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The Austrian Theory of Institutions Applied to Science-Industry Relationships: The Relevance of Innovative Institutions

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Abstract. This contribution aims at using an Austrian approach of institutions to discuss specific institutional arrangements in the current working of science-industry relationships. By combining distinctive characteristics between Menger's and Hayek's research programs, we establish a typology of institutions that goes beyond the usual way to approach business institutions and allows us to identify transitory types of institutional arrangements called "innovative institutions". We apply that Austrian approach of institutions and address its relevance to highlight some puzzling issues derived from empirical evidence. Then, innovative institutions reveal particularly suited to understand how public and private research work together in science-industry relationships.

Key Words: innovation, entrepreneurship, institutions

JEL classification: B53, L33, M13, O31.

1. Introduction

This paper aims at applying an Austrian approach to institutions to the analysis of specific forms of relationships that recently developed among academics and industrial companies. These relationships are designed to pursue the general purpose of creating and promoting new "science-based" products and processes. In that respect, they are refractory to standard economic analyses of science-industry relationships referring to the notion of scientific knowledge as a public good fuelling from academic institutions to firms through information flows. Actually, science-industry relationships take the form of institutional arrangements co-organized by public researchers and private firms, the very object of which being the joint creation of knowledge that does not exist beforehand, even in the realm of basic research. Modern theories of organization (principal-agent theory, property rights theory and transaction cost economics) seem appropriate to deal with such a phenomenon for two reasons. They focus on contractual relations, and some of them use incomplete contracts which seem to be fitted to the uncertain outcomes of R&D joint ventures. However, this body of theory is open to different shortcomings that relate to technological change (Langlois 1988) and the treatment of knowledge (Foss 1999). Moreover, these theories do not really raise questions concerning either the emergence of institutions or how they can evolve in the future. The central aim of our paper being to promote a clear-cut understanding of the emergence and the evolving of new forms of science-industry institutions, we suggest to

complement modern theory of organizations with an Austrian approach to institutions. In fact, the latter allows to make explicit the problems of innovation and knowledge creation in relation to the analysis of the genesis and evolution of institutions.

In order to apply an Austrian theory of institutions to that purpose, we first suggest an original framework elaborated from the works of Menger on "organic" and "pragmatic" institutions and Hayek on "orders" and "organizations" (Section 2). This framework is used as an heuristic device which encapsulates the results of modern theories of organization and, at the same time, opens the analysis to the definition of a new form of institutions. *Innovative institutions*, as we call them, complement the set of business institutions usually dealt with in the standard literature such as firms, markets and interfirm cooperations. The term "innovative institutions" is particularly suited to those peculiar arrangements between public and private research to be found in science-industry relationships. This means that innovative institutions are neither identical to other institutions, nor somewhere in-between. In fact, the process of knowledge creation implemented by innovative institutions makes them essentially informal and transitory, their very nature being to transform into a more classical form of business institution at the end of the creative process. In Section 3, we discuss the diverse profiles of evolution for innovative institutions, depending on the different institutional solutions adopted by agents involved in science-industry relationships. At the end of the process, when the problem of knowledge creation is over, agents choose to settle down into more "standard" business institutions. A first alternative is to create a firm, for instance start-ups from academics; a second alternative is to rely on market relations in the form, say, of patents or licenses; the last alternative is to organize hybrid modes of governance such as more complex and formal R&D cooperative agreements between firms and academia.

2. Science-Industry Relationships in the Light of an Austrian Analysis of Institutions

In the realm of science studies, and according to the distinction drawn by Callon (1995) between economists' "cold" and sociologists' "warm" approaches, economists seem to be mainly interested in the analysis of states of the world where bargaining is the dominant means of reproducing the nature of interactions, whereas sociologists are much more interested in the setting up of processes that will produce these interactions.[1] Following that perspective, a number of French scholars from the "Ecole des Mines" ("Centre de Sociologie de l'Innovation") published case studies about interactions and partnerships between public researchers and firms that result in "entrepreneurs-researchers", that is individuals who choose to move from public research to private entrepreneurship. This issue is somewhat specific to French public management of research, but in fact these studies establish larger results that help to the understanding of institutions located at the interface of science and industry. To highlight that empirical evidence, an Austrian perspective is particularly suited to those approaches to science studies. We shall see that the vision of economics as a process, which lies at the heart of the Austrian economic tradition, is very appropriate to the economic study of science-industry relationships, where the problem is basically the progressive setting-up of new forms of institutions designed to create markets and productive innovations. In this section, we first review the most significant empirical patterns of those

