

Working paper

(presented at the International Network for Network Analysis Conference:
Comet Catherine, Emmanuel Lazega, Marion Selz, 2008, « R&D Partnerships as Social
Exchange », INSNA Conference, St Pete, Floride)

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**R&D partnerships as social exchange:
The structure of mutual exchanges and the management of uncertainties**

Catherine Comet, Clersé, Université Lille 1
Emmanuel Lazega, IRISSO, Université Paris-Dauphine
Marion Selz, Centre Maurice Halbwachs

Keywords: R&D, inter-firm partnerships, innovation networks, knowledge sharing

Introduction

Firms in Research and Development are devoted to increase stocks of knowledge in order to devise new applications and products. While they relate to sectors as various as Agriculture, Manufacturing or Finance and Insurance, their common strategic resource is knowledge. Moreover, they very frequently rely on partners to develop their innovations, insofar as knowledge is almost always distributed among several organizations, mainly research institutes, universities, other R&D firms, suppliers, or customers. As a consequence, the management of partnerships is a critical issue in the innovation process. Firms face important risks linked to notable and long-term investments. They have not only to select reliable partners with staying capacity, but also to manage interdependencies and communication problems. Different options are available to them to manage those uncertainties. According to Transaction Cost Theory (Williamson 1985), firms would better resort to contractual agreements. In contrast, we argue that R&D partnerships raise uncertainties that cannot be easily dispelled with contracts and that firms may privilege relational embeddedness to secure knowledge exchanges. The more uncertain the exchanges, the more embedded (Granovetter 1985), even if embeddedness is costlier than contracts for managers.

We analyze the mutual exchanges in inter-firm partnerships from a survey¹ on inter-firm relationships, conducted by the Ministry of industry and the Ministry of Research in France. Exchanges convey different kinds of resources (knowledge but also staff, raw materials, equipments, buildings). Knowledge exchanges appear particularly reciprocal and symmetrical. We then compare the structure of mutual exchanges according to sectors (industry or services) and to the integration of the partnership inside a group or not. The more uncertain the exchanges, the more reciprocal and multiplex.

Inter-firm networks and knowledge sharing

R&D partnerships generate many uncertainties, which may essentially be due to the specificity of the assets exchanged and to the risks related to partners' opportunism. Indeed knowledge exchanges are strategic for R&D firms, and the uncontrolled diffusion of knowledge may threaten their competitive advantage. However R&D firms have to collaborate with partners to foster their innovation capacity. Under those conditions, the Transaction Cost Theory predicts that firms would privilege contracts in order to alleviate the uncertainties weighing on transactions (Williamson 1985): integrating the activity within their organization would be more efficient than relying on markets, because of transaction costs. In contrast with this approach focused on contracts, economic sociology highlights the role of relational embeddedness to secure transactions (Williamson 1985, DiMaggio and Louch 1998). Uncertainties increase the need for social embeddedness of exchanges rather than for contracts: firms would rather use structural solutions to tackle the problems related to opportunism and bounded rationality, insofar as contracts cannot efficiently protect uncertain transactions, even if social embeddedness is costlier in time and energy.

The importance of social networks for innovative firms is widely recognized. Innovation studies focused extensively on clusters (Saxenian 1994, Llobera et al. 2000, Hamdouch 2009) and alliances (Gulati 1998, Borgatti and Foster 2003). Most researches study the consequences of social networks on innovation (Shan et al. 1994, Powell et al. 1996, Ahuja 2000, Owen-Smith et al. 2002, Owen-Smith et al. 2003, Chesborough 2003, Burt 2005) or on the performance of innovative firms (Baum et al. 2000, Stuart 2003). Fewer investigate the selection process of partners and the cause of structural patterns (Gulati 1995, Stuart 2000, Kogut 2000, Oliver 2001). Interorganizational networks are often considered as conduits to

¹. Emmanuel Lazega and Catherine Comet participated in the Users Committee of this survey (*Enquête sur les relations interentreprises 2002*), which designed the questionnaire.

access various resources, as information. More essentially, they are structural patterns that enable organizations to coordinate. As a consequence, they may depend on the characteristics of technologies in an industry as well as on social norms and institutional factors. Bruce Kogut (2000) shows how technologies and property rights in particular may influence the emergence and the stability of economic networks. While governance configuration determines the imputation of profits among cooperating organizations, it may also affect inter-firm partnerships.

