1

The Process of Institutionalization of Innovation and Production Ecosystems

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Innovation and production ecosystems are emerging forms of the organization of economic activities. The abundance of research dedicated to this topic evidently shows that this is a relevant theme supposed to provide suitable answers for the issues faced by present-day societies in terms of innovation, growth and employment. The main feature of the analysis of localized innovation lies in the contributions made by several knowledge domains: geographic economics emphasizes the benefits of agglomeration economies, institutional economics outlines the path of local learning, studies focusing on governance underline the need to share responsibilities between private and public actors, and approaches based on social capital rely on proximity and the communication channels of tacit knowledge. Finally, the knowledge economy models the interactions required by the innovation process, whose intrinsic nature is prominently collective, open and built on dialog.

This chapter is situated at the interface of these different contributions. The process that leads to the institutionalization and sustainability of these types of organization relies on learning paths that may be hindered by several elements. In particular, the constraints that limit actors in the context of globalization and the impact of the choices made in terms of location immediately reveal the existence of obstacles and the flexible and adaptable characteristics of these ecosystems.

1.1. Technologies, rules and learning dynamics

These types of organization are in line with a long-term perspective. The effective development and use of technological assets requires investments that also affect other categories of assets, justifying a systematic approach that is too often ignored: human capital, transmission channels for knowledge directed at businesses of all sizes, intellectual property rights, industrial structure (well-organized product chains) and so on. By definition, diversity implies interaction between elements. We need to conceive public policies that can structure effective interactions between public and private actors in order to turn this range of assets into a system: university–industry collaborations, production of qualifications of different kinds, creation of data centers and so on. Within the context of radical innovation, sending new messages about the technological, economic and natural environment is supposed to bring about changes in the behaviors of individuals and organizations and, consequently, to modify individual and collective cognitions so as to turn them into new connected forms of organization.

Rather than relying on the preferences and predictions of economic agents, we have to admit that present-day challenges cannot be dealt with by the market forces: markets are *blind* and, even if they do not fail in Pareto's sense, they are unable to provide a renewed and qualitatively different vision of economic development [MAZ 14a]. More precisely, the signals of the market are limited in terms of their ability to guide technological–economic development. Economic development does not result from natural, exogenous and existing competitive advantages, but from an endogenous creation of new opportunities that lead us to define and establish new competitive edges [ROD 11]. Nonetheless, once a direction has been identified, the signals sent by the market affect the innovation rate.

A recent research work [POW 12] analyzed the appearance and transformation of ecosystems over time by using three types of arguments. First, the diversity of organizational forms suggests the existence of different selection environments and constitutes a repository rich enough to enable the emergence of practices, standards and rules. Second, the process whereby different organizations are assembled and connected requires the presence of an *Anchor Tenant*

[AGR 03], whose role is not to compete or dictate, according to Powell et al. This actor is situated in such a position within the system of relationships that it can gain access to other actors, and it is acknowledged as legitimate enough to act as a catalyst, direct efforts toward collective action and facilitate the growth of common resources[1]. Therefore, we admit that not all actors are in the same position in terms of critical resources (influence, network of relationships, reputation) and legitimacy to promote and institutionalize new practices. This may be a university, a research organization, a private company and so on. Finally, taking part in multiple activities facilitates the transposition of ideas and models from one domain to another and creates new possibilities that lead the system toward recombination or a changeover.

This means that, leaving the creation of complementarities aside, we should attach the greatest importance to the mechanisms through which public and private actors interact. The diffusion of new practices belongs to learning dynamics structured in three phases:

– framing. This phase involves elaborating new concepts (cognitive mechanism) and new representations of an activity, creating legitimacy and promoting agreement. In this context, laboratories (companies, universities) tend to direct their R&D efforts toward the formulation and hierarchization of problems rather than their solution. Complex problems require a theorization that needs an organizational environment favoring the exchange and recombination of knowledge [FEL 14b];

– the resources and complementary actors involved in a process are combined by establishing new norms and professionalizing the actors in relation to the new dynamics;

– the progressive coordination of the activities based on rules facilitates the creation of a network, organization of skills and adoption of good practices. This last aspect raises the issue of

1 “Anchor companies play a disproportionate role in seeding cluster development. Anchor companies support cluster development by acting as magnets for other major companies; organizing other companies in the cluster for collective action; supporting projects that improve the local quality of life; and producing numerous spin-out companies, which strengthen key elements of the cluster” [POR 00, p. XVI].

governance and, in particular, the question of sharing and using aggregate information.

The fact that innovative practices may be regarded as public goods within an ecosystem or, in other words, that the innovation made by an actor does not decrease the possibilities offered to the other actors implies that the collective performance is improved when information about these practices is shared. Even if we assume that this information is shared, nothing allows us to claim that there will be a convergence toward optimal practices [LAZ 11]. The type of learning needed in a changing environment is based on the idea that the actors of an ecosystem have multiple connections and a "limited attention span". If innovative practices can be easily observed, the individual ability to process information will be limited in relation to the quantity of information available. As the authors of this article point out, everything depends on visibility ("A can emulate B if and only if A observes what B is doing") and, consequently, on the nature of innovation [LAZ 11, p. 315]. Innovative practices can be more or less easily observed and, even when this is the case, they tend to spread without entailing the production of firmly established information about what is actually working well. Inter-organizational relationships are therefore necessary.

The creation and diffusion of innovative practices is summed up in Figure 1.1.

We distinguish between the R&D phase, the problem solving phase and the phase involving the implementation of the new practices, as they belong to opposed approaches [NIG 14]. As for research – and, more precisely, basic research – the laws of nature allow scientists to rely on known initial conditions (the causes) to reach an unknown result (or effect). On the contrary, when we deal with technology, the desired result is known, whereas the starting conditions (the specific configurations of the components) are unknown. A wide range of notions may lead to the desired result. Technological functions are *imposed upon* rather than part of a unique relationship between some causes and a result. More precisely, technology is produced by making choices about operational principles that will define the way it functions. As for radical innovations, operational principles are chosen at the top of the hierarchy. This choice concerns the definition and design of the project and expresses social choices and value judgments. On the contrary, incremental changes are often reduced to their technical dimension and concern lower levels of the hierarchy. Moreover, as Nightingale aptly pointed out, innovative practices integrate tacit knowledge, which plays the role of active integrator and is not involved in inference or deduction processes. This element makes it difficult to observe innovative practices. This remark is somehow comforting in terms of innovation: the decreasing complexity of a problem is proportional to an easier dissemination of information about practices and a higher chance for the forces of conformity to prevail over creativity. On the contrary, as Lazer and Bernstein pointed out, the increasing complexity of a problem is associated with a trickier dissemination of information due to its tacit nature, while the agents will be gradually led to explore more wildly and delve deeper into the field of the problems in order to innovate. The lack of visibility about the practices increases creativity to the detriment of conformity.

