CONCEPTUAL FRAMEWORK FOR PUBLIC PRIVATE INNOVATION NETWORK (PPIN): A TECHNOLOGICAL PERSPECTIVE

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ABSTRACT

In this study, we investigate the conceptual framework for public private innovation network (PPIN) to figure out the basic components that lead to the implementation of an efficient process of innovation. Four main internal components are included to build the conceptual framework: 1) inclusions of heterogeneous public and private actors in PPIN collaborate or interact between each other, where each has his own preferences, knowledge and technological competences. 2) Dynamic and evolutionary interaction processes. 3) The interaction-processes (ties decoupling and fragmentation) are combined with the emergence of social network, which would lead to generate knowledge disclosure between the heterogeneous agents. 4) The innovation network follow life cycle growth model, where in each stage of life cycle a set of new interactions and innovation activities take place. In addition, organizational and institutional competences are presented as complementary factors to facilitate efficient implementation of the conceptual framework.

INTRODUCTION

Globalization, convergence of consumer preferences, new technological paradigms stemming from advances in information and communication technologies (ICTs) and spreading similar technologies worldwide have led to organizational and structural deficiencies in the firms. They also hampered the firms' abilities to reformulate their competitive skills, provide solely the resources and competences required to offset high costs and keep pace with new technologies. However, such deficiencies have stimulated a change in the organizing principles of economical activities (Castells, 1996) and enlarged the organizations' boundaries in accessing a wide range of corporate expertise and technological fields (Cantwell and Santangelo, 2006). As a consequence cooperation and collaboration between different organizations through outsourcing, partnership, alliances, joint ventures and societal network (network relationship) have become an optimal choice for firms to persist, where technological and non-technological competencies can flow freely between partners.

The levels of the local connections in firms reduce the sustainability of the innovation processes which become a major difficulty for innovation to occur without exchanging knowledge and information with the surrounded environment. Thus, firms shifted from a traditional perspective to a more system-centered approach of innovation that mainly depends on collaboration between several institutions. Moreover, the linear model has been replaced by non-linear model of innovation that presents the innovation process as "systemic, complex, multi-level, multi-temporal and employ a plurality of heterogeneous economic agents" (Lundvall 1988; 1992, Freeman 1988; Nelson 1988; 1993; Rossi et al. 2009).

Innovation network manifests as a prominent mode of non-linear (complex) innovation process, which consists of several actors with relationships of social and economic context. Moreover, the innovation process is an evolutionary and interactive process that entails "intensive communication and collaboration between different actors, private firms, and other organizations such as universities, innovation centers, educational and financing institutions, standard setting bodies, industry associations, and government agencies"(Todtling and Trippl, 2005). The communications and interactions between network actors assure the diffusion and production of resources (e.g. financial resources, knowledge, information skills and competences) required to enhance innovation.

Recently, innovation network has evolved from uncomplicated network which consists of identical partners with specific economic activities to more complex network with heterogeneous actors. It becomes responsible for implementing most of the sophisticated innovation practices. Public actors are likely to be actively manifesting in this new innovation environment as main providers of complementary knowledge and technological assets, as they have high abilities to provide new institutional arrangements and new technological capabilities through their public institutions (like, government institutions, universities, public research centers and public R&D institutions).

Constructing an efficient interaction processes between heterogeneous actors to produce a successful innovation process is one of the most intriguing question in the new complex model of innovation. This paper will shed light on the answer by formalizing a conceptual framework that contains the structural elements of the public private innovation network (PPIN), needed for an efficient interaction process and successful innovation output.

In the second part, we will focus on the concept of network and its development to include innovation network, as well as the motivation for this innovation network. This will help us to define the network structure and the factors that may lead to successful innovation network. Thirdly, the paper will include the developing of the conceptual framework that will consider the existence of public and private actors, existence of social dimensions of interaction processes and the dynamic process of interactions, which follow specific life cycle growth model. Finally, we will reveal the successful organizational and institutional changes that required to have efficient innovative process.

Definition and Motivation of innovation network the determination of the structure of PPIN and their successful factors require well understanding of the innovation network's concept, and how we move from the cost perspective of collaboration relationships (like networks) to knowledge-based perspective of evolutionary economics as in the innovation network. Then, we will discuss the motivations for innovation network and how the need for an open model of innovation can significantly contribute to the development of the model.

