentive and competence-based perspectives**

#### **3.1. The traditional view of the incentive perspective**

Previous studies that have examined the reorganization that occurs after the acquisition of a high-tech start-up through the lens of the incentive perspective, have relied on the insights provided by property rights theory and simple agency models (see e.g. Puranam et al. 2006, Kapoor and Lim 2007).

In accordance with the property rights theory (Grossman and Hart 1986, Hart and Moore 1990), the acquisition of a high-tech start-up involves a change in the allocation of the property rights on innovations, as the acquiring firm gains control of the operations of the acquired firm. This change has important implications for the incentives of the two parties to make specific investments in innovation (Aghion and Tirole 1994). The exact nature of the innovative activity of the acquired start-up is ill-defined ex-ante. Moreover, the acquired scientists and engineers engage in tasks that are primarily cognitive. Observing their behavior does not provide any reliable information on the level and content of their effort (Zenger 1994, Zenger and Lazzarini 2004). So the two parties cannot contract on the innovative effort that acquired inventors should provide after the acquisition. In other words, their post-acquisition cognitive effort is non-verifiable. The owner-managers and other

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<sup>8</sup> As a corollary, this creates a “measurement challenge” (Ranft and Lord 2002), as variables measuring post-acquisition innovation performance may both considerably lag the acquisition event, and exhibit non-linearity over time.

key inventors who possessed an equity stake in the acquired firm have become salaried employees of the acquirer and are deprived of the control over innovations; so they receive no extra-rewards for innovating (i.e. they have no ex-post bargaining power and cannot appropriate the rent generated by the innovation). Under these circumstances, their incentives to provide innovative effort are minimal. Conversely, the acquirer can freely use the resulting innovation and has appropriate incentives to make investments in innovative activity. If the innovative effort of the acquired personnel has a relatively more important impact on the discovery of new technologies than acquirer's investments, the acquisition is likely to hurt innovation performance.

Traditional agency models of innovative activity (see e.g. Holmstrom 1989) assume that the pay-off to the principal (the firm) of the innovation activity increases with the amount of effort provided by the agent (the personnel involved in innovation activity). However, due to the high uncertainty of innovation activity, performance is only loosely correlated with agent's effort. Innovative effort is costly to the agent and for the same reasons highlighted above, it is difficult to monitor for the principal. In this situation, the principal has two means to induce the agent to provide more effort. She can offer the agent high-powered incentives that link rewards to his measured individual performance. As the agent is risk-averse and/or has limited liability, the noisier the available measure of performance, the higher the cost of the incentives (Prendergast 1999). Alternatively, the principal can opt for low-powered incentives and try to better monitor agent's effort. In either case, agency costs arise due to moral hazard (i.e. hidden action).

When a high-tech start-up is acquired by another firm, the hidden action problems inherent in the start-up's innovation activity become more severe than in the pre-acquisition situation due to the larger size of the combined entity (see Holmstrom 1989, Zenger 1994, Zenger and Lazzarini 2004, Sauermann 2008). On the one hand, innovation activity is performed at larger scale and this magnifies the free rider problem arising from team production. Moreover, innovation performance is influenced by other units of the acquiring firm. Therefore, the link between the individual effort of the acquired inventors (the agents) and innovation output becomes more tenuous, making it more difficult crafting high-powered incentives. On the other hand, the acquiring firm (the principal) experiences serious problems in monitoring the innovation effort of the newly acquired personnel. Due to the greater span of control, senior managers of the acquiring firms cannot rely on direct assessment of and first-hand information on the behavior of the acquired personnel. The monitoring information they receive from middle managers involved in supervision may be unreliable (e.g. due to collusion between the acquired inventors and their supervisors). In turn, performance measurement errors and effort evaluation biases generate substantial social costs within the combined entity. As firm's employees cannot rely on direct assessment of and shared information on colleagues' per-

formance, they are more likely to perceive compensations as non-equitable. Lastly, in the early post-acquisition period the acquiring firm is also likely to incur in hidden information problems, as it is difficult for its managers to assess the knowledge, skills and abilities of the acquired individual inventors (see again Zenger 1994; see also Coff 1999). The human capital assets of key inventors are valuable to both the acquiring firm and other external employers. If the acquiring firm's managers are not able to figure out who are the key inventors and to offer them suitable compensation packages, adverse selection may result in the departure of the best innovators. A decrease of innovation output will follow.

We claim that the theoretical framework offered by the property rights and traditional agency theories provide an interesting, though very partial representation of the organizational problems engendered by the acquisition of a high-tech start-up. In order to gain a better understanding of these problems, it is useful to carefully consider more recent developments in multi-task agency theory (see Holmstrom and Milgrom 1991).

### **3.2. Further insights from recent development in the incentive perspective**

The approaches illustrated in the previous section suffer from a crucial weakness. In these models the assumption is implicitly made that the tasks carried out by the acquired inventors are fixed and innovation performance crucially depends on the effort made by them in carrying out these tasks. In other words, the acquiring firm is able to tell the acquired inventors what to do and in absence of hidden action, hidden information and non-verifiability problems, optimal innovation performance could be achieved. This is a rather inadequate description of the innovation activity of the acquired start-up

As a matter of fact, innovation activity typically involves multiple tasks. The acquired inventors can be employed in different R&D projects, and the marginal product of their cognitive effort is likely to differ quite extensively across projects.<sup>9</sup> Moreover, the acquiring firm does not know in which task the innovative effort of the acquired inventors is most productive (Holmstrom 1977, 1984). Under these circumstances, the fundamental issue for the acquiring firm is to select the most promising projects and to assign the acquired inventors to the tasks in which they are most productive. In this decision activity, the acquired key inventors enjoy an information advantage with respect to the acquiring firm, as they possess *specific knowledge* (Jensen and Meckling 1992)

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<sup>9</sup> For instance, acquired inventors could go on with the research projects that the start-up was involved in before the acquisition; or these projects may be discontinued, and they could be employed in different research projects. They may also devote their effort to making the technological assets of the acquired firms compatible with and integrated into the technological offer of the acquiring firm. It is self-evident that their effort productivity will differ in these different tasks.

relevant to the post-acquisition innovation activity of the acquired start-up.<sup>10</sup> In order to make effective decisions, this knowledge should be colocated with decision authority. However, the tacit and context-specific nature of the knowledge of the acquired key inventors makes it costly to transfer (Polanyi 1962, Winter 1987, Reed and DeFilippi 1990, Kogut and Zander 1992, Grant 1996).<sup>11</sup> In other words, the information on which the acquired inventors' specific knowledge relies is "*soft*" (Stein 2002) and cannot be verified by third parties. Under these circumstances, as will be discussed later in greater detail, if the acquiring firms' managers are assigned decision authority and base their decision on the information communicated by the acquired key inventors, these latter would be induced to *communicate strategically* so as to influence the decisions of the former to their advantage (Dessein 2002, Marino and Matsusaka 2005, Friebel and Raith 2007, Alonso, Dessein and Matouschek 2008, Dessein, Garicano and Gertner 2008).