New signals about the environment

⇩

Formulation/hierarchization of the problems [R&D]
(exchange/recombination of knowledge)

⇩

Problem-solving
(interactions between actors)

⇩

Implementation of innovative practices
(sharing and using information)

Figure 1.1. *Path followed by innovative practices*[2]

2 Concerning solving the problems: "In other words, with collective problem solving, the search for the best basket of activities to form a solution is distributed among a set of individuals; there is a defined division of labor and rewards for reaching a solution that are distributed across members of the group (although not necessarily equally)" [LAZ 12, p. 8].

This approach to the problems leads us to wonder about the boundaries of the notion of national innovation system[3] [LUN 92]. The organizations and firms that adapt their organizational forms to the institutions in place can face inefficiencies when significant changes affect technologies, products, markets or the environment. Fighting against this inertia fundamentally means innovating against the logic of the national innovation system, which is what is expressed by the notion of "contra-system innovation" [HUN 11]. Bringing about differentiation in relation to the system in which the actors are involved requires, according to the authors, the creation of new organizational forms, the invention of new tools or the transformation of the existing ones. The actors are naturally limited by their institutional position, but they have certain degrees of freedom in relation to the institutions in place. It is acknowledged that they have a *right to change*, because the system offers them resources to take action, which can be of two kinds: (a) developing ideas, acquiring credibility and legitimacy; (b) conceiving other paths that lead to innovations, growth and employment.

We also support the acknowledgment that, unlike the other economic decisions (financial assets, expanding a company), innovation is a process that does not follow the laws of probability and whose chances of success or failure cannot be determined beforehand. Moreover, innovation does not take place at random, but it tends to create systems (an ecosystem is a relevant analytical framework in

3 The notion of national innovation system (NIS) refers to a set of interacting elements aimed at reaching a goal: increasing the global rate of innovation by favoring production and the transfer of knowledge. In several fields, the issue is not to increase the general rate of innovation but to channel scientific and technological policies in a certain direction, namely to allocate preferential resources to some technological paths. In the NIS approach, the innovation process results from a complex (on a national scale) interaction that increases the stock of general economic knowledge. We implicitly assume that this stock is *malleable* enough, namely that it represents an entire range of technological abilities that, under certain conditions, give rise to innovations in the shape of new goods and services of higher quality and/or with lower associated costs.

that it involves linked and complementary activities). Finally, innovation progresses cumulatively and is a path-dependent process when what is done today is built on what was made yesterday [MAZ 14b]. It is because of these characteristics that innovation is not an individual and risky act that can be modeled like a lottery, requiring instead strong economic, social and cognitive interactions between the actors.

Research carried out in the United States shows, for example, that public authorities finance the *public good* aspect of an emerging technology (*proof of concept*) and the private sector funds the rest. Besides, high-risk R&D phases may represent technological platforms with several commercial applications that are progressively specified by the companies' expenditure on short- or medium-term applied research. This means that long-term policies require short-term (structure of partnerships, creation of research infrastructure, definition of research goals) and long-term (creation of qualifications and skills, inventory of knowledge and technologies necessary for the configuration of the product chains) intermediate goals to be determined and reached. Innovation and production ecosystems are the ideal places for localized dynamic learning.

1.1.1. *Structure and mechanism of an ecosystem*

Conceiving a purely local integration, however, raises some objections. An ecosystem does not develop in isolation: it is part of an industry, and, in this respect, it cannot be analyzed as an independent unity unrelated to the national and international industrial system [BRE 11]. According to these authors, a historical and dynamic analysis re-associated with the national and international perspective of the development of this industry may be useful if we want to explain the non-emergence of certain ecosystems. Their cross relationships are essential to understand the development paths of these forms of organization, once we acknowledge that it is possible for a CEO, a highly qualified employee or a company to belong to a dynamic industrial community without remaining in the same position throughout the lifecycle of this company. We should not be so naïve as to think that the ecosystems we analyze are not subjected to forces of social fragmentation and hierarchical relationships.

When an ecosystem is progressively implemented, the growing number of individuals involved increases its legitimacy in relation to two aspects [ALD 94]: a *cognitive* one, referring to the extent of knowledge about this activity, which becomes meaningful for producers and consumers, and a *socio-political* one, referring to the public acceptance of this activity, the public aids it benefits from and the prestige of its leaders. Cognitive legitimization in the eyes of the producers reinforces the trend of industries, especially high-tech sectors, to be geographically grouped together, adopting an organizational structure called regional cluster[4]. This suggests both that the proximity of the knowledge sources that represent R&D inputs has actual significance [AGR 06] and that newcomers will more likely copy an existing organizational form rather than have to test it[5]. Besides, the creation of research consortia or joint ventures in a region simultaneously facilitates the production of localized knowledge and their protection by means of intellectual property rights. More generally, once a collective action is directed at a common goal, the legitimate activities are appropriated by the members of organizations and mutually interpreted, thus becoming customary.

Nonetheless, if the multiplication of components and of their relationships – therefore, the increase in the diversity of these *environments* – may represent a response to the imperative need for innovation by favoring exploratory abilities, compromises about other characteristics concerning performance (cost, environment, quality of the relationships, etc.) are required. Diversity comes at a price [STI 07]. Some options are inevitably constrained in terms of

4 The US Cluster Mapping Project defines a cluster as "a regional concentration of related industries" and distinguishes between *traded clusters* (51), with interregional and international aims, and *local clusters* (16), exclusively oriented toward local markets.

5 Organizational practices are easier to imitate than technological practices, especially for small structures

available resources and they require: either downscaling or more limited types of learning or growing costs, increased complexity or a loss of coherence when the number of components becomes larger and the transaction costs increase (information overload, high coordination and communication costs). The difficulty lies in finding a balance between the advantages of diversity and the contrary forces that emerge when governing knowledge, innovation and choices concerning development.

The literature of evolutionism, thanks to the concept of related variety, underlines the importance of assembling different pieces of knowledge that, however, complement one another. The extent of diversity is then limited: knowledge is transferred from one activity to another when it is complementary in terms of skills. This phenomenon may take place in a sector or between sectors as long as there is a technological relationship. This analysis, carried out on a regional level [ASH 11], can also be applied to those clusters believed to be able to produce diversity in related activities. Budding takes place through mechanisms of knowledge transfer: spinning off, diversification of companies, labor mobility and networking of actors. The authors quoted admit that these transfer mechanisms enjoy a local advantage: spin-off firms and the mother firms are in the same position, new divisions of existing firms develop in organizations that are already in place, jobs are taken up by new individuals in a localized work market and knowledge networks are often organized by actors who are socially and geographically close.