DEVELOPING OF INNOVATION NETWORK CONCEPT

Network has multidimensional applications, as it is found in social sciences, sociology, anthropology, human geography, organizational theories and economics. Therefore, scholars have no consensus about one single definition for network. Nevertheless, the network is defined as a group of actors (like individuals, organizations) connected by a certain type of relations (Joy, 1964; Iacobucci, 1996). Gipouloux (2000) determined four main elements for the structure and operation of a network: 1) actors; 2) resources that represent the main exchange items between network' actors; 3) a binding mechanism which aims at providing coherence to the network (like, license agreement, shares in equity and subcontracting agreement); 4) activities includes the outcome of the network.

Some scholars defined network as a social structure between a group of actors, where social substance of network comes from the process of decoupling and fragmenting of ties. For example, Doreian (2001) defined network as "G = (V, R)", where V is a set of social actors and R is a social relation defined over the elements of V. Meanwhile, Agapitova (2003) illustrated the social specificity of the network through two dimensions: content (information, advice, friendship, trust, etc) and strength (amount of time spent together, emotional intensity, etc).

Since the beginning of 1990's, the concept of network has been employed in the discussion of innovation as a prominent application for open model of innovation, in which the complementary financial resources are not the only concern of cooperation, while the level of partners' technologies, know-how, and skills are also crucial.

Innovation network is new organizational forms that replacing the firms as dominant actors in the knowledge-based economy (Belussi and Arcangeli, 1998). Freeman (1991) was one of the first scholars who introduced an apparent network definition of the innovation process. He defined innovation network as "new institutional arrangements" or "organizational changes" to cope with systemic innovation. The institutional arrangements may include public research institutions, technology mediating organizations (technology licensing offices, innovation centers, etc.), and educational institutions (universities, polytechnics, vocational training institutions, etc.). Freeman's definition was quoted many times and most of the following definitions of innovation network were derived from it. In general, the structure of innovation network doesn't differ significantly from that of the other networks. It consists of several connected actors and the needed processes for final output determination. The innovative nature of output determines the specificity of actors and the kinds of exchange resources between them.

In technological innovation network, complex knowledge and technological resources are likely to be the main endeavor for different network actors. Therefore, to capture the main characteristics of the innovation network (inter-firm learning, the exploitation of complementarities, and the creation of synergies), it is important not only to focus on cost-perspective, but also to rely on the knowledge-based perspective of evolutionary economics (Pyka, 1999), and the inclusion of innovation network through intersection between organizational learning and knowledge-based view (Thijssen et al. 2004).

Innovation system and innovation cluster are two other concepts which are similar to innovation network, that entail interactive or collaborative processes of innovation in systemic and spatial frameworks (Freeman, 1987; Lundvall ed., 1992; Nelson, 1993; Freeman, 1995; Edquist ed., 1997; Hamdouch, 2009). In the former, scholars established "innovation system framework" that depends on the interactive learning theory, where the system includes agents (industries, universities, public institutions, etc) along with their main competences and features and the interactions produced among them. In the latter, we have a multi-agent collaborative relationship, where a variety of actors (like, organizations, public institutions, suppliers) interact together and exchange knowledge, technologies, skills and competencies

in respective geographical localizations that occur at a variable spatial space and specific institutional environments, so as to produce different modes of innovation (Hamdouch, 2009).

MOTIVATION OF INNOVATION NETWORK

The accumulation of knowledge (both explicit and tacit), skills and technological capabilities is fundamental to enhance firms' competences and innovation activities. Meanwhile, the emergence of complex knowledge and technologies require a new set of constant organizational changes and several types of learning competencies (like, know-how, skills and capabilities) to commercialize these new complex technologies (Rycroft, 2002). Therefore, collaborative relationships come into sight as crucial organizational changes in this new technological-based economy to off-set the deficiencies in firms' internal organizational and learning capabilities.

An innovation network manifests itself as prominent and sustainable way in accessing external technological capabilities and in delivering innovation in today's environment. Tushman (2004) determined four main reasons for firms' tendency to innovate through network rather than depending only on their internal activities. 1) Increase development time, 2) increase costs, 3) decrease product life cycle, 4) rapid globalization and competition for limited scientific expertise.