If the individual preferences of the acquired key inventors were aligned with the objectives pursued by the acquiring firm, the distortion in communication and decision-making would be minimal. However, while performing research inventors reportedly enjoy substantial *private (non monetary) benefits* (Aghion and Tirole 1997). They arguably prefer to be assigned to projects in which they are able to further develop their human capital, making them more valuable in the labor market. They are also likely to have intrinsic motivations (see e.g. Osterloh and Frey 2000, Sauer mann 2008); for instance, they may have a "taste for science" (Stern 2004) and prefer more scientifically challenging pet research projects with inferior expected returns, but with greater personal intrinsic rewards. The greater the private benefits of the acquired key inventors, the greater the bias in the information that is communicated to acquiring firms' managers, the worse the pay-off of their decisions.

The other option the acquiring firm has for colocating decisions over the post-acquisition innovation activity of the acquired start-up with the specific knowledge that is valuable to those decisions, is to delegate decision authority to the acquired key inventors. In the next section we will

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<sup>10</sup> The neglect of the agent's information advantage was already recognized as a serious weakness of agency theory in Holmstrom's (1979) seminal paper: "In many respect the model we have analyzed is very primitive. One unrealistic feature is the assumption that the agent chooses his action having the same information as the principal..... Commonly this will not be the case. After the sharing rule is fixed, the agent will often learn something new about the difficulty of his task, or the environment in which it is to be performed" (Holmstrom, 1979, p. 88).

<sup>11</sup> As was mentioned earlier, the acquisition literature has long recognized that the primary driver of the acquisition of high-tech start-ups is the desire to obtain the technological resources and distinctive capabilities that are possessed by the target and cannot be reproduced internally by the acquirer. Quite often, these resources and capabilities are inextricably linked with the tacit knowledge and unique skills that key inventors have accumulated through context-specific experience (Ranft and Lord 2000). In accordance with this view, Ranft and Lord (2002, p. 428) document that in all examined cases the underlying knowledge of the target firm had one or more of the following characteristics: "(1) largely unarticulated and uncodified, (2) dependent on expertise and skills developed through cumulative experience, and/or (3) complex because of many different and interactive components".

closely examine the benefits and costs of delegation. Before doing so, some further remarks are in order.

First, any decision relating to the post-acquisition innovation activity of the acquired firm, be it centralized in the acquiring firm or delegated to the acquired key inventors, need to be implemented by these latter. Implementation effort is complementary to use of “local” specific knowledge (Raith 2004, Van den Steen 2006). The marginal product of the time spent by the acquired key inventors in doing R&D and other innovation related activity is greater if it is devoted to good rather than bad quality projects. This makes selection of good quality projects even more critical.

Second, innovation activity is inherently serendipitous. Independently of project selection, the marginal product of the innovation effort provided by the acquired key inventors is affected by uncertainty. Unexpected events may change the way innovation output is produced, changing the value of different decisions. We will use the term “technological uncertainty” to refer to this type of uncertainty so as to differentiate it from uncertainty that influences innovation output but does not affect decision choice (i.e. noise). Recent work in the incentive perspective (see e.g. Zabojsnik 1996, Prendergast 2002, Baker and Jorgensen 2003, Raith 2004, Rantikara 2008)<sup>12</sup> shows that greater technological uncertainty renders use of the specific knowledge of acquired inventors in decision-making more critical. In a more uncertain technological environment the acquiring firms’ managers are likely to have even less clear ideas about what the acquired personnel should be working on; so the information advantage of the acquired key inventors is amplified.

Third, the competence-based literature highlights that acquisitions of high-tech start-ups allow the unique technological capabilities of these firms to be combined with the complementary assets and capabilities of the acquiring firm (Teece 1986, Gans and Stern 2003). For example, due to use of the acquiring firm’s brand and global distribution network, the expected return from an innovative product (e.g. a new software package) developed by the acquired start-up is greater than in a situation in which the start-up would operate in isolation. The greater the combination potential of the acquisition the greater the marginal product of the acquired key inventors. This makes selection of good quality projects more important (see again Raith 2004).

Fourth, there often is the need to coordinate decisions relating to the post-acquisition innovation activity of the acquired start-up with other decisions made by the acquiring firm (or by its other subsidiaries) relating to both technological and non-technological matters (e.g. production, marketing, and distribution decisions). Lack of coordination of these decisions will negatively affect

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<sup>12</sup> In this literature this situation is modeled through a random innovation production function. Note that scholars sometime use the term “volatility” to refer to technological uncertainty. For a in depth analysis of this issue see Rantikara (2007). For the sake of simplicity, in the following we will use the term “uncertainty” to refer to technological uncertainty.

innovation performance. Moreover, because of externality, decisions that are locally optimal (i.e. they are optimal for the acquired start-up) need not to be optimal for the acquiring firm as a whole. For instance, a newly developed software package might exhibit superior technological performance should it not be integrated in the software platform of the acquiring firm. Similarly, making a new product easier or less expensive to manufacture (e.g. by using standardized components) may hurt its technological performance. This creates a delicate trade-off between high-powered local incentives which link the rewards of the acquired key inventors to the innovation performance of the acquired start-up, and firm level incentives (see Athey and Roberts 2001, Stein 2002, Alonso et al. 2008, Dessein et al 2008). The greater the latter, the more the externality on other operations of the acquiring firm is internalized by the acquired key inventors. The drawback is that with a weaker relation between rewards and individual innovation performance, the acquired key inventors may excessively indulge in the pursuit of private benefits and provide insufficient effort.

Fifth, with delegation of decision authority, the discretion of the acquired key inventors and the associated pursuit of private benefits to the detriment of the acquiring firm, are limited by the ability of the acquiring firm to deter decisions that badly hurt its economic interests (e.g. through the threat of retracting authority, see Baker, Gibbons and Murphy 1999). Conversely, when decision authority is centralized, the acquiring firm must be in the position to enforce orders so as they are effectively implemented by the personnel of the acquired firm (see Marino, Matouschek and Zabojsnik 2006). The enforcement capability of the acquiring firm is weaker the greater the costs to the acquiring firm of replacing the acquired personnel. These costs are likely to be especially high with the acquired key inventors, as the distinctive technological capabilities of the acquired start-up often are inextricably linked with the knowledge, skills and social relations of these individuals (see again Ranft and Lord 2000, 2002). Moreover, for key inventors who enjoy a solid reputation as “star scientists” (or “star engineers”) in the labor market, the costs of finding a new job are presumably quite low. This again weakens the ability of the acquiring firm to enforce decisions. Therefore, the likelihood that orders given by acquiring firm’s managers to the acquired key inventors be disobeyed is quite high.