forms of science-industry relationships, and second, we propose an analytical framework inspired by an Austrian theory of institutions in order to treat these observations more properly.

2.1. The Setting-up of Relationships between Science and Industry: The Notion of Innovative Institutions Emerging from Empirical Observation

In-depth empirical studies focusing on contractual agreements between public and private research (Mustar 1991, Cassier 1995a, 1995b, 1997, Quéré and Ravix 1997a) and on the understanding of larger research institutional contexts (Gambardella 1995, Flésia 1996, Joly, Lemarié, and Mangematin 1998) can be used to draw the main characteristics, peculiarities, and difficulties to implement those kinds of contractual agreements. First, they are really uncertain at the outset, and they allow for a mutual discovery, which can be called "science in action", as Cassier (1995a) puts it, referring to Latour (1989). Second, differences between initial skills and capabilities held by the partners involved are of great significance for the working as well as the innovative outcome of the process. Third, those contracts aim at setting-up new knowledge emerging from that joint action which can be purely tacit or partly embodied in particular artifacts progressively shared and used by each of the partners. Fourth, the temporal dimension of the contract is a very important issue because it allows the partners to organize the transition from a private toward a public statute of the knowledge resulting from the initial partnership, i.e. to organize the protection of the results through the reservation effect of the contract. This latter issue is particularly crucial because the difference between the time when the results remain purely privatized and the time when the same results will be diffused for public use is strategically important for the companies concerned. During this time period, the company needs to take decisions (to patent partly or totally those results, to pursue research investigations, to implement results in empirical applications, and so on). Therefore, Cassier (1995b, 1997) emphasizes this time lag as an essential issue in order to benefit from any contractual partnership between public science and private research. In that respect, the author provides an interesting distinction between private data, pooled data, and public data.[2]

Learning from the empirics of science-industry relationships (and of related contractual agreements) calls for a necessary change in the analytical perspective. The usual way to discuss issues such as basic research and R&D agreements in a standard framework is to address the problems of optimizing the timing of innovation processes and identifying information structures and related incentives alignments (Lazear 1996). However, this approach does not fully cope with the main characteristics of science-industry relationships underlined by the above empirical observations, particularly since the uncertainty underlying the process of discovery of new scientific and technological resources is neglected, as well as their progressive transformation into actual productive resources. Such difficulties remind criticisms from Kreps (1996) who emphasizes that, contrary to a common statement that transaction-cost analysis has been translated in the mathematical language of game-theory, even the models that appear to him the most fruitful to consider life-like phenomena (i.e. adaptive co-learning models) miss important aspects of this issue because they "stick rigidly to the standard rules of our toolkit" (Kreps 1996:592). Then, phenomena like bounded rationality, social embeddedness, interactive learning cannot be fully captured through those models.

A more appropriate perspective to deal with science-industry relationships can be drawn by implementing two core analytical shifts: the first one is to move from information to knowledge by considering the latter as the central component of science-industry relationships. In that respect, what is at stake among the partners involved is less an exchange of information but the production of new knowledge resulting from the process of interacting diverse components. In fact, the emergence of new knowledge becomes the result of a discovery process which is organized by the partners themselves: hence the problem of science-industry relationships is not one of managing information, but of creating knowledge (Quéré and Ravix 1996). The other analytical shift is to move from an approach of adaptive learning among different partners towards considering the actual character of interactive learning by coping with the social embeddedness of the production of knowledge (see Lundvall 1985, 1988). This has to be done by enlarging the scope of the interactions among partners like scientists and companies and considering the institutional infrastructure into which those interactions occur. Both shifts result in putting a central emphasis on innovation as a process, i.e. as a discovery procedure for which uncertainty and new knowledge resulting from interactive learning among various partners are central characteristics to be faced by the analysis.

