

The dynamics of coordination in innovation networks

1461

ABSTRACT

Investigations into the internal operation of inter-organizational networks have become increasingly common in the literature over the last few years. Nevertheless, empirical studies are still relatively rare. The void is even more striking in the case of networks set up by small firms. The objective was to identify and characterize the coordination mechanisms and their different forms, and also to better understand how they evolve. Three main dimensions had an effect on coordination: hub firm dependency, existence of prior business relations, and type of conflict. Our empirical analysis of six innovation networks analyzed how these three dimensions influenced the type of coordination form used by the hub firm. The manner through which coordination mechanisms are implemented evolved according to the type of interactions established between partners and to the emergence - or not - of conflict. The implications of these results are discussed.

Keywords: coordination mechanisms; dependence; SME; hub firm; innovation network.

INTRODUCTION

Empirical studies on the internal operation of innovation networks are scarce (Ahuja, 2000; Dhanaraj and Parkhe, 2006). Most researches have focused on innovation networks from the point of view of their creation or structure, also of the factors leading to their collapse. Networks facilitate the exchange of information and the transfer of expertise but they also encourage the development of opportunistic behaviour (Goerzen, 2007).

The existing literature has highlighted the existence of a link between coordination mechanisms and the level of dependence of hub firms, their prior business relations and the type of conflict. However, no study has taken a further step to analyze the details of the different implementations for such mechanisms. Furthermore, research on coordination mechanisms has essentially addressed these mechanisms individually (Das and Teng, 1998). Our study aimed to remedy this situation by analyzing the coordination mechanisms that are created within innovation networks, the manner in which they are implemented and their evolution in the course of the cooperative innovation process. Our aim was to explain how the three main dimensions identified in the literature affected the coordination mechanisms, their forms and their evolution. The emphasis was placed on hub firms as they hold a central position in innovation networks (Ahuja, 2000) and take on a leadership role by channelling the network members' scattered resources and capabilities (Dhanaraj and Parkhe, 2006). Hub firms possess certain fundamental resources such as property rights. They have authority over the other members and also establish the largest number of links with network members.

When studying coordination aspects in with agency or transaction cost theoretical lenses, the focus is often placed on a specific activity or transaction. In the context of innovation and organization, this static focus is necessarily incomplete. Innovation poses the problem of dynamic coordination, of how firms manage their business activities over time as conditions change. In this study we focused on internal changes inherent to the project and its

developmental process. Organizational structures (here, the hub firm) must facilitate the execution of current tasks, and adapt to as yet unforeseen future tasks.

The article is organized as follows. In section 1, we present a brief review of the literature on coordination mechanisms in innovation networks and discuss the concept of dependency as viewed by the resource dependency theory (Pfeffer and Salancik, 1978). We also address two other main dimensions that may influence coordination mechanisms: prior relations and the type of conflict. In section 2, six innovation networks are examined in order to compare the coordination forms used by the hub firms in the course of the innovation project. The results for each coordination mechanism are discussed in section 3 and the conclusion mentions current limitations as well as avenues for further research.

1. CONCEPTUAL BACKGROUND

We chose to focus on innovation networks as they offer fertile ground for understanding the ways of implementing coordination mechanisms and their evolution. A hub firm is defined here as a firm *“that possesses prominence and power gained through individual attributes and a central position in the network structure, and that uses its prominence and power to perform a leadership role in pulling together the dispersed resources and capabilities of network members”* (Dhanaraj and Parkhe, 2006: 659). An innovation network consists of a set of vertical and horizontal relations established between various organizations (public/private, partner/provider) that are orchestrated by a hub firm so as to enable the latter to take advantage of its invention(s). Having filed a patent the hub firm needs to call on other firms in order to turn its invention into an innovation. To achieve this goal, the hub firm has to regulate the transactions within its network (Powell, Koput and Smith-Doerr, 1996).

1.1. COORDINATION MECHANISMS AND INNOVATION NETWORKS

Coordination mechanisms are viewed as arrangements between economic entities. They govern how these latter may cooperate in order to develop an innovation project (Grandori and Soda, 1995). This definition focuses on interactions on a strategic level rather than on an operational level (such as the distribution of tasks or communication means). Some authors have proposed that coordination within inter-organizational relations can be achieved through a number of mechanisms (Grandori and Soda, 1995; Das and Teng, 1998; Gilsing and Nooteboom, 2006). Different typologies of coordination mechanisms exist: some authors distinguish formal and informal mechanisms, others those allowing exchange regulation from incentive and sanction schemes, or (most frequently) transactional from relational modes. We did not retain any classification for our study, as these distinctions seemed inadequate to analyze the different forms taken by each mechanism¹. As coordination mechanisms are very numerous, it was not possible to be exhaustive. Therefore, we decided to focus on the five most representative and widely studied mechanisms: the type of exchange and degree of formalization, trust, sharing of benefits, guarantees, and conflict resolution² (see Appendix 1).

Type of exchange and degree of formalization. Formal exchange mechanisms include standardized procedures, technical reports, analytical accounting, budgeting and planning methods as well as confidentiality agreements and contracts (Martinez and Jarillo, 1989; Gulati, 1995; Das and Teng, 1998). Informal exchanges, which are implicit and verbal, include the creation of joint teams (Grandori and Soda, 1995), seminars, meetings and staff transfers (Martinez and Jarillo, 1989) as well as decision-making methods. Informal modes are less costly (Gulati, 1995), they increase strategic flexibility and reduce the risk of conflict

¹ For example, conflict resolution may have various arrangements, some formal, others informal: joint resolution (informal), persuasion (informal), coercion (informal), sanctions (formal or informal, but generally formal and planned in the contract), or the recourse to a third party (formal or informal, but generally formal and written in the contract). Another difficulty is linked to the fact that some "informal" arrangements may be provided contractually.

² Many other mechanisms (also sometimes called governance modes) could have been studied, especially of relational nature: common culture, reputation, inclusion in social networks, etc.

(Nooteboom, Berger and Noorderhaven, 1997). However, they require more time to be implemented (Das and Teng, 1998). In an innovation network, any delay may lead to a product becoming obsolete. Contractual theories (transaction costs, positive agency and incomplete contracts) refer mainly to two types of measurement to assess the degree of formalization of exchanges: the existence or absence of a contract and the number of clauses. The various forms taken by the exchanges between members were also taken into account (whether written and explicit or not).

Inter-organizational trust. Trust is defined as an underlying psychological condition that may be the cause or the result of a specific behaviour (cooperation) or choice (risk) (Woolthuis, Hillebrand and Nooteboom, 2005). In line with Mesquita (2007), we believe that inter-organizational trust has a status of its own. Variations in risk and interdependence can both change the degree of trust (Cullen, Johnson and Sakano, 2000). Trust is often considered to have a direct influence on the success of partnerships (Morgan and Hunt, 1994), especially within the uncertain environment of an innovation project where it can serve to predict the network members' behaviour (Ring and Van de Ven, 1994). Unforeseen events occur on a daily basis in innovation networks, making it impossible for contracts to be fully comprehensive and complete. Note that there are multiple degrees between trust and mistrust.

Sharing of results. An essential element in cooperation agreements lies in the definition of how results will be shared among members. An **equitable** division (each member's payoffs are a function of its contribution) is often perceived as an incentive, encouraging project members to work harder, thereby improving the performance of an innovation project (Kabanoff, 1991). On the other hand, an **equal** sharing implies that the two parties (hub firm and member) will receive an equal share of the results (regardless of the investment). Planned *ex ante* or not (an important distinction in the positive agency theory), this distribution can therefore be carried out in a fair or equal manner (cf. theory of incomplete contracts).