This analysis, which attaches more importance to the mechanisms of production and knowledge transfer as well as the necessary diversity of actors, is quite different from the approach of agglomeration economies as a significant determining factor of geographic location [ELL 99]. We know that Marshall forces that lead to agglomeration include three categories of transport costs: goods, people and ideas. In this context, the costs are decreased when companies become closer, as they share certain features. The same can be said about the co-agglomeration of industries that may be similar in some aspects and differ in others [ELL 10]: for example, two industries may exchange goods (input–output relationships) but employ individuals with different qualifications or hire employees with the same qualifications without exchanging goods. Empirical tests unambiguously show that the Marshall forces affect the models of co-agglomeration of industries, the natural advantages offered by a given location. The input–output flows represent the most significant factor, whereas the flows of technological knowledge have a far less important effect.

The conceptual framework thus described is not suitable for the analysis of innovation and production ecosystems. Naturally, input–output relationships are in line with the existence of value chains that justify the presence in a certain location of suppliers belonging to different industries. Similarly, the creation of companies is linked to the presence of other industries, whose employees and human capital can be highly valued by new entrepreneurs [GLA 08]. On a more general level, research works confirm that there are human capital externalities that may benefit all companies, including the existing ones. By contrast, the weak technological flows shown by R&D spending and patents do not account for richer forms of production and knowledge transfer on which the dynamics of an innovation and production are based. Such an ecosystem relies on the interaction between companies, institutional actors (universities, public laboratories, research bodies) and different kinds of service providers: audit, training, advising, finance and so on.

1.1.2. *Economic behaviors and social relationships*

Some innovation and production ecosystems must be conceived to emerge on a global basis (this is the case for traded clusters in the United States), as a large part of users are located outside national borders, regardless of the activity considered. This assumes a high level of cognitive legitimacy in the eyes of the users. For example, the production of software for timber houses in Sweden and Germany represents agglomerations of service companies, productive unities that are downstream of the timber sector and training institutes that have built, based on specific needs and thanks to essentially regional funding, European-sized markets. In this context, issues concerning scaling and marketing are crucial; globalization is multiplying the number of markets and intensifying their segmentation in increasingly more specific kinds of demand, leading to "semi-customized" applications of technologies of generic products. The process that allows us to reach an effective minimum production size requires public policies oriented toward the creation, in relation with private actors, of resource centers designed to produce public or semi-public goods that the market cannot create on its own: information about technologies and products, creation of instances of risk-pooling and risk reduction (insurance mechanisms), testing and certification committees and committed coordination procedures, headed by either private companies or public bodies [MIT 13] able to take on the role of anchor tenant. It is as if the *selective infusion* of the communication, control and normalization functions, enabled by the access to shared resources[6], transformed the traditional hierarchical relationship.

Top-down economic approaches are ineffective in these forms of organization, because it is impossible for a single actor to identify all the relevant knowledge and mobilize all the adequate types of expertise. Clusters offer significant competitive edges in relation to

6 A report on the European strategy for growth concluded with the following remarks: "Beyond these specific policy recommendations there is a broader observation that emerges: At the heart of a successful New Growth Path-oriented cluster and competitiveness strategy is the focus of investing into 'the Commons'. The Commons are critical both for overall competitiveness […] and for clusters […]. "High road" competition requires the existence of a strong Commons, and a willingness of many organizations to contribute to it. High levels of economic performance at the level of both firms and communities is based on a shared set of assets, and lagging performance often at its heart driven by the failure to invest and sustain such assets. The Commons include assets that generate factor inputs, for example, the education and research institutions that provide a skilled workforce and knowledge. But the Commons also include the institutional fabric that supports collaboration. It bears important overlaps with the notion of capabilities that is at the center of the definition of economic development recently adopted by the US Department of Commence [FEL 14a]. Exploring these concepts further offers a promising future research agenda for the work on a New Growth Path" [KET 15, pp. 31–32].

firms vertically integrated in three domains[7]. Productivity is increased thanks to reduced transaction costs and interdependencies that are not market oriented. Innovation is amplified by the interactive exchange of knowledge between different actors, especially due to the proximity required by the exchanges of tacit knowledge. The creation of new companies is facilitated by the assistance provided in terms of "monitoring, role-model provision, learning, communication, and commercialization gains that arise from operating in a cluster setting" [COO 02, pp. 9–10].

We will add to this the definition of fiscal and financial procedures (namely, via specialized bodies) that facilitate the widespread dissemination of information technologies and the regional funding allocated to the production of qualifications.

Overall, the *relational aspect* becomes predominant if we want to ensure a key function of governance [POW 12]: the interactions between the participants enable the emergence of specific investments in physical and human assets, the definition of new practices and their internalization, while also avoiding opportunistic behaviors. *An ecosystem organizes, in a particular way, the social distribution of risks and rewards (not only monetary) between the participants*. Besides, the procedures and definitions that at first required several efforts, explanations and translations are progressively codified. The equivalent of a phenomenon of "compression" takes place and allows those involved to rapidly understand meanings and nuances [COL 06]. Consequently, the process that leads to the institutionalization of an innovation and production ecosystem is not accounted for by the summary analysis of the behaviors exploited and brought about by monetary incentives, or, at the very least, it makes it more complex.

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7 According to Porter, clusters represent a new form of spatial organization situated between competitive markets and vertical integration. Simultaneously to places of competition and cooperation, clusters have the advantage of reducing issues of competitiveness without imposing the rigid structures of vertical integration or the formal links represented by alliances and partnerships. Thus, this form of organization does not correspond to the hybrid area of Williamson's diagram. For Porter, the informal – and yet still close – relationships between companies in a cluster are a superior form of organization.

The approach suggested leads us to put less emphasis on the exceptional role that may be played by some particularly qualified and innovative individuals, such as *star scientists*[8] [AND 13], insofar as the effectiveness of the device depends on the coordination of the whole. It also forces us to consider more than the mere monetary incentives that limit the reflection about what employees and companies profit from or lose by belonging to a cluster. The works focused on Great Britain clearly show that a location in a cluster is not only determined by knowledge spillovers with the potential to reduce costs, for example, increasing the productivity of R&D or decreasing the costs involved in its implementation. Spillovers may involve different aspects: becoming involved in informal networks, facilitating face-to-face interactions, building formal collaborations, obtaining expertise and guidance, benefitting from the creation of university spin-offs and so on. [ABR 07]. These authors somewhat relativize the importance of human capital by combining it with the role played by institutions. In the pharmaceutical and chemical sectors, the supply of trained students or scientific professionals plays a less important role than university research, especially when the latter is of a high standard, as a location factor of companies spending on internal R&D. The social infrastructure of clusters *frames* the behaviors of economic agents and simultaneously increases the innovative ability of companies. In line with the neo-institutional theory, the actors are integrated in institutional environments: it is as if a script defined the roles and linked the actors to a repertoire of actions, interests and goals to be reached in a specific context [DRO 09].