At the end of the process, science-industry relationships may result in various tangible economic outcomes such as contractual agreements, personal expertise, but also patents, new start-ups, or other organizational designs joining public and private resources. That variety of results appear as unintended outcomes of the underlying process of innovation, and they cannot actually be thought of as resulting from a planned procedure that could exist from the start of the innovation process. The tangible outcomes of science-industry relationships are hardly predictable at the start and need to be considered as resulting from an uncertain process of interactive learning, i.e. as a joint discovery procedure from which innovation results.

In that case, the production of new knowledge cannot be fully captured by identifying actors' interactions to face-to-face exchange of information. Indeed, as sociologists' science studies put it, the understanding of interactive learning requires to take into better account the environmental framework which is made of objects, equipment, and other artifacts. Our point is to argue that, among these artifacts, institutional arrangements must play a major role in the analysis. This is a further reason why the understanding of science-industry relationships can benefit from an Austrian theory of institutions.

2.2. Science-Industry Relationships: An Austrian Institutional Framework

In a situation of economic change and innovation, innovation processes cannot be but described as a sequence of interrelated activities which outcomes are progressively constructed along a discovery process. All along this sequence, agents are subject to "process uncertainty" (Quéré and Ravix 1996:276), meaning that the uncertainty bears on the points of arrival of the innovative process (Amendola and Gaffard 1988). The fact that those points of arrival cannot be known in advance implies that they are not analytically meaningful; it is the analysis of the process itself that counts, and the way by which the coordinative action of business institutions progressively orient and structure this process over time (Loasby

1976). It follows that the economic analysis of innovation can benefit from an institutional approach of economic change.

In the case of science-industry relationships, the creation of new knowledge and resources, and the organization of related future markets are targets for innovative processes which outcomes are not predictable in advance. This is why it is necessary to concentrate the analysis on processes, i.e. on the way through which institutions emerge and structure innovative behaviors. The analysis of institutions that is needed is an "organic" conception of institutions in the line of Menger and Hayek (Langlois 1986), rather than the "comparative institutional analysis" embodied in transaction-cost economics *à la* Williamson. The reason for such a choice is that there is no place for the temporal dimension of production in a Williamsonian approach and, consequently, for any innovation process (Lazonick 1991). Transaction cost analysis is still referring to allocative rationality aimed at identifying the best solution to the efficient distribution of resources. On the contrary, within an organic approach *à la* Menger-Hayek, the economic analysis of institutions includes the temporal dimension of economic activities and, indeed, *process uncertainty* in a much more effective way.

In that respect, the coordination of economic activity becomes a central analytical problem and we need to remind here that Austrian analyses of institutions concentrate on that issue by emphasizing the importance of knowledge. For instance, Hayek [1948 (1937)] develops a subjective theory of individual behaviors that obviously distinguishes the problem of resource allocation from that of coordinating agents endowed with different pieces of dispersed knowledge. Thus, that argument also works to express the role played by business institutions: knowledge of "different times and place" is coordinated by the "market order" through competition considered as a "discovery process" (Hayek [1948 (1945)], 1978). Therefore, institutions are not a means of ensuring an efficient allocation of transaction costs or property rights; they become a means of facing the uncertainty economic activity is confronted to, by conducting a process of trial and error.

However, the characteristics of that very process of institutional coordination can be thought of as the combination of two intertwined but different problems, emerging from the comparison of the Mengerian and Hayekian research programs: that of the origin of institutions, and that of their evolution (see Langlois 1986, 1995, Garrouste 1994). Interestingly, those two complementary aspects cover a significant distinction between the Hayekian and Mengerian research programs which proves to be rather heuristic to highlight the specific character of institutional coordination in the case of science-industry relationships.