Guarantees. These are introduced as prevention systems against opportunistic behaviour. By ensuring that it will be costly for opportunistic members to withdraw from the network, guarantees provide protection against potential damage. Different types of guarantee have been described. Financial integration is not the only way to secure members' loyalty. Other methods include logistic integration (control of capital flowing from a member), media-based integration (promotion of a brand that will be instantly recognized by all the network's customers) and cultural integration (use of organizations that have a relation with the hub firm that is not exclusively economic). Rubin (1990) suggested two types of guarantees: reputation (relational form) and/or specific assets. Future business opportunities also represent a guarantee, as the opportunistic member will experience a downturn in future business in the case of withdrawal. Brousseau (2000) pointed out that not all guarantee mechanisms are contractual by nature, as it is often difficult for a legal authority to determine whether or not the members have correctly fulfilled their contractual obligations.

Innovation networks do not always resort to guarantees. Guarantee mechanisms (direct and indirect) are not mutually exclusive and it is also possible to associate several guarantee mechanisms, especially when the risk of opportunistic behaviour is high. Guarantees can thus be direct, with immediate effect (financial guarantees or specific assets) and/or indirect, with a delayed effect (image guarantees such as reputation, future business opportunities or media and cultural integration).

Conflict resolution. Within an innovation network, it is necessary to consider all possible interactions: two-to-two, one-to-several and several-to-several (Gomes-Casseres, 1994). Hence, if a conflict arises between two technical partners, another member of the network (most likely the project bearer or hub firm) may intercede to resolve the issue. This type of situation has not been addressed in the literature. Conflict resolution mechanisms are therefore more complex in innovation networks. Besides, the level of network members' commitment is very heterogeneous. It is therefore difficult to give an *ex ante* description of a

conflict resolution mechanism. In line with Mohr and Spekman (1994), we retained five conflict resolution mechanisms, which we believe are useful when describing multilateral relations within innovation networks³: (1) Joint resolution of a problem: the different parties agree to work together in order to find a mutual solution to a problem, (2) Persuasion: one of the parties tries to persuade the other members that solution A or B represents the best way to emerge from a conflict situation, (3) Coercion: one partner forces the others to choose its preferred solution for resolving the conflict, (4) Sanction: the network member is expelled, and (5) Introduction of a third party: recourse to arbitration (arbitrator or legal action).

Appendix 1 summarizes the coordination mechanisms and forms as well as the main theories they stem from. A review of the literature highlights the importance of coordination mechanisms so as to offer a better insight into the inner workings of inter-organizational relations and, more specifically, of innovation networks. Research has identified the potential impact of several dimensions (such as hub firm dependence, prior relations and type of conflict) on these mechanisms. However, to our knowledge, no studies have addressed thoroughly the impact on each of these mechanisms and on how they are implemented.

1.2. INFLUENCE OF DEPENDENCE, PRIOR RELATIONS AND CONFLICT TYPE

Three inter-partner relation dimensions have been identified as critical when determining the coordination mechanisms used: dependence (Ambos and Schlegelmilch, 2007), prior relations (Jiang, Gao and Li, 2008) and conflict type (Das and Teng, 2002)⁴.

Dependence. In an innovation network, partners are in a position where they have to share scarce resources, leading to situations of dependency. We defined the “*dependence of an actor A, on another actor B, as directly proportional to A's motivational investment in goals*

³ Mohr and Spekman (1994) added a sixth mechanism for bilateral relations: domination. In our case (multilateral relations), domination is assimilated to coercion.

⁴ Inter-organizational relations are affected by many other dimensions (such as past alliance history, partnership experience, cognitive interpersonal connivance, communication, commitment, type of opportunism, etc.). Our purpose was not to develop an exhaustive list of these dimensions (Jiang, Gao and Li, 2008), but to concentrate on those that appear the most determinant.

mediated by B, and inversely proportional to the availability of those goals to A outside of the A-B relation" (Emerson, 1962: 32). Prior research has attempted to articulate the relationship between the degree of dependence and the level of control that members exert as part of cooperation. Ambos and Schlegelmilch (2007) found that increasing levels of dependence entailed higher levels of socialization and formalization. Other studies (Gencturk and Aulakh, 1995; Baliga and Jaeger, 1984; Gupta and Govindarajan, 1991) have reported a positive relationship between dependence and control. Dependence influences the parties' perception of the benefits they receive (Doz, 1988). The degree of dependence also affects the guarantee systems and conflict resolution mechanisms. Indeed, in dependency situations, partners often adopt coercive and punitive actions towards one another (Kumar, Scheer and Steenkamp, 1998; Lui, Ngo and Hon, 2006). In brief, a high level of dependence will lead to less trust (Kumar et al., 1995), more control (Ambos and Schlegelmilch, 2007), lower continuity of relationship and less cooperative behaviours.

Prior exchange relations. Innovation networks can be created either with unfamiliar partners or through repeated ties with the same partners. With unfamiliar partners (no prior relation), contractual agreements and formal mechanisms are introduced in order to deter opportunistic behaviour. Due to a lack of mutual understanding and trust, partners may feel uncertain about the future of their relation (Ring and Van de Ven, 1994; Doz, 1996; Jiang et al., 2008). Prior relations can be a valuable asset, enabling partners to develop relational capability and capital (Dyer and Singh, 1998). The partners have invested in relation building and have borne set-up costs that would need to be incurred for alternative safeguards (Reuer and Arino, 2007). Familiar partners have developed a better understanding of each other's procedures, management systems and cultures. This mutual understanding can help firms mitigate *ex post* coordination, conflict resolution or information-gathering issues that formal contractual provisions can otherwise attempt to address (Reuer and Arino, 2007). In the same

way, relation-specific knowledge develops from frequent and intense partner interactions, which can enhance the efficiency of cooperation (Dyer and Singh, 1998). Regular relations enhance mutual trust between partners and may reduce the need for contractual safeguards (Gulati, 1995). Such prior collaborative relations can be helpful in avoiding the costs of more complex collaborative agreements (Reuer and Arino, 2007). To summarize, prior relations may lead to commitment and to the development of relation-specific assets such as mutual knowledge of the partners' procedures and values. The repetition of relations over time creates opportunities for mutual learning that, in turn, can lead to the development of trust (Inkpen and Currall, 2004).

Conflict type. In innovation networks, partners have their own individual interests that are not necessarily congruent with their partners' (Das and Teng, 2001). Conflicts often arise in inter-organizational relations due to the inherent uncertainty and interdependencies between parties (Mohr and Spekman, 1994). Conflict refers to the degree of divergence in partners' preferences, interests, and practices (Hardy and Phillips, 1998). Das and Teng (2002) underlined the importance of taking this dimension into account when analysing how cooperation agreements function and how they are coordinated. Conflicts may arise for several reasons, and this will affect the cooperation in different ways. Two main conflict types have been identified (Mooney, Holahan and Amason, 2007):

- Cognitive conflicts appear when partners are in disagreement concerning a given task. For example, in innovation networks, partners can have different views concerning the best-suited technical solutions. In this type of conflict, exchanging ideas during meetings (informal coordination) can be helpful to find a solution (Amason, 1996). Cognitive conflicts generally improve decision-making by fostering mutual understanding (Mooney et al., 2007);
- Affective conflicts involve disagreements of a personal nature, such as power struggles or personal incompatibilities. They arise when private interests and opportunistic behaviour are at

stake. Partners may have incompatible goals that encourage them to maximize their private benefits without furthering common benefits. Moreover, they may adopt opportunistic behaviours in order to appropriate others' tacit knowledge (Das and Teng, 2002). Even if an explicit contract exists, firms often fail to seek legal penalties when conflicts of affective nature arise (Lee and Cavusgil, 2006). Moreover, inter-organisational trust will decrease when one of the partners displays dysfunctional behaviour (Morgan and Hunt, 1994; Lusch and Brown, 1996).

Appendix 2 presents a summary of the literature pertaining to these dimensions and to the coordination mechanism(s) that are affected. **Figure 1** presents our theoretical model.