We can see that it is difficult, while analyzing ecosystems, to separate the geographic dimension from the aspects related to the social structure: proximity and location in a network are closely interconnected [WHI 09]. More generally, the research carried out by these authors shows that the innovation factors in the Boston, San Diego and San Francisco Bay regions are more relational than

8 "The firms that are affiliated with 'star scientists' have a positive impact on other firms in regions where they are located and create higher-value patents, produce more innovative products, create more jobs, and undergo more frequent and successful initial public stock offerings (IPOs)" [AND 13, p. 2].

geographic. The network effect is more significant than the effect due to location. A substantial amount of research had already underscored how, in regions that are significantly structured by clusters, networks of social relationships are the main source of new knowledge for the companies located there. The dissemination of knowledge results from high labor mobility. The analysis of the San Diego technological cluster reveals this phenomenon [CAS 07]. A high labor mobility, which allows experienced managers to leave prestigious careers to work in lucrative, if high-risk, start-ups, cannot exist without a social structure formed by firmly established and effectively organized links. A social network, once set up, decreases the risk for these qualified individuals of joining these companies again and, possibly, leaving them should difficulties arise. The social networks that establish connections between experienced managers must be regarded as institutions, and this institutional infrastructure is at the root of the development of some technological clusters in the United States.

Overall, the appearance and development of clusters rely on two interconnected explanatory factors.

The factor-focused approach draws up a list of criteria that range from the quality of academic research and the education system to the presence of venture capitalists and historical luck.

The structure-focused approach focuses less on the specific features of the factors and gives more weight to the structure of the relationships between the agents, be they companies, individuals, institutions or public authorities [BRE 09]. If these social conditions are not there, clusters will never grow, regardless of the availability of the different factors. Networks allow technological knowledge in particular to be disseminated thanks to the collective learning that has taken shape and the exchange of information between the agents[9].

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9 Breznitz and Taylor [BRE 09] analyzed the three mechanisms through which social capital positively affects the creation and sustainability of industrial clusters: the success of individual companies, the development of the industry situated in the region and the establishment of close relationships between companies and qualified individuals within the local community, making it harder to relocate them outside the region.

Let us also point out that the relation process is in line with a shift toward more open types of governance in terms of innovation and, in this respect, it eludes the traditional analysis of the market–hierarchy distinction and its support in terms of transaction costs, which remains relevant if we want to tackle problems concerning the structure of production [FEL 14b]. There are several governance procedures that cannot be identified as exclusively related to either hierarchical management or the market. The function of an innovation and production system does not involve solving a possible hold-up problem, but facilitating the flows of information and knowledge, especially tacit and living, which are crucial for the success of innovation[10].

In this context, the integrated organization of research within a firm, as it makes it possible to exploit accumulated and diversified technological knowledge, is a recent invention that dates back to the 20th Century. Nowadays, it tends to be replaced by partnerships and alliances, which represent at once federated structures and forms of governance that determine technological courses of action, create economies of scale and consequence and favor the exchange of knowledge. They are *buffer institutions* that create a neutral area between academic and industrial research and leverage their respective abilities [AND 13].

The relational design that underlies the dynamics of an innovation and production system can be established on the basis of research that has focused more specifically on firms [GIL 09]. It is becoming common to think that a key innovation involves implementing a

10 This aspect sets apart the innovation and production systems as we have analyzed them from the platform ecosystems, within which we can observe wars for leadership between the suppliers of platforms, like in the telecommunications sector. These ecosystems are first of all technological platforms whose components are represented by companies. A platform is the property of a firm that allows external firms to gain access to it, without necessarily implying the existence of client–supplier relationships [ATT 14]. Besides, these technological platforms may do without any form of territorial roots, moving to the polar opposite of the notion of “regional cluster”.

system where the regular and mutual supply of information about everyone's skills and desire to cooperate shows how to collaborate more effectively and create mutual types of learning in common projects. Over time, these projects are going to become more precise in relation to the reciprocal predictions and expectations of each participant whose organizational borders are open enough to allow an entity to gain access to technological knowledge situated in other entities. At first, the nature of an innovation and production ecosystem makes it impossible to qualify it: it progressively builds and elaborates mechanisms and tools of governance suitable for the context (characterized by incertitude) where it operates and the tasks it intends to carry out.

More generally, innovation is becoming more collaborative and the involvement of public bodies has changed over the last few centuries. The works carried out on a sample of 1,200 innovations chosen randomly among those considered by *The R&D 100 Awards* are proof of this evolution. Block and Keller [BLO 11] pointed out that in the 1970s 67% of the innovations noted were produced by private sector companies operating on their own. This figure fell to 27% in the 2000s. On the contrary, the number of innovations produced by public institutions (universities, federal laboratories, public agencies) has increased significantly, from 14% in 1975 to 61% in 2006. Similarly, the growing importance of inter-organizational collaboration, especially between private companies and universities, confirms the central role of networks in innovation processes: in 1971, 18% of rewarded innovations involved collaboration between organizations. This figure increased to 68% in 2006. If we only consider funding for innovations as a factor, the results obtained for the same sample indicate that the percentage of innovations financed with federal public funds has increased from 41% in 1975 to 77% in 2006.

1.2. Innovation and production ecosystems and globalization

Globalization exerts several constraints on innovation and production ecosystems. First, globalization brings about the significant re-allocation of productive resources across countries, activities, firms and jobs, and it leads, depending on the circumstances, to strengthened skills or the re-assessment of a technology. Second, it modifies the two dimensions that economic analysis attributes to the production factors: their mobility and their potential of externalities. In terms of economic policy, we can easily imagine how the implementation of national measures in favor of financial capital will only slightly affect the actual economy, given its marked mobility. On the contrary, technological knowledge can be brought about to the profit of regional hubs able to create significant positive externalities for the firms and institutions they include. This does not mean that knowledge spillovers are exclusively within the innovation and production ecosystem and necessarily located on the geographic plane. Some works establish how the mobility of an inventor – who leaves a given local site where he worked with other people for another site and another organization – is coupled with a certain persistence in social relationships that facilitates communication between inventors and favors knowledge spillovers [ARG 06]. The inventors' mobility, therefore, positively affects the accumulation of social capital and leads us to consider the issue of finding out which advantages can be obtained by an innovation and production ecosystem by attracting highly qualified employees who are still part of the network, including the inventors with whom they have previously worked.

1.2.1. *Locations, sources of skills*

The flows of knowledge received inevitably influence the activities performed within these hubs, which require a diversified range of skills in not only research and design but also production, marketing and training. *It is locations themselves, enriched in this sense, that become the source of these skills*. By helping the creation of these hubs, economic policy reminds us that competitiveness is not exclusively of a microeconomic nature and that competition moves toward intermediate levels made up of localized groups of companies and institutions. The rules of the meso-economic game imposed by globalization are as follows: the technologies, knowledge and skills enjoyed by a location must be necessarily different from those of other hubs, lest they become "commodities" [ZYS 07]. First, it is a matter of building different research outputs, products and services. Just like for companies, skills vary widely from location to location and represent neither a coincidence nor the exclusive outcome of a historical process. Naturally, the positions obtained in terms of assets (knowledge, abilities, etc.) have a certain weight, as do the processes implemented: the governance structures, the qualification systems as well as the degree of internal connectedness that facilitates the integration in networks [BEN 11]. What matters even more are the paths taken, as knowledge and skills are cumulative and develop over time through a series of coordinate investments [PIS 15]. The strategic choices made by companies (developing general or specific skills, focusing more on applications or widening the range of domains to which these skills will be assigned) will be all the more effective as public policies have been able to identify the most promising paths. Hence, the need for screening and selection mechanisms that avoid mere window dressing.