Menger [1963 (1883)] differentiates between "organic" forms of institutions or systems of rules, and "pragmatic" institutions. The former emerge spontaneously from the pursuit of individual actions without any collective and conscious will: they are "the unintended result of human efforts aimed at attaining essentially individual goals" (Menger 1963 [1883]:133); as such, they have an organic origin in that their collective outcome is not initially planned. The latter are consciously and voluntarily designed by individuals: they are "organized" from the outset in the sense that they are resulting from an initial common will: "they are the results of a common will directed toward their establishment" (Menger *ibid.*:133). Thus, the mode of explanation used by Menger to distinguish social phenomena is basically to divide institutions according to their origin and to the way they emerge. Here, we need to cautiously

distinguish that problem of the origin of institutions from that of their structures, a distinction made by Menger himself (*ibid.*:146), "there are a number of extremely significant social phenomena which are of "organic" origin (. . .) However, (. . .) they cannot be grouped in common as 'organic structures' and interpreted accordingly". Thus, Menger saw in the origin of institutions "the most important problems of the theoretical social sciences in general and of theoretical economics in particular" (*ibid.*:147).

On the contrary, Hayek (1967) dissociates institutions mainly along their purposefulness. Basically, Hayek's research program encompasses the understanding of "the relations between the abstract rules which the individual follows in his actions, and the abstract overall order which is formed as a result of his responding to the concrete particular circumstances which he encounters, within the limits imposed upon him by those abstract rules" (Hayek 1965, quoted in Machlup [1991 (1974)]:212). Consequently, "orders" like markets are unintentionally resulting from individual actions; they are emerging organically as unintended consequences of purposeful individual actions. Thus, their implementation does not follow a collectively designed purpose: they result from a non-purposive implementation from the outset. At the opposite, "organizations" are, as such, deliberately implemented by individuals and, as a result, are submitted to more concrete and directive rules of functioning (like the firm for instance): they are directed by purposive implementation.

This twofold distinction, of course, does not display the exhaustiveness of Menger's and Hayek's analyses of institutions but it reveals particularly suited to highlight the analysis of science-industry relationships. Indeed, that distinction allows to qualify different kinds of business institutions by dissociating institutional patterns according to their origin (Menger criteria) and to their implementation (Hayek criteria) (cf. Quéré and Ravix 1997b). In Figure 1, the horizontal axis expresses the Hayekian criteria: it dissociates institutions

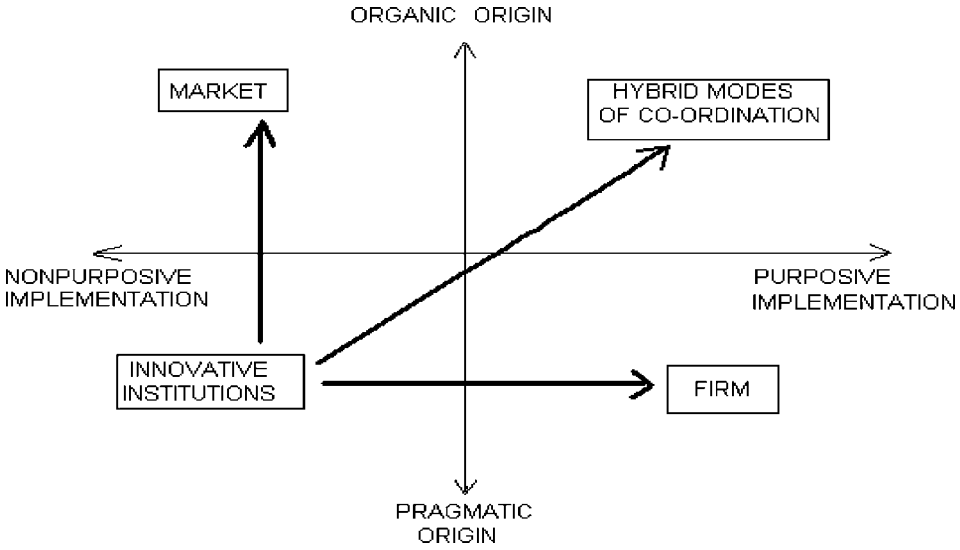

Figure 1. Innovative institutions: Analytical framework.

along their purposive or non purposive implementations; the vertical axis is the Mengerian one: it opposes institutions along their organic or pragmatic origins.