Insert Figure 1 here

2. SETTING AND METHOD

As the details of each coordination mechanism remain largely unstudied, our aim was to explore them, and their development over time. We provide the methodological details concerning case selection, data collection, coding, treatment and analysis.

2.1. CASE SELECTION

We opted for a qualitative case study methodology as the objective was to gain a comprehensive and in-depth understanding of which coordination mechanism was best suited to the different situations, of differences according to hub firm dependence, prior relations and type of conflict, and also of development over time. The six case studies constitute the theoretical sample (Glaser and Strauss, 1967). Care was taken to select innovation networks of different sizes and in different activity sectors⁵ (see **Table 1**) that nevertheless also shared common characteristics (Miles and Huberman, 1994). All the networks studied here focused on

⁵ Until now, most studies on innovation networks have been undertaken in the sectors of biotechnology or information technologies (Gilsing and Nooteboom, 2006). We selected cases from other sectors, often neglected in the literature.

technological innovation, they were composed of at least three members, were structured around a small hub firm, and comprised members of different sizes, including very large firms. Indeed, asymmetry in size between network members tends to affect how alliance relations are managed (Oliver, 1990).

Insert Table 1 here

2.2. DATA COLLECTION AND CODING

Fifty-three interviews (see **Table 2**) were carried out between March 2006 and February 2008 with members of the six innovation networks: the project bearer and the financial, technical, industrial, commercial and legal members⁶. The 53 semi-directive interviews had an average length of 90 minutes. They were designed to identify the coordination mechanisms implemented by the hub firms. Our analysis was also based on secondary data obtained from internal (e-mail exchanges between project members, internal notes made by the project sponsor when presenting the project progress report, business plan, contracts between members) and external sources (Internet, press articles) so as to achieve triangulation whenever possible. For each case, a range of relations was examined (approximately 100 in total⁷) between the hub firms and the network members. For example, for project A, the hub firm was in contact with 29 technical members: 11 partners and 18 service providers.

Insert Table 2 here

Data from different sources were coded using content analysis procedures (Strauss, 1987). First, we coded all data into a number of categories according to our theoretical model (Yin, 1989). These main categories correspond to the five coordination mechanisms (formalization and type of exchange, trust, result division, guarantees and conflict resolution) and the three

⁶ For confidentiality reasons, we cannot provide the names of the innovation projects. The number of members gives the mean number of members during the year of observation. Note that the term “member” is here used to refer to an organization rather than an individual.

⁷ The lack of precision of the number of relations studied is due to the complexity of the subject of our study. The parties usually referred to a group of members (i.e. the technical members), rather than to individual firms.

dimensions (dependence, prior relations and conflict type). Second, we created subcategories for each mechanism. For example, for conflict resolution, the subcategories are the five modes: joint resolution of a problem, persuasion, coercion, sanction and introduction of a third party. Third, a second researcher recoded the data. Selection of the interviews to be recoded was conducted randomly. Eight interviews were used to support this process control (double coding), that is 15% of all interviews. A check was performed so as to ensure that both coders classified the majority of the *verbatim*s in the same themes.

3. RESULTS AND DISCUSSION

We present here the results pertaining to the influence of the three dimensions on the forms taken by each of the five coordination mechanisms, and on their development over time. We present the results for each of them, and discuss them with regards to the theoretical literature.

Degree of formalization (Figure 2). None of the innovation networks studied is composed exclusively of members with which the hub firm had previous relations. In this case, they had recourse to formal exchanges, at least to a confidentiality agreement to protect their inventions. The hub firm's level of dependence also influenced the degree of formalization of the exchange. Rather informal exchanges were used when the level of dependence was low, as the level of risk for the hub firm was limited. Using informal arrangements was preferred as there are no high costs associated with drawing up the contracts. This solution also facilitates exchange flexibility and adaptability with regards to future development of the innovation project. When the hub firm is strongly dependent, informal arrangements proved to be insufficient and were supplemented by formalized relations. Through formal contracting, the hub firm attempts to reduce the risks linked to possible opportunistic or defective behaviour by members. The degree of exchange formalization changed progressively as interactions between members developed. With a partner that is loyal to the hub firm and shares a common vision of the project, the emergence of informal relations will be promoted. In the case of conflict, the

degree of formalization will be enhanced (addition of clauses to the contract and more formalized exchanges). Indeed, contrary to informal discussions, formal exchanges (contracts, letters, emails, written reports, etc.) are tangible evidence of how cooperation evolves. In the case of dispute, they may constitute evidence for a court or a referee. In the cases studies here we did not observe any development from formal to informal arrangements (only).

Insert Figure 2 here

Discussion. Hub firms select members that possess the highest degree of competence (Mitsuhashi, 2002). They do not necessarily favour partners they know. Formal explicit arrangements set out acceptable behaviour. Contracts may indicate the implementation of other coordination mechanisms, such as the way results will be shared, conflict resolution methods, guarantees, etc. (Poppo and Zenger, 2002). When a hub firm has already cooperated with a member, shared values emerge and transaction costs are reduced (Ring and Van de Ven, 1994). Prior satisfactory business relations diminish relational risk (Das and Teng, 2001). The literature indicates a standardization of exchange formalization (Argyris and Porter Liebeskind, 1999). We also observed this phenomenon in innovation networks as, in order to minimize costs associated with the drawing up of contracts, hub firms tend to sign standard agreements with their providers, and specific agreements with their partners⁸. By establishing the role of the parties, contracts introduce a sense of commitment. They also force members to introduce clauses related to cooperation commitment (van Marrewijk, 2005) and reduce the parties' freedom of action. Our results indicate that contracts offer an incomplete frame. Members were required to carry out tasks that were not foreseen in the contract in order to ensure project viability. Even though contracts represent a sign of involvement in the project, they entail significant costs (for small firms). This explains that, in certain situations, hub firms prefers

⁸ In the innovation networks studied here, partners were clearly distinguished from providers (limited engagement, short-term relationship), whose contributions were nevertheless important.

informal exchanges that are facilitated when repeated interactions have led to the development of personal relationships. A low degree of formalization lowers transaction costs, increases flexibility and reduces the risk of conflict. In the innovation networks studied here, informal arrangements developed through frequent interactions between organizations. However, such arrangements take a long time to be implemented (Das and Teng, 1998). They do not always facilitate cooperation as they cause delays that can render the innovative product obsolete.

Trust (Figure 3). Trust as a means of exchange regulation is favourable to the innovation project provided that previous satisfactory relations have helped establish it. Hub firms tend to be cautious when they are dependent and when no previous relations exist with a specific member. Because of its essential role for the project, this member may be tempted to pursue selfish goals and to take advantage of its position to impose its vision to the hub firm. When a hub firm does not have a positive perception of members' intentions (because of a lack of prior exchanges), this generally involves that it will have high expectations in terms of the members' expertise and efficiency (competence based trust, see Sako, 1992). In the last situation (no prior relation and no dependency), other coordination mechanisms such as guarantees, conflict resolution arrangements or exchange formalization are used. This is often a situation where hub firms test how members behave in a cooperative situation. If the member reaches the objectives set by the hub firm and demonstrates high commitment to the project, then trust can develop. For example, one of the providers of the Motorisation network accepted to execute additional tasks requested by the hub firm, leading to enhanced trust between them.

When all runs smoothly throughout the project, trust will develop; otherwise this will turn into mistrust. Within an exchange relation it is possible for trust and mistrust to alternate. For example, due to unfulfilled commitments in Transports by the trading partner, trust turned

into mistrust. When conflicts related to cooperation are not resolved, this may lead the hub firm to consider the other member as an enemy to which it confronts itself (win-lose game)⁹.

Insert Figure 3 here

Discussion. Over the last two decades, many researches have been undertaken on trust in inter-organizational relations. Trust appears to be positively correlated to successful cooperation. Although it may fluctuate (Ring and Van de Ven, 1994), it increases the level of partner satisfaction (Lei and Slocum, 1992). However, it can also turn into mistrust. Trust and mistrust are positioned at both extremities a continuum (Lewicki, McAllister and Bies, 1998).