The variety of R&D partnerships

We analyzed data from a survey on partnerships of French firms. Partnerships are defined as an inter-firm relationship, which must involve a minimum of cooperation, whether formalized through a contract or not, as opposed to simple client-supplier relationships. We selected only firms in R&D, whose main partners are other firms, research institutes, technical centres and non profits.

The sample comprises 1.600 R&D firms. Interviewees had to answer questions on their firm and on its three main partners. The survey thus provides information on the sampled firms (specialization, size, number of partners), on their partners (type, location, reasons for selection), on the type of relationship (joint research, subcontracting, multipartnership, joint venture), on the exchanged resources (staff, knowledge, raw material, equipment, buildings) and on the collaboration result (publications, patents, new products). Half of the sampled firms declared at least one partnership: 264 firms described one relationship, 131 described two and 409 described three. Globally, data provide information on 1.753 partnerships, which are the unit of analysis in our study.

These partnerships do vary to a great extent. We distinguish five categories of partnerships thanks to a hierarchical clustering with the four following variables: length, location, type of partner, and form of agreement.

- The first category comprises two thirds of the partnerships. It mainly relates to outsourcing for specific needs. It mostly covers subcontracting, but also joint research. Partners are essentially R&D firms and public labs, mostly located in France and often in the same region or local area.
- The second category gathers one fifth of the partnerships. It contains a majority of multipartnerships. Besides partners are mostly located abroad and are often research consortiums. The firms from this category more frequently relate to services for enterprises.

- The third category (7% of the partnerships) mainly refers to long-term partnerships relying on a joint venture.
- The fourth category (4%) only refers to partnerships with non profits.
- The fifth (3%) mainly relates to manufacturing of producer goods.

The structure of mutual exchanges

To demonstrate our arguments, we analyze the content of mutual exchanges. We name the focal firm Ego and its partner Alter. In next tables, we consider what kind of resources is brought by Ego to acquire a specific kind of resource (e.g. knowledge) from Alter. Each cell refers to the percentage of partnerships in which a resource A is exchanged for a resource B. In the survey, R&D partnerships never relate to non-reciprocated transfers².

R&D partnerships are particularly knowledge-intensive. Knowledge transfers and sharing are prevailing: Half of the partnerships relate to transfers of knowledge from the focal firm to its partner (252 partnerships), from the partner to the focal firm (230) or to a symmetrical exchange (375). We can observe in the Table 1 that knowledge is the most frequent money used by Ego as well as Alter to obtain any other resource - staff, raw material, equipment or buildings. The percentages of the column “knowledge” are higher than the percentages of the other columns, as well as the percentages of the line “knowledge” toward those of the other lines. Knowledge transfers are highly symmetrical. The most frequent type of mutual exchange is knowledge for knowledge: Two fifth of the partnerships imply exchanges of knowledge for knowledge, and a similar part of raw material for knowledge. From this point of view, knowledge exchanges differ from the exchanges of other resources, which are less symmetrical³.

More generally, exchanges are rather reciprocal and the resources given by Ego and those given by Alter are relatively balanced. The main difference is that the focal firms are more interested in the equipment of their partners than the reverse. The transfers often convey several resources: More precisely, there are as many multiplex transfers (conveying several resources) as uniplex tranfers (conveying only one resource). Because of idiosyncratic investment, even equipment and raw material may often be specific assets, whose transfers

² There are actually 5 non-reciprocated transfers for 1.753 partnerships in the survey. R&D partnerships depart from simple market exchanges and tend to be more similar to social exchange (see Blau 1964). They are rarely one-shot transactions and often tend to be long-term engagements. However two fifth of the survey respondents did not cite any resource transferred, nor received.

³ Symmetry refers to mutual exchanges of the same resource, whereas reciprocity refers to exchanges which are reciprocated, but not necessarily with the same money.

are preferably embedded in other exchanges. It may then increase interdependencies among partners, strengthen their partnerships, and thus secure their exchanges. As interdependencies become stronger among partners, the cost of defection increases, and the threat of sanctions (i.e. exclusion) becomes more credible as well.