1.2.2. *Long-term decisions*

Globalization is making it harder to think long term. The policies in favor of innovation and production ecosystems involve long-term perspectives by means of irreversible decisions that need meticulous planning and a larger amount of information than reversible decisions. Globalization tends to shorten the lifecycle of technologies, narrowing the margins of opportunity. We should add to this the instability of the marginal conditions that affect the environment of the decision: quality of data and prediction models, degree of investment spillover, difficulties involved in financing the first models of a series and so on. The result is that decision makers, due to time constraints, have to lower the essential standards of rationality. In other words, decision makers cannot plan their long-term decisions, which, by becoming less rational, run the risk of being faced with unpredicted *organization failures*. Thus, upstream, it is necessary to increase the abilities and expertise of the public actors in charge of playing a part in some projects that are particularly physical capital, infrastructure and knowledge intensive. Nonetheless, “as the number of options increases, the peoples’ ability to accurately evaluate the different options declines” [WOR 15, p. 181].

A type of failure that is often encountered involves the quality of partnership relations. From this perspective, public policies may re-define the relationships between companies by establishing legal-level binding rules of conduct that large-size operators cannot get around. They must also aim to help small and medium-size companies to cross the growth thresholds by allowing them to gain access to funding tailored to their stage of development (venture capital in the initial phases), to improve their R&D abilities in order to access common resource centers and, consequently, to seize technological opportunities by bettering the quality of the mechanisms of technological transfer.

However, we should not forget that universities in the United States have played a major part in the development of fundamental knowledge, applied science and engineering sciences by producing useful or instrumental knowledge, namely knowledge that is integrated in final products or manufacturing technologies [ROS 13]. In particular, empirical observation and the usefulness of carrying out tests, without necessarily resorting to an abstract scientific model, represent a set of latent opportunities for instrumental knowledge for some SMEs. Knowledge transfer requires inter-organizational structures (e.g. as *ad hoc* laboratories) that favor active collaboration between researchers and practitioners. Therefore, spatial proximity is likely to facilitate the transfer of knowledge from research toward small structures. The advantage is that, besides gaining access to a wide range of scientific skills, companies can benefit from knowledge, whose production costs are lower, as academic researchers simultaneously aspire to monetary and non-monetary rewards (reputation through publications).

We still need to analyze the public aid allocated to R&D, which may help companies of all sizes. R&D gives birth to spillovers of two kinds: technological (or knowledge-related) spillovers with the potential to increase the productivity of other firms working in similar technological sectors within regional clusters, and negative spillovers of business competition, which lead to the subversion of some activities and losses in some parts of the market. Recent econometric works [BLO 13], carried out in the United States on a sample of 10,000 companies over a 20-year period, show that the social returns of R&D are two to three times higher than the private returns (55% vs. 20%) when we take into account net returns, namely when we consider a depreciation rate of 15%. The gap between social and private returns is much higher – and, consequently, spillovers are much more significant – for large companies than for small ones: the former have a higher degree of connectedness with other firms in their technological space, whereas small companies, which operate effectively within more limited technological niches, produce lower spillovers.

Spillovers run the risk of being less significant in proportion to the decrease in R&D spending. A recent study considering Germany focuses on this point [RAM 16]. These authors note that the development of R&D spending in SMEs does not imply a change in the sectorial composition of the productive fabric, but that it has to be analyzed in terms of its behavior, which changed in the period from 2001 to 2013. The data about German firms provided by the CIS (Community Innovation Survey) in relation to this period indicate at once a decrease in the number of companies that have introduced at least a product or a process (43.7% in 2007 and 37.01% in 2013) and a significant contraction of SMEs in terms of their R&D and innovation activities[11]. In order to explain this, the persistence of innovation

11 "Such a development would be of much greater concern because one of the pillars of the competitiveness of the German economy is seen in its highly innovative SMEs. A withdrawal of these firms from innovation would make the German economy considerably more reliant on set of well-known large companies, while grassroot innovation in SMEs may be lost. Moreover, since choices about innovation activities display a high degree of path dependence, these developments may easily become permanent" [RAM 16, p. 3].

activities is associated with the size of the firm. The literature acknowledges that large companies, which can rely on complementary assets and elaborate more complex innovation strategies, are less at risk of adopting discontinuous innovation behaviors. As a result, on the sample observed, it is possible to note a strong contraction of firms that carry out R&D continuously: 28% in the sub-period from 2001 to 2007 and 19% from 2011 to 2013. The trend seems to become more accentuated after the crisis in 2008 and depends on SMEs, especially the small ones. Overall, the authors draw the conclusion that R&D behavior and the innovation of SMEs is modified in favor of a more discontinuous activity.

Persistence also affects other variables. Studies carried out on American data indicate that R&D expenditures do not necessarily boost the growth of small firms. Innovation makes it possible to cross the growth thresholds only if these companies file for patents on a regular basis. The EU's FINNOV program reaches the same conclusion while thinking that this period, in the pharmaceutical industry, must be shorter than 5 years. All these studies converge: R&D and innovation activities only contribute to the growth of SMEs if they are constantly implemented.

This implies that public policies should target their actions more in favor of actually innovative SMEs on a sufficiently promising technological path[12]. The studies that have focused on Great Britain indicate that innovative firms are fast-growing SMEs with a size of 50–170 employees. They are present in high-tech and low-tech sectors simultaneously. However, these SMEs only represent 6% of all the companies. Public intervention in favor of this 6% will yield much more in terms of growth and employment than a horizontal policy targeted at all SMEs [NES 09].

12 The creation of a single European patent (which has not been implemented yet) represents a major institutional innovation.

In this context, innovation and production ecosystems may be regarded as organizational innovations that allow us to counteract the trend toward the concentration of R&D and innovation activities in large companies[13]. Access to privileged funding[14] and potential collaborative projects in R&D stabilize long-term perspectives and ensure the continuity of the efforts made in this direction. Rammer and Schubert aptly identified the risk involved: companies, especially small firms, with inactive R&D are likely to become occasional actors in R&D and above all less likely to carry out R&D activities on a constant basis. In relation to this, the creation of institutionalized frameworks for innovative projects favors newcomers and existing SMEs immediately, especially because these SMEs generate significant spillovers in their region. The studies conducted on the socio-economic structure of regional industries, however, underline that the effectiveness of these units is closely associated with their integration in networks of firms. We come across the well-known idea that an economic agent increases its social capital by establishing different relationships that it may use to access information and find the aspects of demand, sources of qualified labor or financial providers.