Lastly, a recent stream of the literature has focused attention on the implications of the existence of different priors between principal and agent about the right course of action (see e.g. Zabojsnik 2002, Van den Steen 2006, 2007). The acquired key inventors presumably have strong beliefs as to the most promising R&D projects in their technological fields, which may differ from those of the acquiring firm. With different priors, if decision authority were centralized, the acquired key inventors would have low incentives to provide effort to implement the decisions made by the acquiring firm’s managers, which in their view are wrong. They would also be tempted to

disobey orders. Conversely, if the acquired key inventors were assigned decision authority they would select different projects from the ones that would be selected by the acquiring firm, even if they do not obtain any private benefit from these projects. Quite interestingly, the provision of high-powered incentives would make things worse, as it will further stimulate the acquired key inventors to adhere to the course of action that they perceive as the best one.

### **3.3. The benefits and costs of delegating decision authority to the acquired key inventors**

#### *3.3.1. The benefits of delegation*

The crucial advantage of delegating to the acquired key inventors decision authority over the post-acquisition innovation activity of the acquired start-up is that their specific knowledge on relevant technological matters is used in decision making. In so doing, post-acquisition reorganization conforms to the principle of colocating relevant knowledge and decision rights.<sup>13</sup>

In order to get further insights into this issue, let us consider a situation in which decision authority over the innovative activity of the acquired start-up is centralized. In other words, decision rights over these matters are assigned to a manager of the acquiring firm. This latter selects the R&D projects on which the scientists and engineers of the acquired start-up will work, determine the budget of these projects, and give orders to the acquired personnel. In this decision activity, she suffers from an *information gap* which renders decision making inefficient, as she lacks the specific knowledge possessed by the acquired key inventors. In order to extend her information set, the manager of the acquiring firm in charge of decisions may ask the acquired key inventors to provide the necessary information. Nonetheless, this information is “soft”: for the acquiring firm’s manager it is almost impossible to verify whether it is reliable or not. The acquired key inventors clearly have incentives to communicate strategically so as to induce their corporate superior to make decisions that are in their favor (i.e. decisions that generate great private benefits for them, for instance because they improve their human capital or conform with their “taste for science”).<sup>14</sup>

Note that communication is distorted because the specific knowledge of the acquired key inventors is based on “soft” information. If this information is “hard”, that is it is codified and articu-

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<sup>13</sup> This idea is not new: it dates back to Hayek’s (1945) seminal work on the use of knowledge in society. “If we ... agree that the economic problem of society is mainly one of rapid adaptation to changes in particular circumstances of time and place, ..... decisions must be left to the people who are familiar with these circumstances, who know directly of the relevant changes and of the resources immediately available to meet them. .... We must solve it by some form of decentralization”(Hayek 1945, p. 524. See also the extensive discussion of this issue in Jensen and Meckling 1992).

<sup>14</sup> Following the pioneer work by Crawford and Sabel (1982) on strategic information transmission, the in this stream of literature the information transmission that takes place between an informed agent and a uninformed principal is modeled as a strategic communication game or “cheap talk” (see e.g. Dessein 2002, Friebe and Raith 2007, Alonso and Matouschek 2008, Alonso et al. 2008, Dessein et al. 2008, Rantakari 2008).

lated and it can easily be interpreted and absorbed by third parties, things turn otherwise. Under these circumstances the acquired key inventors have incentives to truthfully pass on valuable information to their corporate superior. As they compete with other inventors for the allocation of (scarce) R&D budget, by doing so they can increase the chance of getting a greater budget, performing more research and obtaining greater private benefits (Stein 2002, Friebel and Raith 2007).

Conversely, if the information passed on by the acquired key inventors is “soft”, the manager in charge of decisions knowing that this information is biased, will tend to discard it in project selection. This possibly leads to selection of poor quality R&D projects. The higher the technological uncertainty surrounding the innovation activity of the acquired start-up, the more valuable the specific knowledge of the acquired inventors, the poorer the relative quality of centralized decisions (Dessein 2002, Prendergast 2002, Raith 2004, Rantakari 2008, Dessein et al. 2008). Clearly, the loss of information that occurs with centralized decision making has a direct negative effect on the innovation performance of the acquired start-up. It also has an indirect negative effect, because of the complementarity between the quality of the selected R&D projects and the innovative effort of the individuals to whom project implementation is demanded. As the marginal product of their effort declines if they are engaged in poor quality projects, they will provide a low level of effort (see again Raith 2004).<sup>15</sup>

Note also that even in absence of any information loss, if the acquired key inventors have different priors from those of the acquiring firm as to the most promising R&D projects, centralization of decision rights will result in low implementation effort (Zabojnik 2002, Van den Steen 2006) and high likelihood of disobedience of orders (Van den Steen 2007). The acquiring firm might try to enforce commands by making disobedience costly to the acquired key inventors. However, the cost of their departure is very high for the acquiring firm, as they are difficult to replace; moreover, if they were dismissed, it would be quite easy for them to find a new job. In this situation enforcement of orders is problematic (Marino et al. 2006).

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<sup>15</sup> The acquired key inventors may be willing to cultivate and update their specific knowledge over time so as to maintain their human capital endowment and keep separation costs as low as possible, or they may do so just for fun. However, suppose that these personal motivations are absent. The problem with centralization of decisions is that the acquired key inventors do not get the chance of acting on the specific local knowledge they have. Then the incentives they will have to collect further information on new promising technologies and other technical matters relevant to the innovation activity of their unit, will be fairly low (see Aghion and Tirole 1997, Stein 2002). This may lead to a progressive deterioration of the distinctive technological competencies of the acquired start-up that originally motivated the acquisition, thus hurting innovation performance over time. In addition, it has been argued that R&D projects typically have the nature of real option investments (see e.g. McGrath 1997). The centralization of decision rights increases the risk borne by the acquired key inventors that the selected projects be subsequently abandoned or redirected. As in this case their project-specific human capital investments become less valuable, their incentives to provide effort and make these investments are likely to decline, all else equal (see Wang and Lim 2008).