Table 1: The mutual exchanges of resources in R&D partnerships (N=1.753)

ALTER/EGO	Staff	Knowledge	Raw material	Equipment	Buildings
Staff	7.2%	9.6%	8.9%	5.6%	4.3%
Knowledge	12.3%	21.4%	19.3%	12.1%	7.1%
Raw material	9.6%	15.6%	9.1%	9.7%	6.4%
Equipment	9.1%	14.5%	13.4%	8.0%	4.4%
Buildings	4.0%	5.6%	5.3%	3.0%	2.7%

The structure of mutual exchanges according to categories of partners suggests that R&D firms exchange specific resources with their partners according to their category. Partnerships are specialized. Knowledge is preferably supplied by public research centres and non profits. The partnerships with public research centres are more knowledge-intensive than any other kind of partnership. Nearly 30% of these exchanges are mutual knowledge sharing. Moreover knowledge is often exchanged for staff (19% of the partnerships with labs). Exchanges of raw material and equipment for knowledge are also frequent (respectively 27% and 18%). When partners are non profits, relationships are even more knowledge-intensive yet. In this case, knowledge transfers are highly reciprocal: 37% of the partnerships are reciprocal exchanges of knowledge. This may illustrate a specificity of the institutional organization of research in France, where researchers are mostly concentrated in public research centres.

Nevertheless most partnerships occur with other R&D firms, which often bring knowledge for staff, similarly to partnerships with labs. The structure of these exchanges is close to the mean structure in Table 1. Unfortunately it is not possible data to distinguish competitors among these partners in the survey. We can only presume that they may often be competitors, because of the strong interdependencies among competitors in particular toward knowledge (von Hippel 1987).

Reversely, partnerships with technical centres as well as with firms without R&D are seldom motivated by knowledge transfers. Rather, ego often exchanges knowledge for equipment

with technical centres and for equipment, raw material and to a lesser extent staff with non-R&D firms. Partnerships with consortiums do not offer significant variations with the mean structure.

Table 2: The mutual exchanges of resources according to categories of partners

	ALTER/EGO	Staff	Knowledge	Raw material	Equipment	Buildings
R&D Firms (N=879)	Staff	7.7%	9.9%	9.3%	7.3%	5.6%
	Knowledge	10.1%	19.2%	17.9%	10.1%	6.8%
	Raw material	12.1%	18.5%	10.5%	11.9%	8.6%
	Equipment	8.4%	11.8%	9.9%	7.2%	4.7%
	Buildings	3.8%	4.4%	4.6%	3.1%	3.1%
Research centres (N=381)	Staff	7.1%	9.7%	8.4%	4.2%	2.9%
	Knowledge	18.6%	28.6%	27.3%	18.4%	8.9%
	Raw material	7.1%	11.5%	7.6%	7.3%	3.4%
	Equipment	12.1%	17.6%	19.4%	11.0%	4.5%
	Buildings	4.5%	6.3%	5.8%	3.4%	2.4%
Technical centres (n=196)	Staff	4.6%	8.2%	8.7%	3.6%	2.0%
	Knowledge	8.2%	15.8%	14.8%	8.2%	3.6%
	Raw material	4.1%	7.7%	3.6%	2.6%	2.6%
	Equipment	7.1%	18.9%	18.4%	7.7%	2.6%
	Buildings	3.6%	8.2%	8.2%	2.0%	2.0%
Consortium (N=140)	Staff	9.3%	8.6%	5.7%	4.3%	2.9%
	Knowledge	12.9%	23.6%	14.3%	12.1%	6.4%
	Raw material	6.4%	12.9%	12.9%	10.7%	3.6%
	Equipment	7.9%	10.7%	10.7%	6.4%	5.0%
	Buildings	3.6%	3.6%	2.9%	3.6%	2.9%
Non-R&D Firms (N=92)	Staff	8.7%	13.0%	12.0%	5.4%	7.6%
	Knowledge	7.6%	9.8%	15.2%	7.6%	7.6%
	Raw material	14.1%	22.8%	4.3%	13.0%	9.8%
	Equipment	10.9%	21.7%	12.0%	7.6%	5.4%
	Buildings	7.6%	10.9%	6.5%	2.2%	2.2%
Non profits (N=65)	Staff	3.1%	7.7%	9.2%	1.5%	0.0%
	Knowledge	21.5%	36.9%	21.5%	20.0%	10.8%
	Raw material	7.7%	18.5%	15.4%	7.7%	6.2%
	Equipment	7.7%	18.5%	18.5%	6.2%	3.1%
	Buildings	1.5%	7.7%	7.7%	1.5%	1.5%

The management of uncertainties

In this part, we analyze if the structure of these mutual exchanges may or not vary according to sectors – industry *versus* services – and to the integration of the partnership inside a group. The partnerships of industrial firms sharply differ from those of firms in services. The partnerships from firms in services are more knowledge-intensive and more reciprocal. One third of the partnerships in services convey knowledge mutual sharing against one sixth in industry. The exchanges of industrial firms involve fewer resources in general. R&D partnerships in services may be more uncertain and complex. Property rights are also more difficult to enforce. As a result, they are more likely to be embedded in multiplex and reciprocal exchanges.