The degree of trust that must be established between members is an unwieldy mix (Hamel, 1991). A level that is too high or too low can lead to a lower transfer of resources and skills than what is needed for the project. In both cases, the risks are significant, whether for the project or for the hub firm. Trust must be dosed with caution. Some authors consider this dosage to be a function of the degree of dependence between members. Trust strengthens the level of commitment (Cullen et al., 2000) which, in turn, might intensify the degree of dependence. We also found a link between dependence and trust: hub firms relied on trust when the degree of dependence was low. However, dependence appeared secondary, previous business relations playing a more important role in promoting the reliance on trust (Gulati, 1995; Goerzen, 2007).

Some studies assimilate trust to an informal arrangement (Dyer and Singh, 1998; Martinez and Jarillo, 1989) while others emphasize the complementary nature of contract and trust (Dyer and Singh, 1998; Poppo and Zenger, 2002). In the six cases, trust and formalization were two distinct arrangements which were not systematically linked. Trust did not exclude the existence of contract. However, the existence of *ex ante* trust can reduce the negotiation phase and promote faster progress for the project. Trust therefore should be distinguished from the

⁹ We only included in our configurations those arrangements taken by the hub firm that favoured progress for the innovative project.

degree of formalization. It thus was not possible to conclude that innovation networks that rely on trust outperformed the others. Indeed, some relations that do not rely on trust obtain similar results. For example, in stage 2 the hub firm of Protect mistrusted its industrial partner. However, the latter performed its tasks as well as the industrial partner in which the hub firm trusted.

Trust is thus a coordination mechanism that complements others (formalization, guarantees, conflict resolution, etc.). It does not replace formal arrangements (Poppo and Zenger, 2002). A detailed contract does not appear to harm cordial behaviour and trust (Lee and Cavusgil, 2006), contrary to the idea that a high degree of formalization can destroy trust and exacerbate conflicts (Nooteboom et al., 1997; Woolthuis et al., 2005). In the six innovation networks studied, contracts did not reduce the degree of trust, nor increase the number or the intensity of conflicts. We noted that, on the contrary, contracts could actually facilitate the genesis of trust. Indeed, drawing up a contract requires numerous exchanges. This negotiation phase is often quite long and offers members an opportunity to communicate, to know each other better and to express their motivations and objectives. These interactions during the pre-contract process may encourage the development of trust. Refusing to engage in a contract may even make hub firms suspicious of the members' good faith.

Sharing of results (Figure 4). The distribution of outcomes to which the members agree generally *ex ante*, was equitable in most of the cases studied here. This division is decided upon not only when the hub firm is in a position of dependency but also when it had no previous positive relation with the member. The objective is to encourage members' involvement:

«If you want to work with a company like PSA Peugeot Citroen, it is necessary for its percentage of retribution to be equivalent to its input, otherwise you can always dream that they'll work with you » (hub firm, managing director, Motorisation)

Furthermore, the intangibility of certain resources does not allow for a precise assessment of the level of contribution of each member, making any other allocation method difficult to

implement. Distribution rules are not static. They are renegotiated according to changes in the hub firm's level of dependency and to the trust associated with previous cooperative experience with that member. For example, with its industrial provider the hub firm of Pinc&pile shared the results proportionally to its financial commitment. Trust increased and, when it became a partner in stage 3, the division was balanced – without however becoming equal. The transition from an equal distribution to an equitable division was observed when the partner's level of commitment was less important than what was initially anticipated (as with Telescopic for example). This lack of involvement may be related to a free-riding behaviour (as in Transparts) or to a changes in the resources and skills required for the project. However, when equal distribution was not retained from the beginning, it was not introduced thereafter either so as to avoid potential conflicts that could arise as the result of perceived injustice on behalf of members who have been present and involved since the beginning of the project. However, evolution towards an egalitarian distribution was not observed. Indeed, such a change could have been perceived as being unfair by the initial members who would not have understood this privilege, leading a risk of conflict.

Insert Figure 4 here

Discussion. Before launching the project, the members agree on the respective returns they will be entitled to. Quasi-rent allocation conditions relations. Equitable distribution seems to be a preferred solution for innovation networks characterized by a high degree of uncertainty. Our results show that equity is the only way to introduce certain legitimacy in resource allocation, the issue of fairness being present throughout the life of the project. The importance of the relationship between members' contributions and payoffs, and the sense of distributive justice, is highlighted here. Equitable distribution, seen as an incentive, is supposed to promote project performance (Kabanoff, 1991). The returns are distributed as a function of inputs so as to encourage and reward the most active members: *“equity may be viewed as the means by which*

more powerful parties justify receiving a greater share of outcomes than weaker parties” (ibid: 435). *“It has been argued that equity emphasizes productivity, whereas equality emphasizes cohesion”* (ibid: 421). Equality means that different network members share common values, which creates favourable conditions for maintaining mutual esteem and the development of trust.

Guarantees (Figure 5). Given that cooperative contracts are inherently incomplete and can not *ex ante* anticipate all risks associated with an innovation project, hub firms also have recourse to different types of guarantees. The hub firm identifies the risks associated with the single contract as a means of protection. For instance, in the case of Protect, the hub firm formalized its exchanges with members and also protected itself from potential opportunistic behaviour by using guarantees such as reputation or the purchase of specific machines. In the networks observed for the study, the more dependent the hub firm was, the more it protected itself through a combination of direct and indirect guarantees. The hub firms used such safeguards to prevent against potential opportunistic behaviour on behalf of members that are critical to the innovation project. These guarantees ensured that exiting the network would be costly for the opportunistic members:

« In the contract we specified that the company was to invest in specialised machinery and that we would pay them three months after delivery. So if any problems arose we would have time to identify them and to react. There were also penalties for late deliveries » (hub firm, managing director, Jump)

When a hub firm had no prior knowledge of the member, it used direct guarantees. If the firm was not in a position to harm the reputation of the opportunistic member, it could apply instant penalties punish. For example, in the Motorisation hub firm network one of the technical partners had to purchase a highly specialized machine -a bench- to test the robustness of certain parts. This machine could not be used to test other types of parts: as such it represented a direct guarantee for the hub firm. Apart from direct guarantees, indirect guarantees (such as damaging a member’s reputation) could also be used in order to influence the members’

behaviour. The only case where the hub firm relied essentially on indirect guarantees was when it was dependent and had cooperated successfully in the past with the member. The hub firm of Telescopic, which was dependent on its commercial partner, protected itself only through indirect guarantees. It was not in a position to act when the member was bought out by another firm and subsequently left the project. In the Jump project, the hub firm was in a position to weaken the image of certain members with whom it had close ties. It took only indirect guarantees with one of its technical partners, not only because its competencies were common and easily substitutable, but also because it had previous positive relations with this partner.

The types of guarantee can change in the case of a conflict or if the hub firm manages to reduce its dependence, for instance by requiring a member to invest in specific assets (for Protect: storage areas located in an area chosen by the hub firm; for Jump: purchase of specialized machinery). In the case of conflict resulting from opportunistic behaviour on behalf of a partner indirect guarantees are backed with direct guarantees. This was the case with Transparts where, thanks to its past relation with its commercial partner and its low degree of dependency, the hub firm opted for relations based on trust, informal exchanges and indirect guarantees. However, following the filing of a complementary patent by that partner (patent for powders whereas its own patent concerned solids and liquids), new guarantee procedures and "*Grant Back*" clauses¹⁰ were implemented stipulating that the firm had the right to use (and share the downfall of) any innovation introduced by the members in the course of the project. Conversely, despite the emergence of trust, direct guarantees are generally included in the contract terms and cannot be replaced by indirect guarantees only.

Insert Figure 5 here

¹⁰ A « grant back » clause is defined as a “provision in a licensing agreement under which the licensee is required to disclose and transfer all improvements made (including related know-how acquired) in the licensed technology during the licensing period” (<http://www.businessdictionary.com/definition/grant-back-clause.html>).