In fact, building an open model of innovation is a crucial motivation for developing innovation network. Until recently, innovation has been an internal process to the firm's boundary, directed by a fully controlled system and managed through hierarchical mechanism. Information and knowledge are considered private to the firm, where the diffusion of knowledge for actors out of firm's boundary is not possible under normal conditions. This debate, however, is less rational in a world described by high pace of innovation, high rate of change, globalization, mobile work force and uncertainty, therefore, the socialization of knowledge is demanded for increasing flexibility and reducing the risk of autonomous knowledge production (Sawhney and Prandelli, 2000).

In the innovation network, the firms' technological capabilities encompass both internally developed technologies and technologies developed out of firms' boundaries. In this case, the innovation paradigm will shift from closed to open innovation where firms constitute external connections (channels), social network and knowledge communities that enable these firms to capture both internal and external creativity and commercialize their own ideas to market by developing pathways out of current business (Chesbrough, 2003; Kline, 2003).

In services where the outcome is basically manifested in uncodified and tacit shape, the innovation network has different tasks. It is important in providing non-technological innovation. For example, new methods, approaches, organizational competences and designs lie in the core of those non-technological innovation activities.

CONSTRUCTION OF PPIN CONCEPTUAL FRAMEWORK

Increasing knowledge complexity has significant effect on the degree of complexity of PPIN, such as successful and efficient PPIN includes a wide variety of heterogeneous actors (like, industry incumbents, government policy makers and private actors). The natures of those actors depend on the endeavor of PPIN. For example, traditional PPIN which produce complex technologies need for actors with complex technological competences like universities, research centers. While "non-technological production" PPIN needs actors with non-complex competences like service firms and public service institutions.

As we concern only with traditional PPIN, it is important to know how interaction processes work in these complex structure. In other words, there is a need to define the features of such complex innovation structure by developing a theoretical perspective on how the heterogeneous actors communicate and interact socially and dynamically in a proper way that leads to producing new technological innovations.

To investigate this issue, we will construct a conceptual framework that combines the heterogeneous actors and standardize the dynamic process of interactions that include the key successful factors. In other words, we will develop a mediation framework between public and private actors in a complex networks which finally leads to an efficient and successful implementation of innovation output. Empirically, this conceptual framework can be applied to describe the innovation processes in actual PPIN (like, in transport, health sector, etc) to produce new technological outputs.

The conceptual framework will be constructed to synthesize four basic elements. Firstly, it will take into account the inclusion of public actors as main factors to the innovation networks. The public universities and research centers are the main representatives for those public actors, due to their abilities to provide complex knowledge and technologies. Secondly, the process of interactions between different actors is a dynamic and evolutionary process. Such process is responsible for the network structure overtime. Thirdly, the processes of ties decoupling and fragmentation are combined with the emergent and development of social network. The question is how these social interactions could generate knowledge disclosure between network actors to stimulate different forms of innovation. Finally, the innovation network has evolutionary path (life cycle), where in each stage of life cycle new interactions are re-arranged to construct the network structure overtime.

Descriptive approach supported by a group of theoretical perspectives will be employed in the constructing of the conceptual framework. The theoretical perspectives include diverse of theories from economic, management and social science. For example, interactive learning theory is important to capture the interactive processes between heterogeneous actors in one network, evolutionary economic theory is important to describe the interaction processes between different actors and dynamic processes of knowledge accumulation and diffusion, while social network theory and structuration theory are vital to show that networks are constructed into the social processes presented in the network and that these social processes are crucial to relationship founding and first stage performance, whereas new institution-

al theory and organizational theory are required to capture the institutional and organizational changes accompanied by innovation process and their role in developing innovation.

PUBLIC ACTORS' ROLE IN PPIN

The second part of the last century witnessed changes in the form of public output provisions. The output generally provided by public institutions, is now provided in collaboration with non-public actors. For example, private actors might cooperate with public actors to provide new public outputs. Public- private partnerships lie in the heart of these collaboration agreements. The main goals of collaboration are mitigating risks, minimizing costs and finding complementary financial resources. All these goals are considered non-innovational, while in PPIN, the production and diffusion of complex knowledge and technologies are becoming the main engines for collaboration. In this case the public actors are vitals due to their internal complex knowledge and technological capabilities that provided mainly by universities and public research centers.