In principle, the acquiring firm may deal with loss of information problems through the provision to the acquired key inventors of high-powered incentives that link their rewards to the post-acquisition innovation performance of the acquired start-up. This may induce them to truly reveal their “soft” information to their corporate superior, as private benefits are now given a smaller weight in their preferences. In fact, a key result of the strategic communication literature is that the closer are the preferences of agent and principal, the less distorted is communication (see again Dessein 2002). An additional advantage of high-powered incentives is that they elicit implementation effort. However, high-powered incentives have several drawbacks. First, as is traditionally highlighted by the agency theory literature (see e.g. Holmstrom 1979, Levinthal 1988, Prendergast 1999), high-powered incentives are costly, especially if the available measures of individual performance are noisy. They are also likely to engender high social costs within the acquiring firm as the higher rewards obtained by some employees may be considered unjustified or non equitable by other employees (see again Holmstrom 1989, Zenger 1994). Second, if the acquired key inventors have different priors from those of the managers in charge of decision making, high-powered incentives are counterproductive in that they further stimulate the former to disobey orders given by the latter as they think orders are wrong (Van den Steen 2007). Third, the post-acquisition innovation activity of the acquired start-up is likely to generate externalities on other operations of the acquiring firm. Under such circumstances, high-powered incentives bias the preferences of the acquired key inventors towards locally optimal decisions and away from decisions that are globally optimal for the acquiring firm. Hence, they make communication even more strategic and distorted (see Friebel and Raith 2007, Alonso et al. 2008, Dessein et al. 2008). In order to induce truthful communication, the incentives of the acquired key inventors need to give a sufficient weight to the global performance of the acquiring firm. This however reduces motivation and provision of implementation effort.

In sum, if the acquired key inventors i) possess valuable specific knowledge on local technological matters that is based on “soft” information and cannot be communicated upward the corporate ladder in a reliable way, and/or ii) have strong personal beliefs as to the right course of action that diverge from those of the acquiring firm, delegation of decision authority involves substantial benefits. However, delegation of decisions also has some non negligible costs, that are illustrated in the following section.

### *3.3.2. The costs of delegation*

If decision rights are assigned to the acquired key inventors, the acquiring firm incurs the costs of losing control over the post-acquisition innovation activity of the start-up. These costs are greater

the more divergent the decisions made by the acquired key inventors are from those that the acquiring firm would make if it had the same information set.

First, if the acquired key inventors have intrinsic motivations and obtain *private benefits* from innovation activity, their preferences will not be aligned with those of the acquiring firm. So the R&D projects they will select are not those that maximize acquirer's pay-off (Dessein 2002, Raith 2004). Moreover, even if private benefits are negligible, the decisions that are optimal for the acquired start-up need not to coincide with those that are optimal for the acquirer. In fact, the acquired key inventors are likely to neglect the *need for coordination* of their decisions with those relating to other operations of the acquiring firms. In this respect, decentralization of decision-making has two drawbacks. First, the acquired key inventors focus attention on adapting their decisions to local conditions, and do not fully internalize the externality created by these decisions. Second, while making decisions on local matters they are limitedly aware of what the decisions made elsewhere in the acquiring firm are; this is at odds with effective coordination (see Alonso et al. 2008).<sup>16</sup>

If the divergence between the preferences of the acquired key inventors and those of the acquiring firm is mainly attributable to the existence of private benefits, the rewards of the former can be tied to their individual innovation performance, provided that the available performance measures are not noisy. As was noted earlier, *high-powered incentives* have the additional beneficial effect of eliciting greater implementation effort from the acquired key inventors. In fact, the extant literature unanimously indicates that delegation of decisions and high-powered incentives are complements (e.g. Dessein 2002, Prendergast 2002, Raith 2004). Nonetheless, high-powered incentives are costly. In addition, they exacerbate distortions in local decisions if the source of the divergence is the different "vision of the world" of the acquired key inventors from the one of the acquiring firm (Van den Steen 2006). Lastly, they render coordination problems more severe. In fact, in order for the acquired key inventors to care about coordination of decisions, their rewards need to be contingent on the general performance of the acquiring firm; this however reduces their motivation. In other words, there is a trade-off between motivation which requires high-powered incentives, and coordination which can be achieved through balanced incentives (Alonso et al. 2008, Dessein et al. 2008).<sup>17</sup>

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<sup>16</sup> Note that these coordination problems may be alleviated through the use of organizational arrangements (e.g. joint committees, common social events, and the like) aimed at increasing horizontal communication between different units of the acquiring firm.

<sup>17</sup> This trade-off has similar origin as the one highlighted in the previous section between high-powered incentives and non-distorted communication of "soft" information. Note that when coordination needs are very strong and the bias of the acquired key inventors are small (e.g. because incentives are balanced), the acquired key inventors may have suffi-

It is important to emphasize that if decision rights are assigned to the acquired key inventors, it is crucial for the acquiring firm to discourage the selection of very bad projects (e.g. projects with positive private benefits but low or even negative pay-off). In fact, it has been shown by previous studies that if the decisions made by the agent are not excessively biased, the loss of information problems under centralization of decision authority outweigh the loss of control problems that arise with delegation (see again Alonso et al. 2008). Therefore, if the acquiring firm is able to deter very bad decisions, the appeal of delegation of decision authority increases substantially.<sup>18</sup>

### **3.4. The determinants of the delegation of decision authority to the acquired key inventors: integrating the incentive and competence-based perspectives**

In the previous section we have shown that there are benefits and costs in delegating to the acquired key inventors decision authority over the post-acquisition innovation activity of the acquired start-up. They are synthesized in Table 1. Delegation is more efficient than centralization when the benefits that arise from using acquired key inventors' specific knowledge and eliciting implementation effort through high-powered incentives outweigh the costs associated with selection of suboptimal projects and lack of coordination with acquiring firm's other operations. The aim of this section is to highlight *deal-specific* and *firm-specific* characteristics that modifies this trade-off. For this purpose, we will combine insights provided by the incentive and competence-base perspectives.

First of all, we argue that when in the acquisition of a high-tech start-up greater emphasis is placed on *explorative* rather than *exploitative* motives, assignment of decision rights to the acquired key inventors is more efficient (see Table 2). Moreover, we consider the *technological relatedness* between the acquiring and target firms, the existence of *prior collaborative relationships* between them, and the *prior acquisition experience* of the relevant type (i.e. either of explorative or of exploitative acquisitions) accumulated by the acquiring firm. We claim that the effect of these firm-specific factors on the efficiency of delegation of decision authority to the acquired key inventors as opposed to its centralization within the acquiring firm is moderated by the type of acquisition, either explorative or exploitative (see Table 3).

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cient autonomous incentives to coordinate their decisions with those of the acquiring firm (see Alonso et al. 2008, Rantakari 2008b).

<sup>18</sup> An alternative solution is given by partial delegation (or threshold delegation, see Marino and Matsusaka 2005, Alonso and Matouschek 2008). With this arrangement, the decisions of the acquired key inventors are rubberstamped by the acquiring firm, but only if they do not exceed a given threshold (for instance, if they do not require more than a given budget or they do not imply entry into a unrelated technological field). This form of delegation has two advantages. First, it prevents selection of R&D projects with very low pay-off for the acquirer. Second, it alleviates strategic communication problems. For the sake of simplicity, in the remaining of this paper we focus attention on the dichotomy between full delegation and centralization of decision authority, and we leave the analysis of threshold delegation for future work.