Discussion. In the networks studied, the types of guarantee were not limited to financial guarantees; they were also extended to specialized assets and image. Within uncertain environments these assets can modify the degree of interdependence between the parties, especially in innovation networks. By forcing a member to invest in specific assets the hub firm may decrease its dependency. Using its central position within the network, it can also affect other members' reputation and their future business opportunities. The reputation that precedes an organization through the effects of third parties represents one way of generating trust. In the cases studied here, reputation was distinct from trust. It was a means of contributing to the establishment and maintenance of trust. When cooperation was a key objective for members - this strategic importance being a source of dependency - they developed intangible assets more than physical assets (Zaheer and Venkatraman, 1995). In our results, trust did not appear as a guarantee that could be substituted to others. The more dependent the hub firm, the more it tended to preserve itself through a combination of direct and indirect guarantees, as the fact that a member may exit the network may jeopardize the project.

Conflict resolution (Figure 6). When a conflict situation arose, which can occur at any time in the course of an innovation project, the hub firm took resolution measures which differed according to the hub firm's degree of dependence and to the type of conflict involved: related to the project (cognitive nature) or to the cooperative relation (affective nature).

- *Conflict linked to the project with a non-dependent hub firm:* the six hub firms highlighted the need to communicate with their partners in order to resolve conflicts, to "*calmly solve them through dialogue*". If any issues remained unresolved following discussion (joint resolution), the hub firm attempted to persuade the members to adopt its own choice. If the solution retained fails to satisfy all members, this could entail a loss of motivation for some members, leading to the risk of opportunistic behaviour.

- *Conflict linked to the project with a dependent hub firm:* the hub firm's patents do not represent a sufficient guarantee to ensure bargaining power with all members. In a situation of dependency, persuasion flows from the member to the hub firm. The influential member convinces the hub firm to adopt a solution (investments for instance) that is favourable to its own interests. For example, in the Jump project, it is the technical partner that chose the material (plastic components) according to its own interest.
- *Conflict linked to the cooperation with a non-dependent hub firm:* when a partner displays minimal commitment and acts opportunistically, the hub firm generally prefers for it to leave the project, since it can easily select another partner. This sanction is faster than engaging in potentially lengthy discussions, which could affect the project's progress. The solution that consists in replacing a member is no more expensive than rebuilding a relation that has been destroyed by treachery.
- *Conflict linked to the cooperation with a dependent hub firm:* the hub firm uses coercion or a third party (referee or court) to solve the conflict. Due to its dependence, it must surround itself with members so that, together, they can force the defaulting member to surrender. In addition to coercion, it may also appeal to an arbitrator¹¹, provided that this has been specified in the contract. Otherwise, it will appeal to the courts, where a third party (the judge) will settle the dispute. Such arrangements leave little hope of reviving cooperation among members. A settlement through the courts was used in Pinc&pile and Transparts. In both cases, it resulted in the departure of the defaulting member. This procedure has two drawbacks: it is long (legal proceedings may exceed the duration of the project), and costly, especially for small firms. The hub firm used this method as the contract did not contain an arbitration clause and because the conflict was linked to betrayal.

¹¹ Arbitration is a non-state dispute settlement. It is a method of resolving disputes through an arbitration tribunal composed of one or more arbitrators (usually three). The referee is a judge whose decision is binding on the litigants (<http://www.legalis.net/ata/html/cours.html>).

Insert Figure 6 here

Discussion. Conflicts erode trust, they reduce employee satisfaction, preventing them from carrying out the innovation project in time and undermining the level of commitment in the relation (Cullen et al., 1995). These phenomena are often emotionally charged, their complexity is difficult to grasp using the sole approach of contractual theories. Indeed, these theories offer two main conflict resolution methods: revocation (exit) or court. This view is simplistic compared to the terms found in the case studies. Joint resolution after discussions can also be used, provided that each party accepts the dialogue. Joint resolution is interesting only if the outcome is satisfactory for the members involved. Otherwise, it can prove to be unnecessary and even detrimental to the project as entails a loss of time and frustration. In innovation networks, the relations are not necessarily dyadic and other strategies of influence can come into play, such as persuasion or coercion. For instance, if a conflict arises between a hub firm and its technical partner, the firm may call upon other technical members to lead the partner in the desired direction (Motorization). This type of situation has not been considered in the literature on conflict resolution, which focuses on bilateral relations (Mohr and Spekman, 1994).

Conflict resolution takes place through the gradual use of the five types: joint resolution, persuasion, coercion, penalties, recourse to a third party. Members start by negotiating before turning towards harsher techniques (Mohr and Spekman, 1994) such as coercion or punishment. This graduation was observed in our cases when the conflict was related to the project (Motorization) - but not when it was linked to cooperation (Pinc&pile). In the latter situation, the hub firm used the more drastic solutions (sanctions or court) directly (Transparts).

Tuten and Urban (2001) proposed to extend Mohr and Spekman's model (1994) to include the existence of previous relations as a moderating variable. Resolution methods are "softer" (joint resolution and persuasion) when partners have been in a long-term relationship,

and "harder" (exit or court) when the firms have had only casual relationships. For the innovation networks studied here, previous relationships did not have a significant effect on the conflict resolving methods. In both cases where the disputes were settled before the courts (hard method) the hub firm had maintained long-term partnerships with the members concerned. The type of conflict and the degree of dependency seemed to have more influence than previous relationships over the type of method used.

CONCLUSION

The present study investigated the impact of three dimensions (hub firm dependence, previous business relations, type of conflict) on five coordination mechanisms and the forms that these latter can take. We found that the degree of formalization and trust varied essentially according to the existence of previous positive relationships, result division and guarantees according to the hub firm's dependence degree. Our results provide additional knowledge not only concerning these five coordination mechanisms, but also concerning the different forms these may take and how they can develop throughout the duration of the innovation project. For example, in the early stages a small hub firm is likely to be highly dependent upon the other network members but, as the project develops, it may manage to reduce its dependence, which will affect the coordination mechanisms that were established initially. It is possible to generalise the results:

- With respect to the formalization of exchanges, contracts are inherently incomplete in the case of innovation networks (cognitive incompleteness). With regards to the incomplete contract theory (Grossman and Hart, 1986), sometimes it will not be interesting to draw up a more exhaustive contract as beyond a certain point the marginal cost of the added clauses will become higher than their benefits. However, it is striking to note that the small size of hub firms does not seem to affect the degree of formalization;

- Trust is linked to formalization. In our cases, trust and contracts are complementary, not substitutes;
- Regarding the sharing of the results, contrary to other forms of cooperation for innovation (R&D consortia or exploration partnerships for instance), the innovation networks under study resorted essentially to equitable division. The form of result division chosen seemed to vary according to the more or less fundamental nature of the R&D undertaken. In our case, patents were filed: in a development phase the resources and contributions of each member can be more precisely defined (Gilsing and Nooteboom, 2006);
- Regarding guarantees, reputation was used often, probably due to the small size of the hub firm that would not make it possible for it to harm a defaulting or opportunistic member. Most guarantees were therefore included in the contracts; indirect guarantees were not often used. It would be interesting to analyze whether such guarantee mechanisms vary in the case of an innovation network with competitors. Reputation or cultural integration would probably play a much more important role, as competitors operate in the same economic environment and are often culturally close;
- Regarding conflict resolution, the literature on interorganisationnel cooperation considers that discussion favours cooperation. In innovation networks, this solution is interesting only if all involved members are satisfied; otherwise, it can harm the project as it can entail delays and may lead to members' frustration. The literature on conflict identifies *neglect* (Turnley and Feldman, 1999) as one solution for solving conflicts. In innovation networks, especially during the development phase, with major time constraints, this type of practice (frequent in franchise relations for instance) was not been observed;

Despite these results, our study carried several limitations. First, we analyzed a specific context where the hub firm was also the organization that had registered the patent(s). Our study concerned six European hub firms and it may not be possible to generalise the results to all hub firms, especially in other countries, as intellectual property laws and cooperation

mechanisms may differ. Secondly, we did not address the intensity of the innovation concerned: exploitation or exploration. As the degree of uncertainty grows with the degree of novelty, it is likely that coordination mechanisms will also vary according to the type of innovation. Thirdly, we analyzed the hub firm's degree of dependence without studying the degree of dependency of other members. Further research taking into account the degree of dependence of all network members could shed further light on these aspects. Quantitative studies could also be undertaken on this subject, using more refined Likert scales for measuring coordination mechanisms and the degree of dependency.