The complementarity between public and private competences and the actors' absorptive capacity are important for efficient interaction processes. In other words, it is important to synthesize the interaction processes between public and private actors-they generally have different preferences and competences- in a way that avoids the inconsistency between their preferences and the technological capabilities.

Public actors (like, governmental agencies) have also minor role in the technological PPIN. They can regulate the interaction processes and provide the institutional envelope that will be aligned with the PPIN life cycle. These institutions might include new rules, routines, approaches, legal and government policies, new types of intervention tools, design of political initiatives which are adequate to foster the learning and knowledge exchanging processes and supporting functions that ensure the cross-flows of knowledge and information between other network actors.

Finally, the public role and participation do differ from PPIN to another, depending on the complexity degree of the network, power-sharing arrangements or relative-influence on the innovation between the public and private actors.

SOCIAL DIMENSION FOR PPIN (NETWORK AS A SOCIAL SYSTEM)

The extent of innovation outputs in PPIN depends on the efficiency of the interaction processes. The decoupling and fragmentation of ties lie in the core of interaction processes and are combined simultaneously with the development of social network (Agapitova, 2003). Therefore, PPIN is constructed into the social processes present in the networks (Samli and Bahn, 1992). The social capital enhances the collective learning between heterogeneous actors and impact the exchange behavior (Granovetter, 1985; Uzzi, 1997; Valley, Neale, & Mannix, 1995). Consequently, in PPIN, a socio-economic framework (regime) should be employed to incorporate both technological and social dimension of interaction processes.

Social processes are gaining more interest in PPIN because interactions between network actors strongly determine the innovative output. Therefore, social capital have vital role in relationship founding, first stage performance, and in maintaining the cooperation between network actors in the long-run. They are also crucial to balance the deficiency when using economic dimensions to describe social entities, mainly using physical artifacts and the corresponding R&D and economic activities to describe the different stages of life cycle of PPIN product (Pyka et al.2010).

Social network analysis (SNA) (Freeman 1984) is one of the most prominent techniques used to incorporate social dimensions, analyze social relations between individual firms or actors (Salavisa, 2009) shape the evolution of innovation in innovation networks and to determine the position receptivity or popularity of network actors (Wasserman & Faust, 1994).

SNA has metrics (measures) that can identify network characteristics from both actor-related and network-related level. Actor-related measures (like, degree centrality and closeness) are used to describe the role, power and influence of different actors in the process of exchange, creation and diffusion of new knowledge and technologies. While, network-related measures (like density, clustering coefficient) are important to attribute for the overall measurement of network characteristics regardless of the actor-level assessment. They are important in determination of the evolution of innovation network, and establish other important factors related to the innovation process like, the stability of network (more density network lead to more stable network), the speed and number of channels for information flow (high connectivity provide different ways for knowledge diffusion).

SNA was employed by many scholars in innovation network discussion. For example, Messica (2007) in static analysis of innovation network in high-technology sector used three SNA metrics like, clustering coefficient, the extent of the network and the mean connectivity. He classified innovation networks into five categories: ring, mesh, star, fully connected and line. Cowan et al. (2004) in dynamic analysis of innovation networks, used different SNA metrics like, local order or cliquishness, path lengths and density. They found that knowledge creation through emerging network was the corner stone of the innovation process. Watts (2003) used distance between nodes to estimate the effect of network structure and actors' behavior. Pyka et al. (2010) in their analysis of innovation network, classified SNA measures into two groups. The first group includes actor related measures: degree centrality, closeness centrality and betweenness centrality. The second group includes network-related measures to describe the structure of the whole network: density, connectivity, distance, degree distribution and clustering.

DYNAMIC OF PPIN

The interaction or communication processes between network actors are not static; they are dynamic or evolutionary processes (Arechavala-Vargas et al. 2009) and accompanied with ties decoupling and fragmentation processes (i.e. the entry of new actors and exit of others or forming of new ties and dissolving of others), which lead to different structures with different roles for network actors over time. The efficient dynamic process should match between two network specificities: the enormous complexity of the interac-

tion patterns and different incentives and information that determine the behavior and preferences of actors (Schweitzer et al.2009).

The dynamic processes are important as they induce knowledge accumulation and learning (Garcia-Pont and Nohria, 2002; Gulati, 1999; Powell et. al 1996) and allow accessing for new technologies that promote innovation output. According to Lane and Maxfield's (1997; 2005), the dynamic interaction processes in the innovation network that contains heterogeneous actors can lead to structure that is significant for the innovation processes.