Table 3: Exchanges in industry and in services

	ALTER/EGO	Staff	Knowledge	Raw material	Equipment	Buildings
Industry (N=1.140)	Staff	4.6%	7.4%	7.5%	3.8%	2.6%
	Knowledge	8.0%	14.8%	14.3%	8.2%	4.1%
	Raw material	4.7%	7.6%	4.7%	4.9%	3.2%
	Equipment	6.4%	12.5%	11.3%	6.1%	3.2%
	Buildings	1.9%	4.0%	4.0%	1.7%	1.7%
Services (N=613)	Staff	12.2%	13.9%	11.4%	9.1%	7.3%
	Knowledge	20.2%	33.6%	28.5%	19.2%	12.6%
	Raw material	18.6%	30.3%	17.3%	18.6%	12.4%
	Equipment	14.2%	18.4%	17.3%	11.4%	6.5%
	Buildings	7.8%	8.6%	7.3%	5.4%	4.6%

Exchanges are more knowledge-intensive with partners outside the group. Symmetrical exchanges of knowledge in particular represent one sixth of the partnerships inside the group, but nearly one fourth of those outside the group. The fact that exchanges may be more secure inside the group does not foster knowledge transfers. Firms may have been forced into partnerships with firms inside the group by their holding company, which may not promote intense collaboration. Nevertheless this tendency contradicts the predictions of the Transaction Costs Theory.

Moreover partnerships with firms outside the group do not only convey more knowledge, but also more resources in general. Exchanges are more multiplex with partners outside the group rather than inside the group. As partnerships outside the group may be more uncertain, strengthening interdependencies with partners may thus be a structural solution used by firms to protect their exchanges. Indeed greater multiplexity and reciprocity translate a higher degree of social embeddedness.

Table 4: Exchanges inside the group and outside the group

	ALTER/EGO	Staff	Knowledge	Raw material	Equipment	Buildings
Alter belongs to Ego's group (N=473)	Staff	8,7%	9,9%	8,7%	6,3%	5,3%
	Knowledge	10,6%	15,6%	13,3%	7,8%	6,3%
	Raw material	9,5%	14,0%	7,0%	8,9%	7,4%
	Equipment	8,2%	11,6%	9,7%	6,6%	5,1%
	Buildings	5,1%	6,6%	5,7%	3,8%	3,6%
Alter does not belong to Ego's group (N=1.276)	Staff	6,7%	9,6%	9,0%	5,4%	3,9%
	Knowledge	12,9%	23,5%	21,5%	13,6%	7,4%
	Raw material	9,6%	16,2%	10,0%	10,0%	6,0%
	Equipment	9,5%	15,7%	14,8%	8,5%	4,2%
	Buildings	3,6%	5,3%	5,2%	2,7%	2,4%

Conclusion

Most studies on innovation networks generally scrutinize the structure of networks and their impact on performance or innovation but overlook the content of exchanges. Nonetheless the type of resources exchanged is not negligible. These analyses of the resources conveyed through R&D partnerships show that knowledge transfers and sharing in particular respect rules on status and reciprocity. Besides knowledge is a crucial resource for R&D firms that may manage these exchanges with external partners very carefully. They appear to privilege relational embeddedness rather than contracts. While R&D partnerships are very knowledge-intensive, knowledge exchanges are highly reciprocal and symmetrical. More generally, partnerships often convey multiple resources. However the structure of exchanges varies according to the uncertainties faced by firms. The structure of exchanges among R&D firms diverges between industry and services. The exchanges from firms in services appear significantly more knowledge-intensive and more multiplex, whereas the exchanges from

industrial firms involve fewer resources. R&D partnerships in services are more embedded in multiplex exchanges, since these partnerships are more uncertain and complex and since property rights are more difficult to enforce. In addition, exchanges are more knowledge-intensive and more multiplex outside the group, even if exchanges may be more uncertain outside the group. As a result, relational embeddedness and social exchange are more frequently employed than contracts to manage uncertainties, despite that they are costlier for managers in time and energy.