Coordination mechanisms are also used in other types of networks (such as clusters or R&D consortia). A comparison between the different forms of cooperation for innovation could provide insight on the specificities of the underlying coordination mechanisms for each form, thus making it possible to verify their relevance in heterogeneous contexts. Indeed, these forms may develop in environments that are not all as uncertain or may not carry such high strategic stakes, and which may vary according to the type of financing. It could also be of interest to study whether the mechanisms are affected when there are several hub firms (e.g. an architect, a lead operator and a caretaker) in an innovation network. Finally, other dimensions that may have an impact on coordination mechanisms could be studied, such as the potential role of the hub firm leader's personality and/or personal networks, which are important for maintaining a reasonably varied and large pool of trustworthy potential members among whom to find members eligible for more tightly-coupled action-oriented networks (Grandori and Soda, 1995).

Our results have managerial implications in terms of how hub firms select the type and form of coordination mechanism they use. Based on the degree of dependency, the existence of previous positive relationships, a strategic combination of the five coordination mechanisms can be formulated, that evolves with the emergence of conflicts. This study advocates in favour of further research on this important topic in our innovation-based economies.

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APPENDIX 1 Coordination mechanisms and forms in an innovation network

Coordination mechanism	Mode	Underlying theory (s) *	Definition
Exchange formalization (Lee and Cavusgil, p. 901)	Formal	Contractual theories and trust approach	The use of a formalized, legally binding agreement or a contract to govern the inter-firm partnership.
	Informal		The role of discussion, commitment, and relational capital in the governance process.
Trust (Mesquita, 2007, p. 73)	Trust	Relational and contractual theories	The confident positive willingness of one to be vulnerable to the conduct of another in conditions of interdependence and risk. "Confident positive" means that one will purposefully act on the basis of another's conduct, "interdependence" means that one cannot realize the expected economic outcomes without cooperation with the other, "risk" refers to the probability of loss as perceived by the decision maker. The decision to be vulnerable occurs when the trustor believes in the trustee's abilities, benevolence, and integrity.
	Distrust		Stands for confident negative willingness to be vulnerable to the conduct of another under conditions of risk and interdependence.
Result division (Jap, 2001, p.89)	Equal	Agency theory and incomplete contractual theory	This rule specifies that each party receives an equal share of the payoffs—a 50/50 split.
	Equitable		An equity rule specifies that each member's payoffs are a function of its resources - tangible and intangible contributions, costs incurred, etc. - to the collaboration. They are derived from equity theory (Adams 1965; Walster, Walster, and Berscheid 1978), which states that people judge an outcome as fair when the ratio of their own resources and output equals the ratio of resources and output of others.
Guarantees against opportunistic behaviour (Brousseau, 2000)	Direct	Contractual theory	With immediate effect. They can control the behaviour of members.
	Indirect	Contractual theory	With an impact at $n + 1$. They are based on the ability to harm the reputation of a member or to exclude a future business opportunity.
Conflict resolution (Mohr and Spekman, 1994, p. 139)	Discussion	Relational theories	Joint problem solving. Different groups come together to find a mutual solution for a problem.
	Persuasion	Relational theories	Partners attempt to persuade each other to adopt particular solutions.
	Coercion	Relational and contractual theories	One or many partner(s) restrain the others from choosing the conflict resolution solution.
	Sanction	Contractual theories	Excluding the partner from the innovation network.
	Third party arbitration	Contractual theories	A third party (arbitrator or court) provides the solution.

APPENDIX 2**Dependence, prior relations and conflict type**

Authors	Dimension	Coordination mechanisms
Gencturk and Aulakh, 1995 Baliga and Jaeger, 1984 Ambos and Schlegelmilch, 2007 Gupta and Govindarajan, 1991	Dependence	Formalisation / control level
Kumar et al., 1995	Dependence	Trust and confidence
Doz, 1988, Siriam et al., 1992	Dependence	Sharing of benefits
Lui et al., 2006	Dependence	Guarantee systems
Kumar et al., 1998 Lui et al., 2006	Dependence	Conflict resolution mechanisms
Ring and Van de Ven, 1994 Inkpen and Currall, 2004	Prior relations	Trust
Doz, 1996 Lui et al., 2006	Prior relations	Formalization
Gulati, 1995	Prior relations	Trust / contractual safeguards
Klein, 1980	Prior relations	Safeguards
Reuer and Arino, 2007	Prior relations	Conflict resolution mechanisms
Amason, 1996	Conflict type	Conflict resolution / formalisation
Lee and Cavusgil, 2006	Conflict type	Formalization
Morgan and Hunt, 1994 Lusch and Brown, 1996	Conflict type	Trust

Figure 1. A theoretical model of dependence, prior relation, conflict type and coordination mechanisms