### 3.4.1. *The motives of the acquisition: exploration versus exploitation*

The acquisition literature has highlighted that two fundamentally different motives drive the acquisition of high-tech start-ups: *exploitative* and *explorative* motives (Ranft and Lord 2002, Puranam et al. 2006, Puranam and Srikanth 2007).<sup>19</sup> On the one hand, the acquirer may want to obtain access to the existing technologies embodied in the technological artifacts (e.g. a new product, a prototype, a patent) developed by the target firm and to their underlying knowledge. Here the logics for the acquiring firm is to exploit the acquired start-up's technological achievements, using it in combination with its own complementary resources and capabilities or as an input to its innovation processes. On the other hand, the main objective of the acquiring firm may be to hinge on the technological capabilities of the acquired start-up to generate an ongoing flow of innovations, over and beyond those that this latter has already developed at the time of the acquisition. In this situation, the need arises to explore the technology opportunity space in search for innovative solutions to unsolved technological problems. In this learning activity, the unique skills and knowledge of the acquired key inventors play a crucial role.

Of course, the acquisition of a high-tech start-up may be driven by both exploitative and explorative motives. Nonetheless, one of these motives generally prevails over the other one.<sup>20</sup> The studies reviewed in Section 2 show that when exploration is relatively more important than exploitation, better innovation performance are obtained if the acquired start-up is kept structurally separated as an autonomous unit or subsidiary (Puranam et al 2006, Puranam and Srikanth 2007). Even though we have mentioned earlier that the correlation between structural separation and delegation of decision authority is less than perfect, one may presume that it is positive. Our conceptual model helps explain why delegation of decision authority is more effective than centralization in explorative acquisitions.

In these acquisitions the specific knowledge possessed by the acquired inventors plays a crucial role both in indicating the most promising directions for future research and in allowing efficient local search along these directions. In absence of this knowledge, decisions about project se-

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<sup>19</sup> For a discussion of the properties of “explorative” and “exploitative” activities of firms see March (1991) and Levinthal and March (1993).

<sup>20</sup> For instance, Puranam et al. (2006) convincingly argue that exploration is given relatively more emphasis when at the time of the acquisition the target firm still has not yet launched its first product. Of course, the relative weight of exploration and exploitation objectives evolves over time. Exploration is more important in the immediate post-acquisition period as the acquired firm's technologies may require modifications and improvements to be made interoperable with those of the acquiring firm or to be suitable for large scale manufacturing and commercialization (see again Puranam et al. 2006). For the sake of simplicity, in this section we will neglect this longitudinal aspect and we will focus attention on cross-sectional heterogeneity across acquisitions. We will turn to longitudinal issues in Section 5.

lection are likely to be of poor quality. Moreover, this knowledge typically is cumulative, context-specific and tacit (see Nelson and Winter 1982); so, it is based on “soft” information that cannot be communicated in a reliable way.<sup>21</sup> The loss of information that occurs with centralization of decisions would badly hurt the post-acquisition innovation performance of the acquired start-up. The fact that explorative activities are inherently uncertain due to the serendipity of research in untested fields, renders use of the specific knowledge of the acquired key inventors in project selection even more important.

Moreover, the wish of the acquiring firm to extend its set of technological capabilities and capture “economies of cognitive scope” (Nooteboom 1992) is the primary driver of explorative acquisitions. Therefore, the technological capabilities of the acquired firm differ from the ones of the acquirer: if they were too similar, these economies would not materialize. As a corollary, the cognitive frames of the acquired key inventors which underlie their unique knowledge and skills - that is their “vision of the world”, differ from those of the acquiring firm. In this situation, centralization of decisions would lower the motivation of the acquired key inventors. They would also be likely to disobey orders they perceive as wrong.

Moreover, it is important to emphasize that in explorative acquisitions, the need to coordinate the post-acquisition innovation activity of the acquired start-up with the other operations of the acquiring firm is fairly limited though not totally absent. Creativity in the search for new technological solutions prevails over efficiency objectives, and externalities are negligible. So locally optimal decisions are likely to be also optimal for the acquiring firm.

Conversely, in exploitative acquisitions the main objective of the acquiring firm is to obtain the technological artifacts developed by the target. Their integration with the other technologies of the acquired firms and their modification or customization for manufacturing, marketing or distribution purposes, create considerable costs if decisions are not duly coordinated. Moreover, while use of the specific underlying knowledge possessed by the acquired key inventors makes it easier to smoothly transfer and efficiently exploit the existing technologies of the acquired start-up, it clearly plays a less dramatic role than in explorative acquisitions. Note also that a considerable portion of this knowledge is articulated and codified (e.g. in manuals, patent applications and other documents), that is it is based on “hard” information. Hence communication upward the corporate ladder is less biased than in explorative acquisitions.

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<sup>21</sup> We have argued earlier that if information is “soft”, the acquired key inventors have incentives to communicate it strategically so as to influence to their advantage the decisions made by their corporate superior. It is fair to recognize that even independently of the strategic nature of communication, timely and reliable transmission of this type of information is almost impossible due the bounded rationality of economic agents who clearly experience limits in their capacity to transmit, receive, store and process information (Simon 1945).

In sum, in explorative acquisitions the benefits of delegation of decision authority to the acquired key inventors are likely to outweigh its costs. The opposite holds true for exploitative acquisition. We therefore derive the following proposition.

*Proposition 1. In explorative acquisitions, delegation of decision authority over the innovation activity of the acquired start-up to the acquired key inventors leads to better performance than centralization of authority. The opposite holds true in exploitative acquisitions.*

#### *4.4.2. The positive effect on delegation of decision authority in explorative acquisitions of technological relatedness, prior alliances, and prior acquisition experiences*

In this Section we focus attention on explorative acquisitions. We examine the impact on the effectiveness of delegation of decision authority to the acquired key inventors of technological relatedness between the combined firms, the prior alliances they have established with each other, and the prior experience accumulated by the acquiring firm in managing explorative acquisitions.