That mapping induces the following discussion:

The North-West quadrant includes organic institutions and spontaneous orders common to Hayek's and Menger's approaches. The traditional example of institutions endowed with such characteristics is the market as an institution emerging "organically" and regulating spontaneously economic activity (money, as defined by Menger [1995 (1892)], also belongs to this type of institutions). At the opposite, the South-East quadrant includes pragmatic institutions deliberately implemented as organizations, the archetypal form of which is the firm. The North-East quadrant is regrouping the so-called "hybrid" modes of governance belonging to the *continuum* between firm and market as defined by Williamson (1985); these institutions are concerned with a purposive implementation but their origin is organic rather than pragmatic, in the sense that they are issued from the pursuit of individual interests rather than from a collective common will: the existence of those hybrid modes implies for each partner to keep first into account his/her own interest. In that respect, it cannot be but an organic origin. Any cooperative agreement among agents (be they contractual agreements, joint R&D or marketing ventures) have an organic origin in that they exist only because each partner involved is motivated by the need to pursue his/her own individual interests. Otherwise, if they were the result of an *ex ante* collective action (i.e. if they had a pragmatic origin), they should have to be logically considered as an organization like the firm, and formally located in the South-East quadrant.

Finally, the South-West quadrant includes institutions which are at the same time pragmatic at their origin and non-purposive in their implementation. These institutions are deliberately created to pursue a collective task, that of creating knowledge. They are labeled "innovative institutions" because they are facing process uncertainty and implement processes for which the future outcomes are unknowable at the outset. For these reasons, they are analytically different from more standard forms of cooperation such as R&D joint-ventures which are located in the North-East quadrant of the figure. Many kinds of science-industry relationships appear as relevant illustrations of innovative institutions. For instance, the substantial aim of cooperation between academics and companies' scientists is often not defined *ex ante*. When an initial aim is expected, it is no more than an informal target in that cooperation's result is often unintended knowledge applied to other purposes than those initially expected. In that respect, the institutional form supporting the implementation of this type of cooperation, that we call innovative institutions, is very different from those defined in the other quadrants.

Besides that taxonomy of institutions, the above figure makes also possible a systematic ordering of different theories of economic institutions. Thus, confronting the North-West and the South-East quadrants expresses the former bimodal vision of transaction cost analysis opposing the market and the firm as alternative stable modes of coordination regulating economic activity (Williamson 1975). In a complementary perspective, the North-East quadrant expresses hybrid modes of coordination which, following Williamson (1985), also appear as stable coordinating devices, such as inter-firms cooperation, alliances, subcontracting, and the like. This threefold distinction of business institutions was already introduced by Richardson (1972) who provided a clear-cut justification of cooperation as

a business institution complementing the firm and the market for coordinating industrial activities.

The peculiarity of those three types of business institutions lies in their stable and well-defined characters. On the contrary, "innovative institutions" can be opposed to those three traditional institutional forms of coordination because they are structurally unstable. The South-West quadrant cannot find its place in the standard neo-institutionalist literature, because this literature is not open to cope with the problem of process uncertainty and to address the problem of business institutions emerging in a context of economic change and innovation. Innovative institutions correspond to a discovery procedure and, as such, they are a means of facing and progressively solving process uncertainty. Therefore, they are unstable in the sense that they cannot be but transitory; sooner or later, they necessarily need to evolve and move toward a more stable and predictable form of coordination, whatever its final result (market, firm or usual modes of cooperation).

The interest of our typology lies essentially in the fact that it complements the modern theory of organization with an Austrian analysis of institutions. The former body of theory is useful enough to analyze the institutional structure of industry in a stable context. However, in a context of economic change, the comparative efficiency of different modes of coordinating economic activity is less significant than the dynamic evolution of innovative institutions, that is the understanding of the mechanisms allowing to move from an unstable toward a more stable institutional device. This is the problem that we address to in the next section.