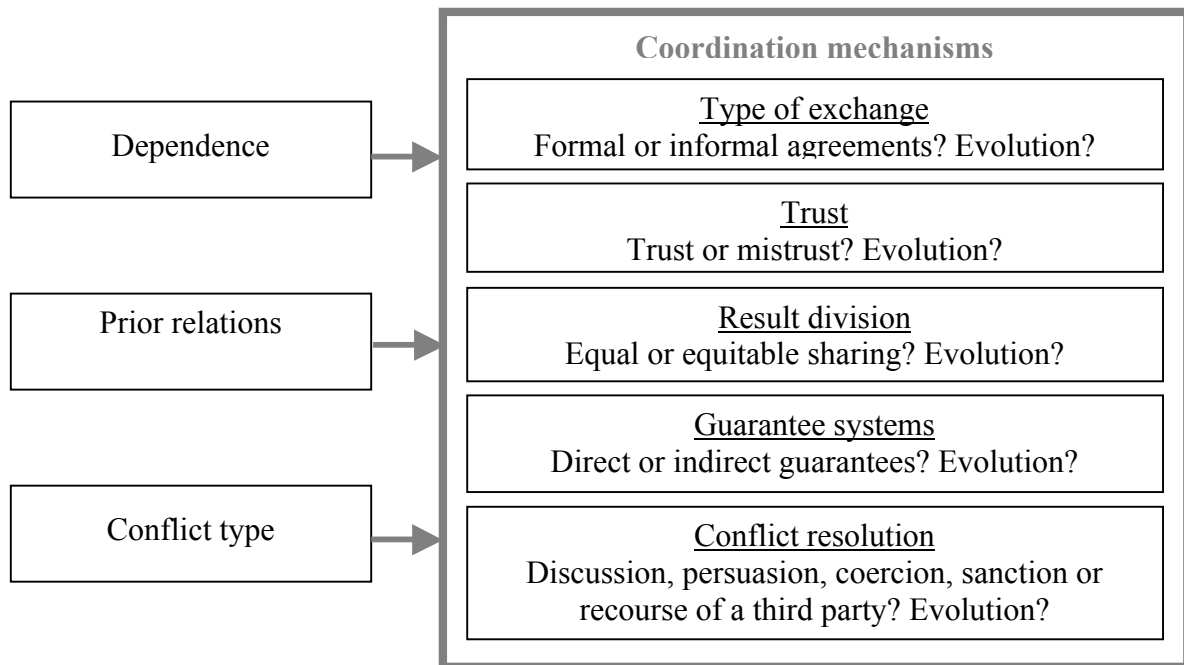


Figure 2. (Re)Defining the degree of formalization

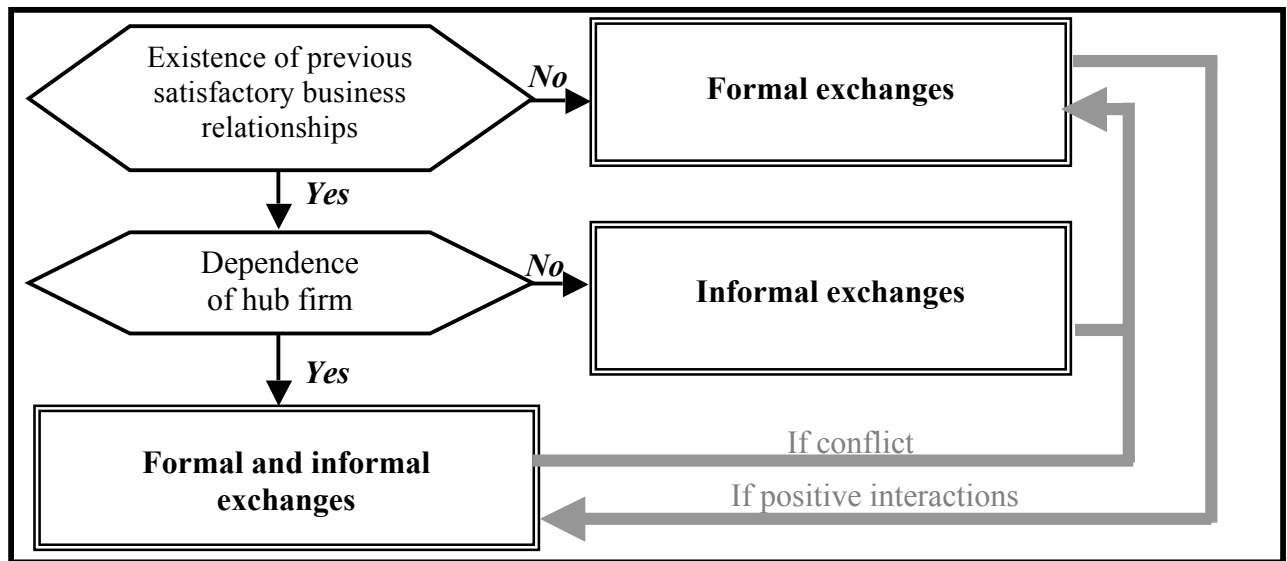


Figure 3. (Re)Defining trust

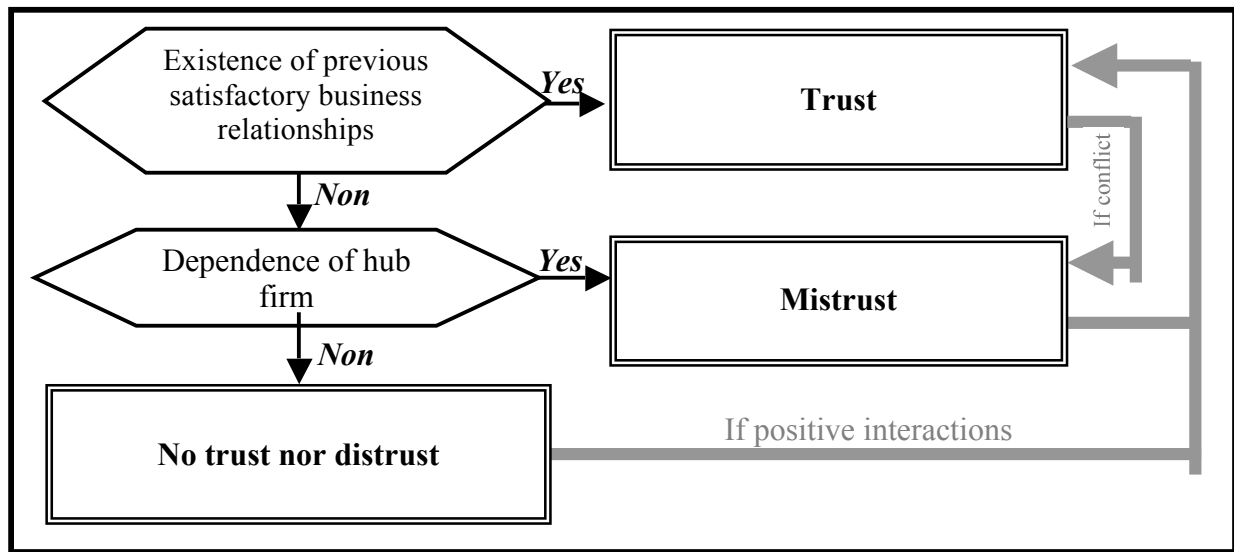


Figure 4. (Re)Defining result division

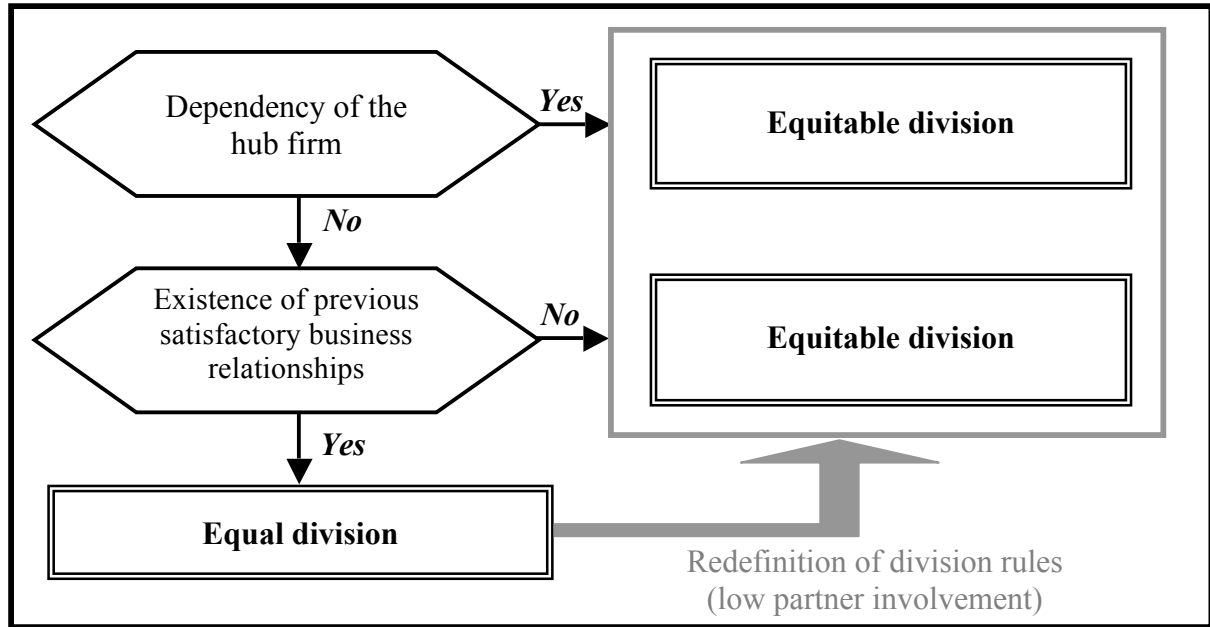


Figure 5. (Re)Defining guarantees

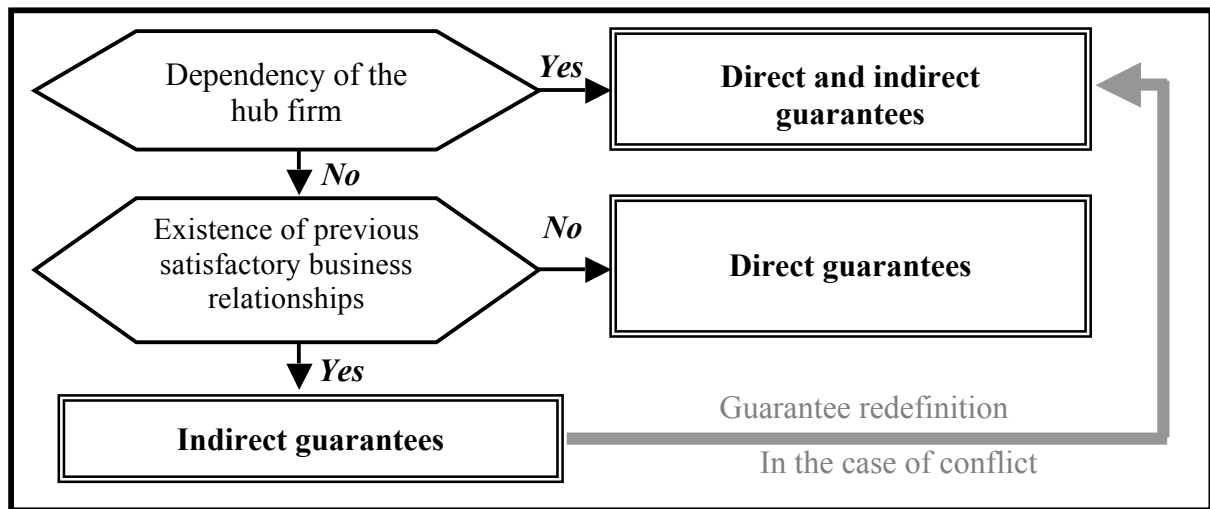


Figure 6. (Re)Defining conflict resolution forms

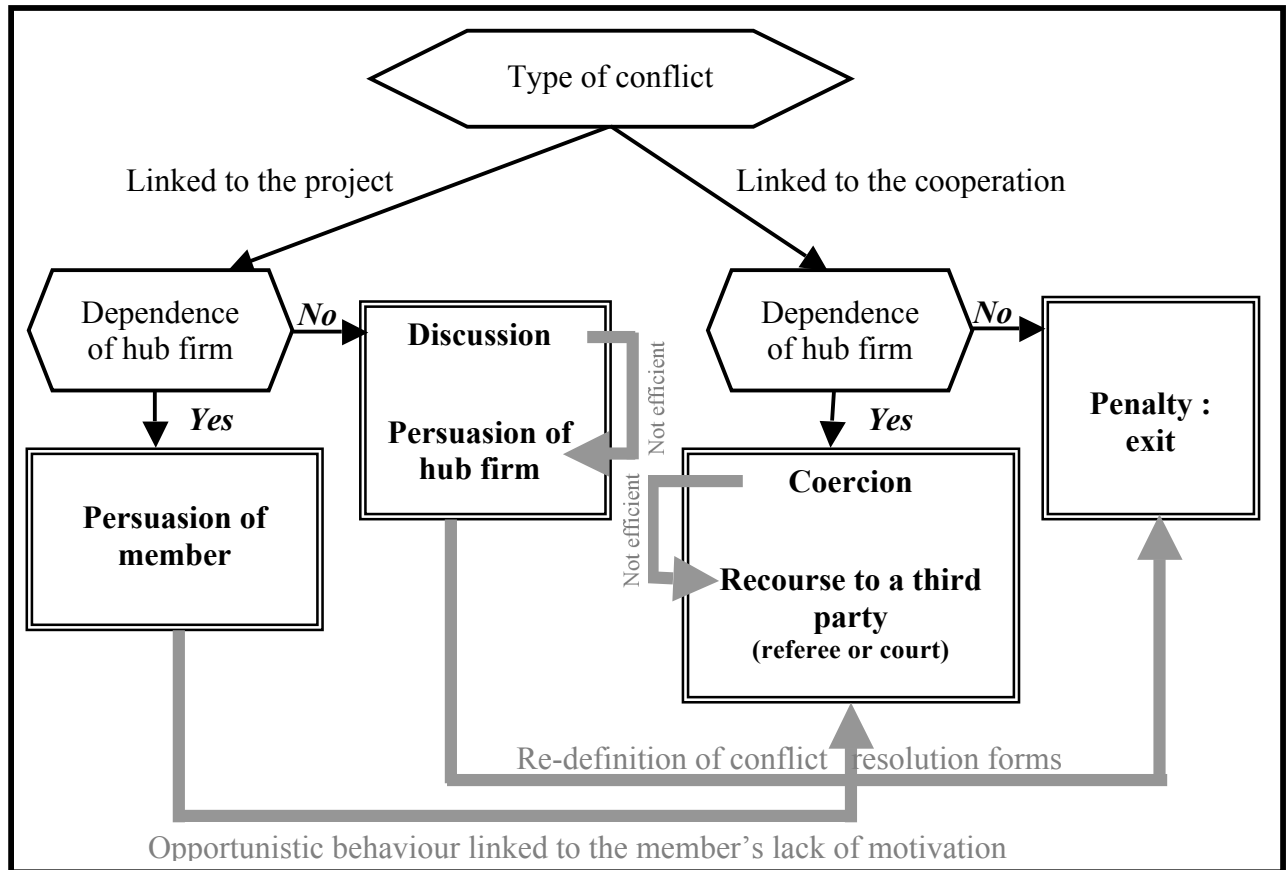


Table 1. The six innovation networks studied

Project	Hub firm	M*	Subject	Business sector	Characteristics
Project A Motorisation	SME (12 people)	65	Essential component for automobile manufacturers	Automotive	Highly ambitious project: very high investment and highly technical
Project B Pinc&Pile	SME (2 people)	8	Product for beauticians (B to B)	Large-scale retail	Very conflictual situation: the commercial and industrial partner was claiming property rights on the patents already filed
Project C Telescopic	Independent (1 person)	11	Product for every-day use	Large-scale retail	Stagnant project: Oligopolist target market leading to distribution problems
Project D Transparts	SME (3 people)	9	Machine improving the processing of small parts	Industry	Opportunistic behaviour of a commercial partner: complementary patent filed without notification
Project E Protect	SME (6 people)	24	Protection for sports	Sports and leisure	Project that was running successfully without too many problems
Project F Jump	Independent (1 person)	6	Sports material	Sports and leisure	The hub firm benefited from the experience of another project sponsor