Moreover, the integration of innovative SMEs in clusters is facilitated once the latter can be legitimized socio-politically in relation to public authorities and other companies so as to be identified as partners in institutionalized practices that combine the use of technologies and rules.

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13 A survey conducted in Canada reveals that, as a rule of thumb, large companies are more innovative than medium-size and small companies. For example, in the period analyzed (2012–2014), 78.1% of large companies are innovative, whereas the figure goes down to 64.5% for medium-size companies and 53.5% for small companies. However, innovations are not weighted in terms of turnover.

14 Public aid allocated to SMEs can be justified by other factors, for example, the fact that these companies are less able to appropriate the returns of their own R&D, or the imperfection of capital markets. In France, the number of SMEs that benefit from research tax credit has allegedly multiplied by 2.5 since 2007. Small and medium-size companies finance on average a third of their R&D spending thanks to this benefit.

1.2.3. *Basic research and development of products*

Innovation and production ecosystems are structured on complex problems that challenge individual solutions obtained rapidly. Easier access to information and knowledge results in the dissemination of the existing signals among a larger population of actors. Consequently, the reduction in information asymmetries increases the number of adopters and, at a second stage, innovators, besides facilitating the integration of SMEs in value chains. At an earlier stage, the reduction in information asymmetries makes it easier to coordinate knowledge in the innovation sequence. Some works have shown that a *valley of death* tends to appear in phase 2 (converting an idea into a potentially marketable product), which occurs after basic research, often guided by the public sphere (phase 1), and before phase 3, which involves marketing and dissemination. This may lead to the disappearance of discoveries that cannot benefit from enough funding. The less private investors act in tandem with public laboratories, the more they will lack expertise, at once scientific and commercial, to involve funding for projects in phase 2, and the more they will tend to localize their skill and investments in R&D near the final stages of the innovation sequence. Intermediate projects are characterized by a type of incertitude that is at once scientific and market related, and the sunk costs required to acquire this double skill are too high to be financed by private investors.

In other words, the *valley of death* appears as the producers of knowledge in stage 1 produce more outputs than the localized agents in stage 2 can process. Their objectives differ markedly: maximizing well-being through scientific and technological progress goes against the profitability-centered behaviors of private companies, which we analyze here as a behavior that involves waiting for public science to validate future technologies. As a result, firms must invest in scientific research to widen their knowledge base, and the creation of suitable organizational forms (public–private partnerships, joint ventures, specialized bodies) reduces information asymmetries, decreases sunk costs and shortens the amount of time required to go from theory to application. In this context, it is likely that *transposition* becomes an essential operation thanks to which knowledge and abilities are transferred to new domains where they are recombined with existing practices [POW 12]. Through this mechanism, the identities of research institutions in the United States, in *Life Science Clusters*, have changed, as individuals and organizations have moved from one domain to another and cognitive frameworks have been modified, for example, due to the blurring of the boundaries between basic and applied research or between public and private science.

In the United States, the National Institute of Standards and Technology (NIST) has just taken the interesting initiative of funding two specialized institutes belonging to the National Network for Manufacturing Innovation (NNMI). These institutes group industrial producers, universities, higher-education communities, federal agencies and public organizations with the aim of bridging the gap between basic research and the development of a product. Innovation lies in how the NIST (see Box 1.1) has not pre-determined at the beginning a precise sector for each ecosystem: suggestions may concern any project related to industrial robotics and biopharmaceutical manufacturing, as these two fields are identified as critical technologies likely to meet national needs and strengthen competitiveness.

As for the NIST, public intervention aims to invest in production technologies at a precompetitive stage that are relevant to the national needs and whose applications involve a wide range of activities. Operators can rely on shared assets that encompass cutting-edge technological equipment and training opportunities for employees immediately.

The US Commerce Department's National Institute of Standards and Technology (NIST) announced that it has issued a *Notice of Intent* to fund up to two institutes as part of the National Network for Manufacturing Innovation (NNMI). For its first institutes, the Commerce Department will provide up to a total of $70 million per institute over 5–7 years. Commerce funding must be matched by private and other non-federal sources. The institutes are expected to become self-sustainable within the time period of the award.

"Today marks a major milestone for the future of American innovation", said US Secretary of Commerce Penny Pritzker. "The collaborative, cutting-edge technologies being designed, developed and commercialized at our NNMI institutes are essential to America's long-term economic growth, competitiveness and job creation. Our new institutes will build on the success of the existing seven, and for the first time, the topic areas have not been chosen in advance but will depend on industry interests and input. Together, our growing network of institutes will ensure America remains on the leading edge of the 21st century economy".

"Each institute serves as a regional hub of manufacturing excellence, providing the innovation infrastructure to reinforce the competitiveness of the US manufacturing sector as a whole", said Under Secretary of Commerce for Standards and Technology and NIST Director Willie E. May. "NIST is pleased to support this national effort to build critical capacity in important technology areas, in support of US manufacturing".

This will be the first NNMI solicitation in which the funding agency has not pre-determined an institute's area of focus. NIST is open to receiving proposals in any topic of interest to industry, particularly those relevant to manufacturing robotics and biopharmaceutical manufacturing. These two subject areas were identified by the President's Council of Advisors on Science and Technology (PCAST) Advanced Manufacturing Partnership as technology areas critical to supporting national needs.

A collaborative manufacturing robotics institute would focus on developing advanced robotic systems that can safely operate in collaboration with humans or other robots, be tasked and re-tasked easily and be integrated into the rest of an enterprise seamlessly and quickly.

A biopharmaceutical manufacturing institute would center on "biological" therapies that are manufactured using living cells instead of conventional chemistry. The institute would aim to stimulate innovation in manufacturing that will enable new, more cost-effective treatment of disease and solidify the domestic competitiveness of the US biopharma industry.

Box 1.1. *NIST program (source: [OFF 15])*

In other countries, innovation programs are offered in technological sectors. This is the case for Singapore, which favors the following four technological sectors: healthcare, advanced manufacturing, digital services and economy, urban solutions and sustainability. These fields have a largely transversal and inter-sectorial nature, involve several activities and meet societal and global needs immediately. The city-state of Singapore seems a place where innovation is managed in various ways.

1.2.4. *Innovation and production ecosystems and the choice of location*

Due to globalization, innovation and production ecosystems may have to make choices about the location of production. In the optoelectronic sector, the manufacturers of components organized in clusters had to tackle the following problem: developing new integration technologies on-site or outsourcing to developing countries the production of non-integrated existing technology. Integrated technology costs less when it is produced in the United States, whereas existing technology is more competitive when produced abroad [FUC 10]. Two elements have favored outsourcing: the uncertainty of the domestic market and the exchangeable nature of the service provided, which manifests itself as a more favorable wage/productivity ratio (for equal skills) in emerging countries. Choosing a technology ultimately depends on the context, historical circumstances and the actors' behaviors rather than any kind of optimizing rationality. We know that inferior options may prevail over apparently superior technologies.