3. The Relevance of Innovative Institutions for the Understanding of Science-Industry Relationships

Our previous analytical considerations allow to identify a type of institutions that is not usually considered in the economic literature. We have called them "innovative institutions", as they organize today the emergence of knowledge stemming from science-based activities. The specific character of innovative institutions lies in their intrinsic instability: innovative institutions are "pragmatically" designed to create knowledge and they are implemented along a discovery procedure that result at least in a more stable and predictable form of coordination, whatever their final forms (market, firm, or cooperation). Then, what is required by the analysis is not only to characterize innovative institutions as another specific mode of coordinating economic activity, but to understand the determinants that organize and conduct their evolution, that is the mechanisms allowing to move from an unstable toward a more stable institutional device. According to Figure 1, processes followed by innovative institutions starting from the South-West quadrant have alternative points of arrivals in the neighboring quadrants. The process of 'institutional improvisation' (Cole 1968) that characterizes the development and evolution of innovative institutions necessarily results in more stable modes of organizing future economic activities.

What becomes essential is the understanding of the determinants for such a process. In fact, the issue is twofold: first, one needs to identify what types of institutional arrangements

appear as points of arrival for innovative institutions starting from the limbo of science-industry relationships; second, one has to discuss the mechanisms that drive the evolution of innovative institutions towards one or the other more stable modes of coordinating economic activities resulting from that evolution.

3.1. Science-Industry Relationships: The Different Points of Arrival for Innovative Institutions

The previous analytical framework can be adapted to take into account the different coordination designs that result from specific innovative institutions to be found in science-industry relationships. This can be expressed in Figure 2.

The evolution of unstable innovative institutions can result in a diversity of stable forms of points of arrival belonging to different (but traditional) modes of coordinating economic activities in the field of science-industry relationships.

An usual point of arrival is the establishing of a new company, a start-up that allows a scientist (or a group of scientists) to test the feasibility of new products or activities. This procedure can be a purely individual or collective process of establishing the conditions for a new company to exist and be profitable. However, the creation of a start-up is not the only explicit means of implementing scientific capabilities in stable organizations (private companies). An individual scientist can also move from his/her research institution toward a full-job position inside an already existing company: in some cases, innovative institutions experiment potential productive opportunities but do not sufficiently result in effective productive outcomes. Those are situations where innovative institutions do not sufficiently vanish the process uncertainty associated to their implementation. In that case,

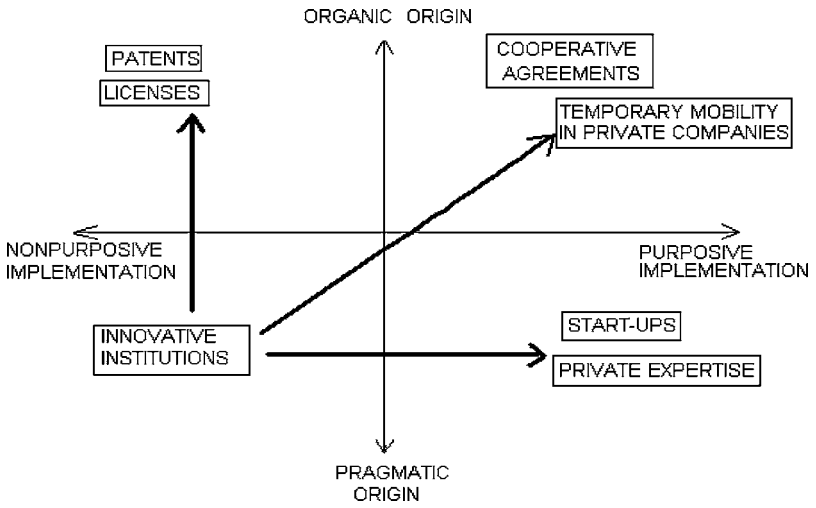

Figure 2. Innovative institutions: Empirical framework.

individual scientists can decide not to engage in a specific start-up but to complement his/her capabilities with others technical or financial requirements already existing and working in private businesses. As a consequence, from the scientist viewpoint, taking a position within an existing company can be thought of as a more secure process for developing private capabilities and business from his/her research expertise.