Dynamic innovation network mean that the state of the network in one period determines their state in subsequent periods. Therefore, the initial form of network has fundamental role in the evolution of the network at later stages and determining of its final structure. Nevertheless, this does not imply that the innovation network will maintain a stable form over time. A network may start spontaneous with informal interactions between actors where the entrepreneurs play vital role in making the network function and develop the innovation in its initial form. Then, at later stages develop into permanent network and become more professional in terms of internal management and developing of learning toward network sustainability (generating series of innovation) (Weber, 2009).

Topologically, it is expected that the conceptual framework for PPIN considers both the dynamic process of interactions and the structure of the network, because different evolution rules lead to different network topologies.

EVOLUTIONARY MODEL FOR PPIN

The dynamic process of PPIN is systematic. It follows evolutionary path (life cycle model) structured in a way that leads to new innovative products. Meanwhile, each new innovation output requires different modes of interactions between network actors (i.e. the exchanged knowledge to produce output "X" will certainly be different from that of producing output "Y"). So, it is important to have a theoretical concept that explains the way the structure of innovation networks change or evolve overtime (theoretical life cycle model) arriving to an efficient network structure.

The life cycle model is important to explain the network function and success factors, redefine actors' roles over time and distinguish between different networks (i.e. if there are similar temporal patterns of evolution across different networks) regardless the mode of innovation output which might extending from technology-intensive to primarily organizational changes.

In literatures, we can find many approaches to describe the network life cycle model. Jackson and Wolinsky (1996) for example, introduced a game theoretical setting (co-author model). Li (2005) proposed a socio-cognitive model for newly development product illustrating the dynamic of interaction between technological platform/hard architecture of knowledge and communities/soft architecture of knowledge that lead to open innovative and new products. Podolny et al (1996) used niches in evolutionary theories of technological network (technological network niches). Weber (2009) proposed other theoretical model that explains the network life cycle like, chaos theory or cybernetics for public-private network.

Product life-cycle growth model were found to be the most prominent theoretical concept that used to incorporate the network dynamic process (Weber, 2009; Pyka et al., 2010). Product life cycle model has four[1] main stages: initial, growth, maturity and decline stage. The innovation networks evolve through life cycle model and each stage has different form of innovation activities.

The product life cycle model was successfully applied to describe the life cycle of innovation networks in manufacturing sector to produce new technological output (technological innovation) (Jovanovic, 1994; Klepper, 1996; 1997). Therefore, the application of product life cycle model on traditional PPIN is likely to be efficient.

Two important points should be considered when applying product cycle growth model on PPIN. Firstly, it should consider the social dimensions that are important in the formation of PPIN. Secondly, it is difficult to follow the four life- cycle stages (initiation, growth, maturity, and decline) in some forms of PPINs, due to the dissolve of network before decline state, the start of a new cycle within the same network (Tushman and Anderson, 1986) or in some cases, network follows more than one evolutionary paths (Weber, 2009).

The introducing of "socio-economic approach" that consists of both economic measures (relative performance) and relevant social indicators (measures) allow to adjust the product life cycle model to incorporate the social dimensions of interaction process (Cowan, 2004; Koenig et al. 2007 and Pyka et al., 2010)

CONCEPTUAL FRAMEWORK FOR PPINS

PPIN framework is a process of comprehensive conceptualization for an innovation process that formed through the synthesizing between the four constructing elements in an open, complex, social and interactive process of innovation (see fig.1). The synthesizing process involved the consistency between public and private actors who interact dynamically in the product life cycle model, reinforced by social capital and supported by appropriate institutional and organizational changes to facilitate the process of interactions and lead to efficient and successful innovation process. The innovation output under the conceptual framework will be provided as follows: the public and private actors communicate and interact between each other where complex knowledge and technologies are exchanged between them in a collaborative environment and supported by the social capital, to produce new technological innovation. The complementarities between actors' knowledge and technological resources are crucial for successful and efficient interaction processes. The interaction processes and the production of new innovation output are dynamic processes along the network life cycle. In each stage of network life cycle, the nature of interaction processes and innovation activities (the mode of innovation in the first stage of network formation is different from that at the growth or maturity stage) are different determined by the type of actors, the SNA dimensions and the mode of knowledge and technologies exchanged. The diversity of innovation activities along the evolutionary path is critical underpinnings for a successful PPIN life cycle.