These results may enlighten the bias of most studies on innovation networks, whose data are based on contracts. They plead for a broader perspective, which integrates informal dimensions of partnerships management. The approaches based on contracts may produce interesting results on the choice of partners and on the effects on innovation for instance, but they cannot totally catch how firms do manage the uncertainties they face in these partnerships. One important question deals with the partnerships with competitors. We could not distinguish in the survey those among the partners that were competitors from those that were not. The more multiplex the exchanges, the more long-lasting. Nevertheless competition may interfere in knowledge exchanges and may trigger divergent relational trajectories. These hypotheses should be tested with longitudinal studies.

References

- Ahuja G., 2000. « Collaboration networks, structural holes and innovation: a longitudinal study », *Administrative Science Quarterly*, 45(3), pp. 425-455.
- Baum J. A. C., Calabrese T., Silverman B.S., 2000. « Don't go it alone: alliance networks composition and startups' performance in Canadian biotechnology », *Strategic Management journal*, 21(3), pp. 267-294.
- Blau P. M., 1964. *Exchange and Power in Social Life*. New Brunswick: Transaction Publishers.
- Borgatti S. P. & Foster P. C., 2003. « The network paradigm in organizational research : A review and typology », *Journal of Management*, 29(6), pp. 991-1013.
- Burt R. S., 2005. *Brokerage and closure. An introduction to social capital*. New York, Oxford University Press.

- Chesborough H., 2003. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press.
- DiMaggio P., Louch H., 1998. "Socially embedded consumer transactions: For what kinds of purchase do people most often use networks?", *American Sociological Review*, 63, 619-637.
- Granovetter M., 1985. "Economic action and social structure: the problem of embeddedness", *American Journal of Sociology*, 91(3), 481-510.
- Gulati R., 1995. "Social Structure and Alliance Formation Patterns: A Longitudinal Analysis", *Administrative Science Quarterly*, 40, pp. 610-652.
- Gulati R., 1998. "Alliances and Networks", *Strategic Management Journal*, 19(4), pp. 293-318.
- Hamdouch A., 2009. "Networking, clustering and innovation dynamics in the global economy: general presentation", *Journal of Innovation Economics*, 2, pp. 5-13.
- Kogut B., 2000. "The network as knowledge: Generative rules and the emergence of structure", *Strategic Management Journal*, 21, pp. 405-425.
- Lazega E., 2001. *The Collegial Phenomenon – The social mechanisms of cooperation among peers in a corporate law partnership*. Oxford and New York: Oxford University Press
- Llobrera J., Meyer D., Nammacher G. 2000 « Trajectories of industrial district: Impact of strategic intervention in medical district », *Economic Geography*, Vol. 76, pp. 68-98.
- Oliver A.L., 2001. "Strategic Alliances and the Learning Life-cycle of Biotechnology Firms", *Organization Studies*, 22(3), pp. 467-489.
- Owen-Smith J., Powell W., 2003. « Knowledge networks as channels and conduits: The effects of spillovers in the Boston Biotechnology Community », *Organization Science*, 15(1), pp. 5-21.
- Owen-Smith J., Riccaboni M., Pammolli F., Powell W., 2002. « A comparison of U.S. and European University-industry Relations in the Life Sciences », *Management Science*, 48(1), pp. 24-43.
- Powell W., Koput K., Smith-Doerr L., 1996. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology", *Administrative Science Quarterly*, 41, pp. 116-145.
- Saxenian A.L., 1994. *Regional advantage. Culture and competition in Silicon Valley and Route 128*. Cambridge, Harvard University Press.
- Shan W., Walker G., Kogut B., 1994. « Interfirm cooperation and startup innovation in the biotechnology industry », *Strategic Management Journal*, 15, pp. 387-394.

- Stuart T. E., 2003. « Governing strategic alliances » In Buskens V., Werner Raub and Chris Snijders (Eds). *Research in the Sociology of Organizations*. 20th ed. JAI Press, pp. 189-208.
- Stuart T. E., 2000. "Interorganizational alliances and the performance of firms: a study of growth and innovation rates in a high-technology industry", *Strategic Management Journal*, 21(8), pp. 791-811.
- von Hippel E., 1987. "Cooperation Between Rivals: Informal Know-How Trading", *Research Policy*, 16, pp. 291-302.
- Williamson O. E., 1985. *The economic institutions of capitalism: Firms, markets, relational contracting*. New York and London: Free Press.