Another point of arrival is one which allows scientists to use market mechanisms more directly. This is a situation where the scientific content is encapsulated in artifacts like patents or licenses because the accumulated expertise is not sufficiently secured from the viewpoint of its industrial feasibility. The latter does not offer to academics a clear vision of what could be done from a profitable viewpoint. As a consequence, individuals do not identify sufficient incentives to move from public research institutions toward a more unsecured context (the industry). However, deciding to protect their scientific knowledge under the form of a patent or a license makes explicit the fact that scientists consider that this knowledge can potentially be useful for further productive and profitable applications. As such, innovative institutions result in scientific expertise embodied in specific "products" (patents or licenses) that can be traded onto a market. Selling licenses or patents to a private company is thought of as the most acceptable solution to cope with the uncertain profitability associated to the industrial implementation of new scientific capabilities. Note that such a point of arrival addresses the question of who will benefit from the return expected from the concerned patents or licenses. A recent trend in the contemporary working of academic institutions lies in the decrease of individual patenting whereas academic institutions have developed more effective technology transfer offices that become very professional in their ability to manage such processes.

Finally, points of arrival exist which allow both types of partners (academics and companies) to preserve future options opened. Joined processes of cooperation or temporary mobility of individual scientists toward companies appear as institutional arrangements that, at the same time, aim at establishing the conditions for sharing discovery procedures and allow to keep open further opportunities by preserving individual interest for each of the partners involved. In that case, innovative institutions contribute to establish the required conditions for cooperative agreements to be implemented as well as to test their feasibility. Innovative institutions result in more formal but punctual and transitory agreements which establish a relational framework keeping process uncertainty in an acceptable range, compatible with the discovery of future options deriving from the cooperation process. Indeed, what is generally thought of as hybrid modes of coordination becomes in our framework an option to pursue in a collective frame the individual interests of the partners involved in the working of the related and initiating innovative institution.

These three main types of institutional arrangements are only the result of the process of implementing innovative institutions and, consequently, are associated in different institutional points of arrival for a dynamic process of setting-up new economic activities. Therefore, we insist on the fact that it is the process of moving from innovative institutions toward one or another more formalized mode of coordinating industrial activity which is crucial. In that respect, the focus of the analysis has to be put on the determinants by which each one of these points of arrival is progressively chosen. This requires a clearer understanding of the mechanisms that orient the process in time.

3.2. The Main Determinants Influencing the Working of Innovative Institutions

As indicated below, market, cooperation or firm appear as three different types of coordination mechanisms resulting from the evolution of innovative institutions. However, those more stable modes of coordination are not mere alternatives; they result from a progressive and irreversible process for which the main determinants have still to be identified. According to empirical evidence, we consider that, at least, three different categories of components influencing the working out of the points of arrival can be identified: the technical capabilities of individuals involved in the functioning of innovative institutions, the combinatory character of the process of implementing innovative institutions, and the environmental factors that constraint the current working of innovative institutions.

Technical capabilities belonging to individuals involved in the process include not only the related research skills and capabilities but also all extra-capabilities necessary to ensure the implementation of innovative institutions (including economic, financial, and managerial competencies). The high quality in scientific individual expertise appears as a necessary but not sufficient condition to guarantee the viability of this implementation. It is a necessary condition because scientific development and progress largely influence the design of innovative institutions in the course of their implementation (Mustar 1991). Because of discontinuities in available scientific knowledge and the underlying continuous process of discovery, conjectures on the future can change very rapidly, depending on the evolution of the resources required by innovative institutions. Therefore, the quality of scientific expertise appears as a crucial element to influence the characteristics of the results of the process. However, this is not a sufficient condition because the ability of individuals to complement their scientific expertise by other knowledge derived from business, accounting, marketing and/or finance appears extremely influential to understand how the final point of arrival is progressively designed. Interestingly, the way by which this kind of complementary knowledge is incorporated in the working of innovative institutions is also very influential (Flésia 1996). The latter can result from an 'internal' strengthening, that is the fact that scientists expand their individual expertise from their own initiative, or from the inclusion of 'external' capabilities, i.e. developing interactions with external resources. In both cases, it progressively designs the most suited institutional arrangements for the working of innovative institutions.