Nonetheless, outsourcing production creates some holes in the productive fabric (loss of information and knowledge, severed links with providers) and implies an *endogenous obstruction of innovation* and a questioning of the dynamics of an innovation and production ecosystem. When faced with this, public authorities have reacted in two ways. First, they promoted the creation of consortia that favored the entrance of technologically similar firms driven by the desire to carry out research in and manufacture integrated technologies. Then, they resorted to Defense Agencies so as to obtain funding for these technologies.

Overall, we can see after a few years that technological and productive offsetting effects have been brought about by larger innovation and production ecosystems. Thus, the make-up of an innovation and production ecosystem can change once links outside the cluster have been established, especially by large companies. Similarly, the *anchor tenant* changes his identity when new technological opportunities arise. We can also see that, in the context of globalization, choosing a technology is affected by the location of the production.

> When she was asked “You work a lot with small companies, which are often taken over by foreign groups. How can we prevent French research from being siphoned off?”, Marie-Noëlle Semeria, CEO of the LETI, replied:
>
> “Our experience shows that once start-ups are outsourced, they often find a less rich environment that is not as favorable for their growth. When the American company INvenSense took over Movea (*a start-up spun off from the LETI*) in 2014, not only did it leave it on-site, but it also decided to increase its research and development. This creates jobs in Grenoble. The same goes for Intel taking over Docea Power (*in September 2015*). The more it thrives, the more attractive the ecosystem, and the richer it becomes. If there were only start-ups, this wouldn’t work. We need large groups, the constellation of SMEs, and a sturdy research institute”.

Box 1.2. *Ecosystems and outsourcing of companies (source: [SEM 15])*

1.3. Synthesis

We can now, with the elements considered, represent graphically the process of institutionalization of an innovation and production ecosystem and highlight the interplay of trends that challenge the stability of this form of organization.

Several authors think that the process of institutionalization is improved by being established while taking into consideration the temporal boundaries "that are defined by a set of events and the relationships among them" [LAW 01, p. 626]. Thus, a typical model can be put forward (Figure 1.2), without implying that there is only one strategy for all clusters. Each ecosystem must adopt a distinctive approach on the basis of its specific assets and advantages [POR 01].

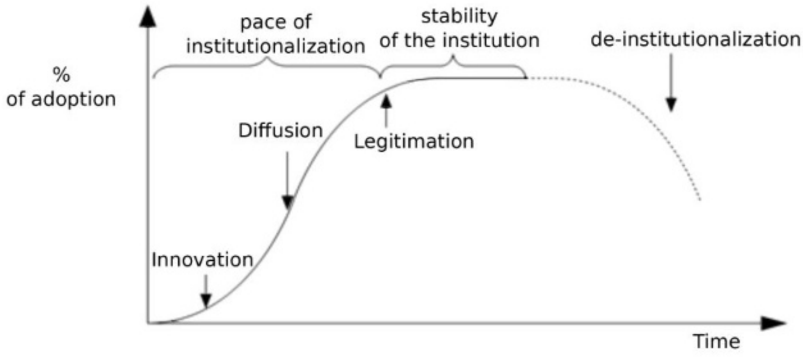

Figure 1.2. *The institutionalization process (source: [LAW 01, p. 626])*

Innovative projects are first implemented and acknowledged, as a first step, by a small number of actors. This is a preliminary phase of partial acceptance, which corresponds to the implementation of a social infrastructure, namely a network of links that becomes progressively larger. There then follows an intermediate phase of more marked diffusion and wider acceptance, which conveys a higher social density. Then, there is a phase of stability that shows the existence of phenomena of saturation and complete legitimization. A *social connectedness*[15] threshold has been crossed, and from now on the cluster becomes sustainable and the effects of innovation involve

15 "Connectivity relates to the usefulness of the network in terms of the number of individuals linked together" [CAS 07, p. 446].

a large number of companies. This tipping point shows a non-technological scale effect: the cluster has reached a critical mass for its sustainability [CAS 07]. This process can be represented with an S-curve that expresses the idea that new technologies, practices and operating rules emerge progressively and spread within an organizational space. According to Casper, the social infrastructure of clusters represents the equivalent of a common or public good. It is an emergent property, a product of the collective behavior of individuals (experienced managers in his study), companies (innovative start-ups) and institutions (universities). It is not very likely to remain systematically stable.

If this hypothesis is correct, the process of institutionalization of innovation goes backward by entering a phase of de-institutionalization that, according to us, corresponds to:

– The stage of production outsourcing and, implicitly, to the choice of a more traditional technology. Public policies may counteract this process by widening the technological range so as to involve other actors and by taking action directly through funding. A stage of re-institutionalization becomes possible: it corresponds to a re-configuration of the social networks and will be established once a form of legitimacy has been attained;

– A lock-in process. In other words, the set formed by the technological system, companies and private and public institutions tends to freeze. In particular, ecosystems may find it difficult to pair changed circumstances with a set of existing rules and norms. Situations become ambiguous and it is difficult to specify which rules are appropriate. The standard reaction to the pressures of the environment, which is essentially conservative as it is based on preserving the existing rules, may turn out to be counterproductive. As March and Simon pointed out in relation to organizations, "rule-based action can, of course, lead to foolishness" [MAR 93, p. 310]. It is as if organizations and institutions temporarily protected themselves against a misunderstanding of the situation and tended to keep following a path of development in their initial form for shorter or longer periods, remaining trapped in tested learning processes and their historical approach to problems [UNR 00].

In this context, "innovation remains curbed by a bonus given to what is already in place and applied to the current productive base (decommissioning results in losses and makes productivity gains uncertain) as well as the established economic judgments" [GUI 13][16]. As we are dealing with institutions, the lock-in takes place when standards are acknowledged and required by public authorities: innovation may be compromised, and rent-seeking behaviors (non-Schumpeterian) prevail over other considerations. In some cases, public agencies may be "ensnared" by private interests that they were tasked with regulating. On a more general level, dominant technological, organizational and institutional designs may hinder the system and the appearance of alternative technological and organizational solutions. In this context, the ecosystem is split into parts as the historically accumulated organizational capital leads companies and institutions to become rigid. Channeled ways of thinking and the durability of rules and norms have the potential to provoke the brutal obsolescence of organizational capital and may jeopardize the co-evolution of technologies, companies and institutions. According to the amount of pressure, we may find that the answer is to seek protection from public authorities (e.g. when the ecosystem represents a significant portion of regional employment) rather than to acquire new information and access new collective knowledge by increasing R&D spending.