* Number of members

Table 2. Data collected pertaining to the six innovation networks

Information sources	Primary data		Secondary data	
	Interviews	Passive observation (frequency and cumulated total duration)	Internal data	External data
Motorisation (A)	13 including 5 hub firms 5 technical members 2 financial members 1 industrial member	Very frequent 7 days	Contracts (7) Funding request files (2)	Internet site 54 press articles ¹²
Pinc&pile (B)	9 including 3 hub firms 2 legal members 1 technical member 1 financial member 2 industrial members	Frequent 3 days	Contracts (3) File for innovating project contests (1)	20 press articles
Telescopic(C)	6 including 2 hub firms 1 legal member 2 technical members 1 financial member	Not frequent 1 day	Meeting reports (8) Email exchanges (50)	Internet site 28 press articles
Transparts (D)	7 including 2 hub firms 2 legal members 2 financial members 1 commercial member	Not frequent 1 day	Email exchanges (25) Legal mails from lawyers (13)	Internet site 12 press articles
Protect (E)	10 including 4 hub firms 1 legal member 3 technical members 1 industrial member 1 commercial member	Very frequent 5 days	Contracts (16) Email exchanges (10)	Internet site 35 press articles
Jump (F)	8 including 2 hub firms 1 financial member 2 technical members 1 industrial member 2 commercial members	Not frequent 2 day	Contracts (3) Email exchanges (20)	Internet site 8 press articles

12 Gathering secondary data was facilitated as hub firms had already done this in view of various presentations, financial requirements, etc.