This issue of including complementary resources in the working of innovative institutions is at the frontier with the second category of determinants, that is the combinatory expertise of individual scientists. In fact, empirical observation of science-industry relationships shows how crucial is the way by which individual scientists develop an ability to combine the overall knowledge necessary for the development of an innovative process (Cassier 1997). This question is not reducible to the accessibility conditions of relevant information; it has essentially to do with the organization of knowledge which is at central stake in the implementation of innovative institutions. Here again, we need to dissociate between technical and non-technical knowledge. If the former does not seem to be very influential, this is not the case for the latter. The way by which non-technical expertise is progressively collected and aggregated in the innovative institution largely influences the

point of arrival that will be attained. More precisely, inter-individual networking effects initiated by scientists, their ability to glue industrial partners in the working of innovative institutions as well as their ability to question and reshuffle the organizational design in the process of implementing innovative institutions, appear as the most influential elements for understanding how a specific point of arrival is progressively designed over time (Quéré and Ravix 1997a).

Lastly, the third category of determinants is the environmental influence that academic people are facing. This category contributes to establish a sort of framework, a set of rules that influence the process of choosing among potential points of arrival. For instance, the legal system to which academics are confronted can contribute to favor specific options for academic entrepreneurship. According to the French case, the recent new law on innovation (1999) induces important consequences on the ability of public researchers to become shareholders of new industrial companies as well as to develop themselves new companies. Public facilities depends from one national context to another and their characteristics contribute to define the most favorable options to secure innovative institutions in more stable forms of institutional arrangements. The range of factors that define this environmental influence is far to be exhaustive. However, public authorities play a central role through their direct or indirect actions. Financial facilities for academic entrepreneurship, simplifying patenting procedures, supporting doctoral students, encouraging technology transfers in industrial companies, all these measures express the huge range of public intervention that contribute to influence the evolution of innovative institutions towards one or the other of more stable institutional devices that will be associated to a specific point of arrival.

4. Conclusion

In this contribution, our aim has been to highlight the importance of an Austrian approach of institutions in dealing with a specific range of problems in the realm of science-industry relationships. By combining distinctive characteristics between Menger's and Hayek's research programs, we establish a typology of institutions that goes beyond the usual way to approach business institutions. The value of such an approach is to establish a peculiar type of institutions, defined as innovative institutions. These institutions are specific forms of relations among academics and companies which main characteristics is to be useful only during the period of creating new knowledge. After this period, these institutions evolve to more standard forms of business institutions (firm, market and cooperation).

Therefore, the process analysis characterizing the Austrian approach of institutions appears particularly interesting to cope with empirical puzzles exhibited by the current working of science-industry relationships. Our analysis shows how it is essential to understand the mechanisms by which innovative institutions develop, evolve, and transform themselves in order to finally design a more stable point of arrival. That understanding of how process uncertainty is fitted by the agents along their innovative paths allows for highlighting and ordering the various forms of concrete results due to the implementation of innovation in the field of science-industry relationships (start-ups, patents, licenses, individual expertise, contractual agreements).

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Notes

1. Callon's criticism concerns the "economics of science" (Diamond 1996, Stephan 1996) that developed in different directions, from the analysis of strategic interactions among scientists to the discussion of individual or collective efficiency for research activity. However, as regards the so-called "new economics of science" (Dasgupta and David 1994), evolutionary economics and related perspectives in innovation studies are already tackling the issue of knowledge and learning processes.
2. The second characteristic could be used to describe more general R&D collaborative agreements. Some complex contractual agreements for R&D may be built on highly distinctive capabilities among the partners, even if it is not so usual. The matter is that all characteristics taken together are necessary to define mutual discovery, i.e. to qualify what Latour (1989) calls "science in action".

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