Porter [POR 98] acknowledged that clusters may perish under external and internal pressures. In particular, technological discontinuities may neutralize the advantages obtained, and the assets accumulated (information about the markets, workforce qualifications,

16 "This lock-in occurs with ideas as well as artefacts… Technologies, once developed, have a persistence and autonomy that helps structure and reinforce these social relationships in ways that become more persistent as technologies embed in their surroundings" [NIG 14, p. 21]. According to Porter: "such rigidities tend to arise when government suspends or intervenes in competition or when companies persist in old behaviors and relationships that no longer contribute to competitive advantage" [*Ibid*., p. 17].

scientific and technological expertise, etc.) no longer correspond to the evolution of the users' needs, creating a divergence between local needs and needs deriving from the global market. Internal rigidity may result from administrative constraints, trade-union excesses or a lack of progress in the quality of institutions such as universities and training bodies.

To be more precise about this point, we should underline that the institutionalization rhythm and the initial phase of legitimization vary from cluster to cluster. The process whereby knowledge and innovation is created has become gradually more complex and it is marking an increasingly finer division of innovative labor. Knowledge bases may be grouped in three categories: synthetic, analytic and symbolic[17] [ASH 11]. An analytic knowledge base has a science-based nature, and the processes of codification are predominant (e.g. biotechnology and nanotechnology). Knowledge is coded in electronic reports and records, promotes fairly radical innovations and leads to the filing of patents and licensing. The process whereby new firms and spin-offs are created (start-ups collaborate intensely with large companies) is supported and, with its inevitable related series of successes and failures, the institutionalization draws out. On the contrary, a synthetic knowledge base gives rise to fairly incremental innovations. Research is less important than development. Innovation is mainly driven by applications and recombination of knowledge. This path is steadier, routines and operative norms are more quickly established and the spin-off process is sporadic. As clusters are built on activities relying on varied knowledge bases, public actions can only be based on a *one size fits all* policy, which would be completely inappropriate.

The legitimization phase also varies if we agree to take into consideration the industrial dynamics underlying the development of the cluster and the relationships of interdependence among clusters.

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17 Symbolic knowledge characterizes the production of movies, advertising, brands, fashion and so on. Its ability to interpret habits, behavior norms and the culture of social groups is more limited. It is not covered by our inquiry.

In this case, the difficulties involved in its emergence can be explained by the asymmetric influence that dominant and firmly established clusters exert on nascent clusters. A macro-economic perspective allows us to deal with these failures as pieces of a national system that establishes a hierarchy among dominant clusters and those that are underlined by the strong attraction of the former. Nascent clusters, which aspire to become stronger, then play the role of "catchment areas" of qualified assets. Breznitz and Taylor call them *feeder clusters* [BRE 11]. To justify these migrations of skills, we assume that investments in the production of knowledge in the dominant clusters do not necessarily create the expected levels of innovation and competitiveness.

Unlike the models of endogenous growth, which assume that the knowledge produced gives rise to significant externalities, we admit that there is a "knowledge filter" between investments in R&D and their concretization into marketable products or services [AUD 08]. By attracting new firms, especially entrepreneurial, the economic agents of the dominant clusters partially assign to them the task of exploring new knowledge, hoping to benefit from their skills. The entry of new entrepreneurial firms may lead to the removal of the uncertainties and asymmetries that characterize the new concepts, especially the most radical ones, and to the rejection of a *status quo* position shared by public (universities, research centers) and private research teams whose opinions are pooled due to the complexity of knowledge and the difficulties involved in identifying and assessing it.

In this context, the approach centered on the sustainability of a cluster becomes wider to make room for other arguments: the social structure of a cluster is strengthened and made more durable, as the investments in physical and human capital, as well as in R&D, and social networks are coupled with a sense of belonging to a form of organization: a form of political citizenship as necessary as economic or social citizenship.

Social capital is understood here as "civic capital" [GUI 10]; it represents all the durable and shared values and beliefs that allow the members of a community to solve problems concerning collective action and to strengthen cooperation. Civic values are built through informal relationships and reinforce confidence-building mechanisms and the cultural norms of respect and exchange among the several parties involved. The development of this civic capital prevents the appearance of "free-rider" behaviors[18] to which individuals and companies whose skills are enticed by the dominant clusters are sensitive. As Guiso, Sapienza and Zingales aptly pointed out, we should distinguish between the effects of civic capital from those brought about by institutions. Institutions cannot be *carried* and do not move with the individuals once the latter leave their region. On the contrary, the norms and beliefs engrained in the minds of people move with them and tend to spread in their new locations. Civic capital is therefore less developed in *feeder clusters*.

A strictly economic interpretation of this phenomenon leads us to associate the total factor productivity (TFP) and geographic concentration of companies within clusters. As for France, the result is an inverted-U shape [DUR 08]. Entering a cluster can only benefit companies: the curve deceases in its initial phase, or, in other words, the profits linked to the process of innovation appear only when a certain critical size has been reached. This tipping point indicates that the cluster is becoming sustainable and that companies, for example, as providers of inputs, benefit from being concentrated in certain areas. According to the authors quoted, the congestion effect points out the existence of concentration costs such as the insufficient specialization of companies due to the multiplication of providers. The performance dynamics convey the sub-optimal organization of the value chain. Besides the concentration costs, we sense the existence of other congestion costs: increase in the transportation costs for employees, pollution and lot prices (as the growing costs of the fixed factor hinder the re-location processes).

18 The economic agent gets around the rules of the game in force in the cluster to benefit from the opportunities offered to those who are most qualified and, consequently, can superimpose other rules reserved for the insiders.

1.4. Conclusion

In this chapter, we have put forward a theoretical analysis of innovation and production ecosystems by taking into consideration their technological, economic, social and organizational aspect. The mechanisms whereby the technologies, business practices and rules established are learned belong to a process of institutionalization that marks the development of these forms of organization in several phases: a small number of actors, the implementation of a social infrastructure, the development of productive resources, including social networks, growing economic density and reaching the critical mass. The process analyzed does not simply involve that "the institutionalization of common idea or purpose is a necessary ingredient of a true cluster" [MAL 06, p. 56]. It naturally incorporates not only the notions of identity and sense of belonging but also the determination of rules, values and beliefs that pervade the actors' behaviors. Once these elements have been gathered, the ecosystem becomes sustainable and the effects of innovation involve a large number of participants: large companies, innovative start-ups, institutions, structured and effectively organized social links. More precisely, we have seen that the innovation factors in some American clusters are more relational than geographic. The network effect is more significant than the impact of location if we want to understand the development of these ecosystems.

The appearance and development of innovation and production ecosystems are simultaneously influenced by companies, public authorities, universities, research centers, several training institutions, funding and so on. The interactions between the parties involved favor specific investments in physical and human assets, the establishment of new practices and their internalization. These forms of organization have emerging properties because the economic, social and institutional resources created on the way are greater than the sum of the contributions of each actor.

The resulting institutional framework stabilizes the economic outlook of the actors, especially SMEs, which are, as we have underlined, especially fragile in this period. Nevertheless, this structure is not permanent. Innovation and production ecosystems are subjected to not only the force of decline, which may start due to certain choices made in terms of outsourcing and production trends leading these systems to freeze or become rigid, but also the gap in relation to the evolution of demand. As a result, not every innovation and production ecosystems necessarily “succeeds”.