*Technological relatedness.* Let us assume that the acquired start-up and the acquiring firm operates in the same or in closely related technological fields and draw on a common knowledge base. In other words, technological relatedness between them is high. We claim that delegation to the acquired key inventors of decision authority over the post-acquisition innovation activity of the acquired start-up is more effective than in situations where technological relatedness is lower. First, as was argued above, explorative acquisition are driven by the wish of the acquiring firm to internalize the unique technological capabilities possessed by the target start-up. With higher technological relatedness, the acquirer has greater “absorptive capacity” (Cohen and Levinthal 1990, Zahra and George 2002), and so it can profit more from the innovative knowledge generated by the acquired start-up in the post-acquisition period. On the one hand, the acquirer is in a better position to understand the value of the new discoveries of the acquired firm’s personnel (Kogut and Zander 1992, Grant 1996, Lane and Lubatkin 1998). On the other hand, once promising new technologies have been discovered and new technological artifacts have been developed, the acquirer also has greater ability to “digest” these new technologies and apply them in its other operations. As the combination potential of explorative acquisitions increases with firms’ technological relatedness, using the specific knowledge of the acquired inventors in project selection and eliciting implementation effort

from them become even more important. This is more easily obtained through delegation of decisions.<sup>22</sup>

Second, in the acquisition of high-tech start-ups acquiring firms generally confront severe hidden information problems as it is difficult for them to assess who are the individual inventors who crucially contribute to the acquired firm's technological capabilities (Zenger 1994). When technological relatedness between the acquirer and the target is high, these hidden information problems are mitigated (Coff 1999). If the combining firms have R&D operations in similar technological fields, their inventors being part of the same scientific and technological community, are likely to be aware of the respective unique knowledge and skills. Before the deal they may have had the opportunity to meet while participating in common events (e.g. conferences, technical committees) or to become familiar with their technical and scientific productions (i.e. patents, scientific papers, published technical reports). After the deal, the acquiring firm may hinge on this first-hand information to identify among the acquired personnel the key inventors to whom decision authority should be assigned. Even if the acquirer's and target' inventors are not knowledgeable of each other before the deal, the acquiring firm drawing on a knowledge base similar to the one of the target, is in a position to form a sound judgment about how valuable are the knowledge and skills of the acquired individual inventors. Therefore, delegation will be less costly the higher the technological relatedness between the combined firms.

Third, if the acquiring firm has an adequate understanding of the innovation activity of the target, post-acquisition hidden action problems are also more limited. On the one hand, the acquiring firm will find it easier to design accurate measures of the post-acquisition performance of acquired key inventors. In turn, this renders use of high-powered incentives that are a complement of delegation of decisions, more efficient. On the other, it would also be easier for the acquiring firm to discourage the selection of very bad projects by acquired key inventors.

From the above argument, we derive Proposition 2.

*Proposition 2. In explorative acquisitions, delegation of decision authority over the innovation activity of the acquired start-up to the acquired key inventors leads to better performance the higher the technological relatedness between the acquired start-up and the acquiring firm.*

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<sup>22</sup> The acquisition literature generally hypothesizes an inverse U-shaped relation between the technological relatedness of the target and acquiring firms and post-acquisition innovation performance (see e.g. Ahuja and Katila 2001, Kapoor and Lim 2007). It is argued that if the target firm has technological capabilities that are that too closely related to the one of the acquirer, the potential for cross-fertilization of ideas is reduced. However, we mentioned earlier that in the acquisitions under scrutiny here the primary driver of the acquiring firm is the desire to extend its set of technological capabilities. Therefore, start-ups having very similar technological capabilities to the ones of the acquiring firm are unlikely to become the target of an explorative acquisition.

*Prior alliances.* Independently of the overlap in their knowledge base, the acquiring firm may be knowledgeable of the unique innovative abilities of the acquired individual inventors if before the deal, it established with the acquired firm one or more alliances with this latter firm that offered to the personnel of the combining firms the opportunity to collaborate with each other. Conversely, if prior alliances between the acquiring and acquired firms relied on the specialization of tasks between the parties (see e.g. Nakamura *et al.*, 1996) and provided little room for personal interaction, hidden information problems are likely to remain unaltered. Alliances of the former type include technological collaborations that involve joint R&D and intense communication and exchange of knowledge between the partners. Inter-firm technological collaborations that simply allowed the acquiring firm to obtain access to a proprietary technology possessed by the acquired start-up (e.g. through licensing), or alliances aimed at commercializing a new product this latter had developed, are unlikely to have any positive effect on the reduction of hidden information problems. If the acquiring firm is confident about the identity and abilities of the acquired firm's key inventors because of the first-hand information accumulated in prior alliances, the costs of delegation decrease.

Moreover, the experience of joint work in prior technological alliances provides the acquiring firm with a better understanding of the specific preferences of the acquired key inventors. Therefore, the biases in project selection that may arise if decision rights are delegated to these individuals become more predictable. This again decreases the costs of delegation (see Dessein 2002, p. 830).

Lastly, it is important to emphasize that the experience of mutual collaboration in prior alliances, of the pertinent type, is likely to have a more positive effect on the efficiency of delegation when technological relatedness between the acquiring firm and the acquired start-up is low. In this situation, in absence of prior alliances, hidden information problems would be quite severe. Propositions 3a and 3b follow.

*Proposition 3a. In explorative acquisitions, delegation of decision authority over the innovation activity of the acquired start-up to the acquired key inventors leads to better performance if before the deal, the acquired start-up and the acquiring firm have established alliances that gave their personnel the opportunity to work together.*

*Proposition 3b. In explorative acquisitions, the positive effect of prior alliances on the effectiveness of delegation of decision authority to the acquired key inventors is greater the lower the technological relatedness between the acquiring firm and the acquired start-up.*

*Prior acquisition experience.* The acquisition literature contends that there are learning processes in acquisitions (see e.g. Lubatkin 1987, Halebian and Finkelstein 1999, Hayward 2002, Zollo and

Singh 2004, Puranam and Srikanth 2007). If the acquisition of a high-tech start-up is driven by explorative motives, the experience the acquiring firm has accumulated in prior acquisitions of the same type is likely to positively affect the effectiveness of delegation of decision authority to the acquired key inventors. The reason is simply to be traced to learning by doing effects (see Vermeulen and Barkema 2004). In prior explorative acquisitions the acquiring firm is likely to have assigned decision authority over the post-acquisition innovation activity of the acquired firms to the acquired key inventors. In so doing, the acquiring firm has probably developed specific organizational routines in activities like the identification of key scientists and engineers among the acquired personnel, the choice of accurate indicators of their post-acquisition individual performance, the design of efficient high-powered incentives for them, and the deterrence of selection by acquired key inventors of pet research projects with very low pay-off for the acquirer. The acquirer is also likely to have experienced the benefits of this delegation strategy.

It is worth emphasizing that the learning effects mentioned above are contingent on the specific motives of prior acquisitions. If the acquiring firm in spite of a long series of prior acquisitions of high-tech start-ups which were driven by exploitative motives, is a novice in explorative acquisitions, these learning effects do not materialize and delegation of decisions to the acquired key inventors is less effective. Note also that for reasons similar to the ones that have been illustrated in the discussion of prior alliances, the influence of acquisition experience is likely to be more beneficial if the acquiring firm and the acquired start-up have lower technological relatedness and so the organizational challenges that the acquiring firm faces in delegating decision authority are greater. Propositions 4a and 4b follow.

*Proposition 4a. In explorative acquisitions, delegation of decision authority over the innovation activity of the acquired start-up to the acquired key inventors leads to better performance if the acquiring firm has a longer history of explorative acquisitions of high-tech start-ups.*

*Proposition 4b. In explorative acquisitions, the positive effect of prior acquisition experience on the effectiveness of delegation of decision authority to the acquired key inventors is greater the lower the technological relatedness between the acquiring firm and the acquired start-up.*

4.4.3. *The positive effects on centralization of decision authority in exploitative acquisitions of technological relatedness and prior acquisition experiences*

We have highlighted above that when the main driver of the acquisition of a high-tech start-up is the exploitation by the acquiring firm of the target's existing technologies, centralization of decision authority is more efficient than its delegation to the acquired key inventors. While we expect the establishment of prior alliances between the target and the acquirer not to have any specific influence on the benefits and costs of delegation or centralization of decision authority in this type of acquisition, we claim that technological relatedness and prior acquisition experience again play a crucial role.

*Technological relatedness.* In exploitative acquisitions, the main factors inducing the acquiring firm to centralize decision authority rather than delegating it to the acquired key inventors, are the need to closely coordinate the post-acquisition innovation activity of the acquired start-up with the other operations of the acquired firm, and the negative externalities that locally optimal decisions made by the acquired key inventors may have on the acquiring firm. Clearly the existence of negative externalities is more likely and the opportunity costs of lack of coordination are greater if the innovation activities of the combining firms are closely related, that is if technological relatedness is high. Under these circumstances, the relative advantages of centralization of decision authority increase considerably. Conversely, if the acquired start-up operates in technological fields that are distinct from those of the acquiring firm, for instance because the acquisition is part of the technology diversification strategy pursued by the acquiring firm, delegation of decision rights to the acquired key inventors is unlikely to provoke great damages.

In addition, the specific knowledge possessed by these individuals is less important in exploitative acquisition, and it is largely based on "hard" information that can be passed upward the corporate ladder quite efficiently. So project selection and task assignment are likely to be performed quite efficiently under centralization of decision authority. Therefore, the crucial remaining problem for the acquiring firm is to elicit implementation effort from the acquired personnel. We have argued above that when the acquiring firm operates in technological fields close to those of the acquired start-up, it clearly has advantages in designing non-noisy performance measures. Therefore use of incentives that rewards the acquired key inventors for their post-acquisition performance is less costly. In turn, this renders centralization of decision authority more effective.

From the above reasoning, we derive the following propositions.

*Proposition 5. In exploitative acquisitions, centralization within the acquiring firm of decision authority over the post-acquisition innovation activity of the acquired start-up leads to better performance the higher the technological relatedness between the acquiring firm and the acquired start-up.*

*Prior acquisition experience.* The arguments relating to the influence of the prior acquisition experience of the acquiring firm on the delegation or centralization of decision authority in exploitative acquisitions mirror those developed earlier for explorative acquisitions. The logic is exactly the same. Learning by doing matters in acquisitions, but only to the extent that the challenges that must be met are similar, and so the organizational solutions that are found can be replicated from one acquisition to the other. Accordingly, the experience of efficient centralization of decision rights that the acquiring firm may have accumulated in prior exploitative acquisitions of high-tech start-ups helps in managing the post-acquisition reorganization that occurs in subsequent exploitative acquisitions to the extent that they again involve centralization of decisions. Moreover, this experience is more valuable the higher is the technological relatedness between the acquiring firm and the acquired start-up, and so the more challenging is post-acquisition reorganization due to the need for efficient management of externality and coordination problems. Propositions 6 follow.

*Proposition 6a. In exploitative acquisitions, centralization within the acquiring firm of decision authority over the post-acquisition innovation activity of the acquired start-up leads to better performance if the acquiring firm has a longer history of exploitative acquisitions of high-tech start-ups.*

*Proposition 6b. In exploitative acquisitions, the positive effect of prior acquisition experience on the effectiveness of centralization within the acquiring firm of decision authority is greater the greater the technological relatedness between the acquiring firm and the acquired start-up.*

#### 3.4.4. A synthesis

In the previous sections we have analyzed the factors that determine whether delegation to the acquired key inventors of decision authority over the post-acquisition innovation activity of the acquired start-up is preferable to centralization within the acquiring firm. The considerations we have made are synthesized in the flow chart illustrated in Figure 1.

First of all, the acquiring firm has to carefully examine the key motives of the acquisition. If the acquisition of the high-tech start-up is primarily driven by exploration motives and accordingly the acquiring firm mainly aims to obtain a new source of ongoing innovations thus extending its collection of technological capabilities, delegation of decision authority is more likely and more efficient than centralization, all else being equal. The opposite applies when for the acquiring firm the main objective is to obtain access to the technological artifacts developed by the acquired start-up and the existing underlying knowledge.

The flow chart clearly highlights that other factors crucially influence the balance between delegation and centralization, namely the technological relatedness between the combining firms, the prior alliances involving some forms of joint work between their personnel, and the prior acquisition experience of the acquiring firm. Even more interestingly, the influence exerted by these factors is crucially moderated by the motives of the acquisition. If the acquisition is instrumental to exploration, the higher the technological relatedness, the more beneficial is delegation. If technological relatedness is low, the more intense the prior collaboration between the combining firms and the longer the history of explorative acquisitions of the acquirer, the more beneficial again is delegation.

Conversely, when the acquisition is of exploitative type, technological relatedness and the experience accumulated by the acquiring firm in prior exploitative acquisitions favor centralization of decision authority within the acquiring firm. Moreover, we expect the extent of the positive effect of acquisition experience on centralization to increase with higher technological relatedness.

**Table 1. The benefits and costs of delegation of decision authority to the acquired key inventors: a synthesis**

<i>The benefits of delegation</i>	<i>The costs of delegation</i>
Use of the specific knowledge possessed by the acquired inventors in “local” decisions. More important if there is high technological uncertainty	Selection of projects with great private benefits, but limited pay-off for the acquirer. It can be alleviated through use of high-powered incentives
Avoid distortion from strategic communication of “soft” information upward the corporate ladder	High-powered incentives are costly if performance measures are noisy
Elicit implementation effort from the acquired key inventors, especially if they have strong beliefs that diverge from the ones of the acquiring firm	High-powered incentives are counterproductive if biases in project selection are driven by the strong beliefs of the acquired key inventors
Avoid problems arising from the acquired key inventors’ disobedience of (supposedly wrong) orders.	Lack of coordination of decisions with and neglect of externality on the other operations of the acquiring firm. It can be alleviated through use of balanced incentives

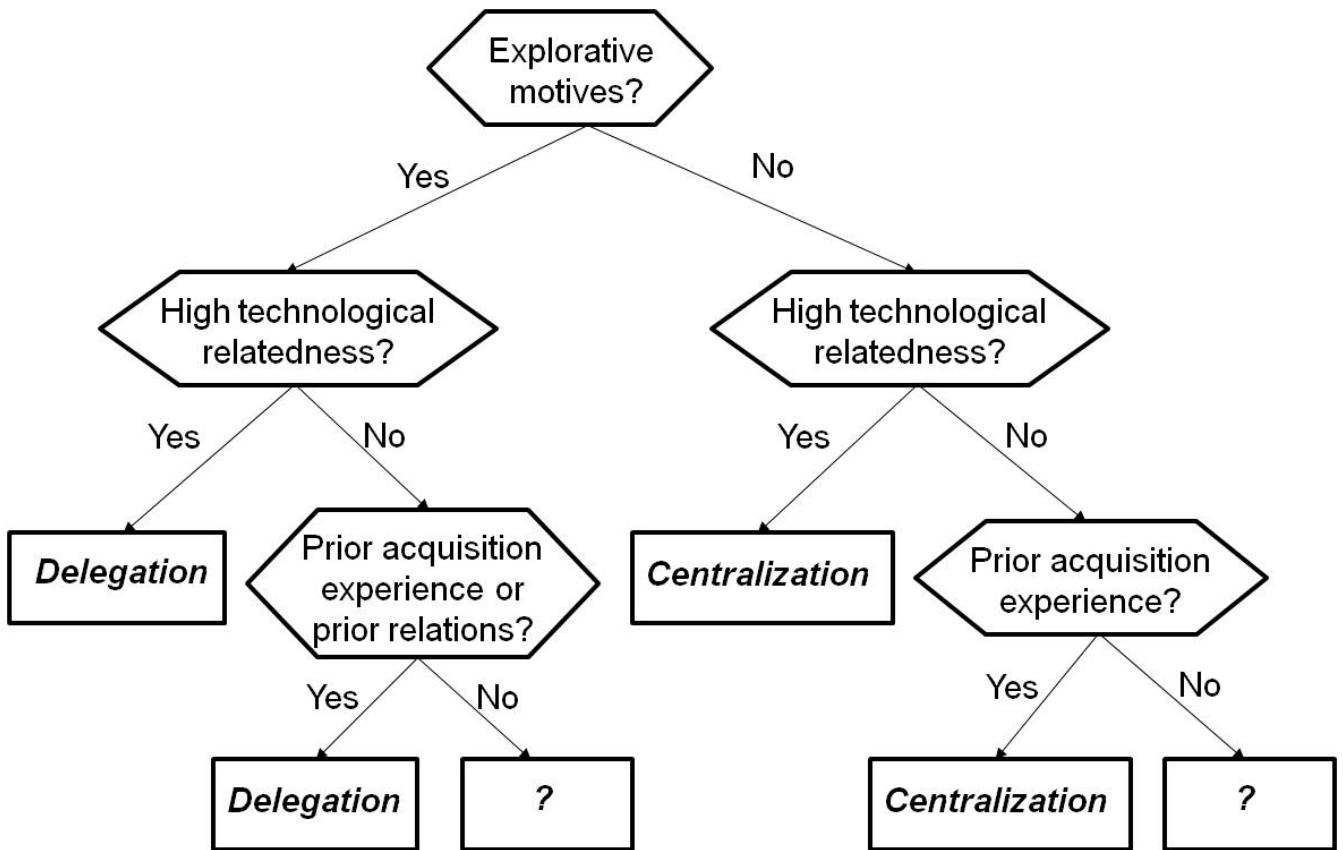
**Table 2. Factors favoring and hindering the delegation of decision authority to the acquired key inventors: explorative versus exploitative acquisitions**

<i>Explorative acquisitions: direct positive effect on the delegation of decision authority</i>	<i>Exploitative acquisitions: direct positive effect on the centralization of decision authority</i>
Key role of the specific knowledge of the acquired key inventors for effective decision making	Limited role of the specific knowledge of the acquired key inventors for effective decision making
Tacit, non-verifiable nature of the acquired key inventors' specific knowledge, that is based on "soft" info	Codified, articulated nature of (most of) the acquired key inventors' specific knowledge, that is (largely) based on "hard" info
Information advantage of the acquired key inventors amplified due to high technological uncertainty	Information advantage of the acquired key inventors less important due to low technological uncertainty.
Strong beliefs of the acquired key inventors that diverge from those of the acquiring firm	Convergence of beliefs between the acquired key inventors and the acquiring firm
Limited need for coordination of the decisions relevant to the post-acquisition innovation activity of the acquired start-up with those made elsewhere by the acquiring firm	Need for close coordination of the decisions relating to the post-acquisition innovation activity of the acquired start-up with those made elsewhere by the acquiring firm

**Table 3. The role of technological relatedness, prior alliances, and prior acquisition experience in favoring the delegation or the centralization of decision authority in explorative and exploitative acquisitions**

	<i>Explorative acquisitions</i>	<i>Exploitative acquisitions</i>
<i>Technological relatedness</i>	Positive influence on <i>delegation</i> of decision authority to the acquired key inventors	Positive influence on <i>centralization</i> of decision authority within the acquiring firm
	<ul style="list-style-type: none"> <li>• Greater combination potential, because of the greater absorptive capacity of the acquiring firm</li> </ul>	<ul style="list-style-type: none"> <li>• Greater need for close coordination of the innovation activity of the start-up with the other operations of the acquiring firm</li> </ul>
	<ul style="list-style-type: none"> <li>• Smaller hidden information problems in identifying acquired key inventors</li> </ul>	<ul style="list-style-type: none"> <li>• Greater ability of designing non-noisy performance measures</li> </ul>
	<ul style="list-style-type: none"> <li>• Greater ability of designing non-noisy performance measures</li> </ul>	
<i>Establishment of prior alliances</i>	Positive influence on <i>delegation</i> of decision authority to the acquired key inventors if alliances involved intense interaction and communication between the personnel of the combining firms	
	<ul style="list-style-type: none"> <li>• Smaller hidden information problems in identifying acquired key inventors</li> </ul>	
	<ul style="list-style-type: none"> <li>• More predictable biases in project selection.</li> </ul>	
	<ul style="list-style-type: none"> <li>• Greater positive influence with low technological relatedness</li> </ul>	
<i>Prior acquisition experience</i>	Positive influence on <i>delegation</i> of decision authority to the acquired key inventors if prior acquisitions were exploration driven	Positive influence on <i>centralization</i> of decision authority within the acquiring firm if prior acquisitions were exploitation driven
	<ul style="list-style-type: none"> <li>• Learning by doing effects in explorative acquisitions</li> </ul>	<ul style="list-style-type: none"> <li>• Learning by doing effects in exploitative acquisitions</li> </ul>
	<ul style="list-style-type: none"> <li>• Greater positive influence with low technological relatedness</li> </ul>	<ul style="list-style-type: none"> <li>• Greater positive influence with high technological relatedness</li> </ul>

**Figure 1. The effects of the motives of the acquisition, technological relatedness, prior alliances and prior acquisition experience on the dichotomy between delegation or centralization of decision authority: A synthesis**



*Legend: ?*:Low likelihood of success.

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