The existing of social capital in the innovation network safeguards continu-

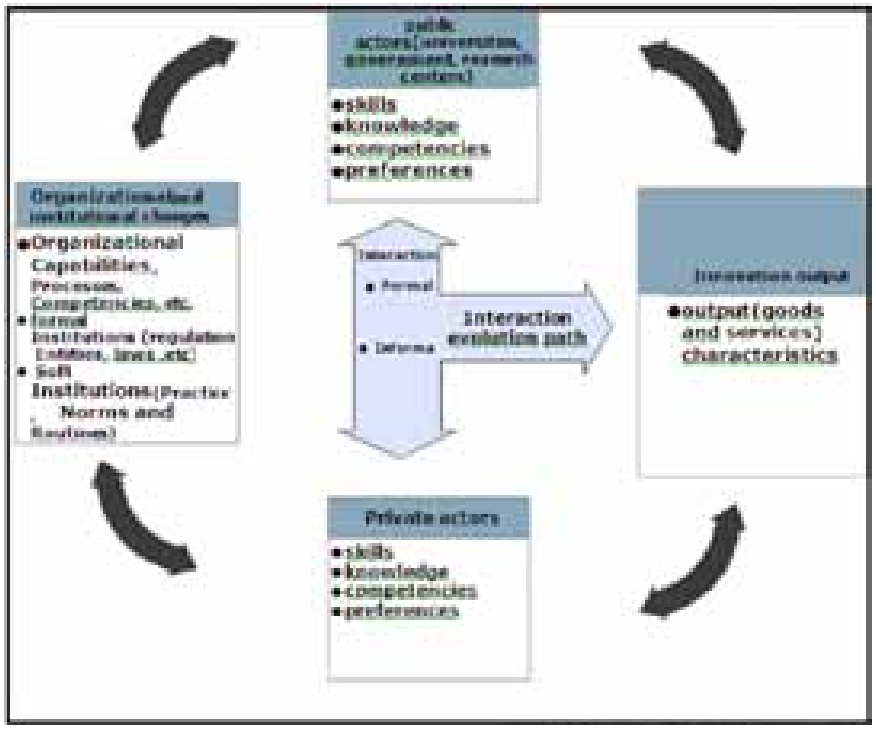

Figure 1: PPIN Framework

ous and efficient process of flowing knowledge and technologies between public and private actors. In addition, the definition of public and private actors' roles in the innovation process in all life cycle stages reveals a crucial point upon applying SNA in PPIN. For example, actor with high degree centrality (enabling or control power) means that they have a prominent role in the success or the hamper of innovation process, as they can control the creation and flow of knowledge and technologies through the network and determine the quantity and quality of interactions with other network actors.

The dynamic process of PPIN allows for the transition from the initial to the decline stage of the network life cycle and shows how the competences and preferences of one actor co-evolve overtime with the competences and preferences of the other network actors supported by a "feedback mechanism", where actors either reinforce each other to produce and diffuse of new technological resources or they conversely block the effect of each other.

INSTITUTIONAL AND ORGANIZATIONAL DIMENSIONS OF CONCEPTUAL FRAMEWORK.

Organizational thinness and weak building of institutional framework are two main network failures. Transformation from a close notion of innovation process (innovation is a decision of one actor) to an open process of innovation (innovation output is a result of collaborative effort of several actors) entails decisive path-shifting in terms of organizational and institutional patterns to form a supportive instrument for the innovation process and avoid any possible contradictory forces between the heterogeneous preferences and competences of network actors, which if not handled appropriately might lead to the emergence of lock-in forms of innovations. Consequently, PPIN must undertake organizational and institutional changes to evolve in a different level along the network life cycle, where inappropriate organizational changes and divergent orientation of existing institutions in one stage may lead to serious innovation problems in other stages.

In fact, organizational changes represent a parallel path for the network evolutionary path. Organizational competences are developed to cope with the creation and diffusion of new knowledge and technologies along the network life cycle, where the shift from one stage to other requires the shift in the organizational patterns to organize the behavior of actors and the interactions between them.

The process of innovation and institutional adaptation are two interactive entities in PPIN structures. The institutional competences in PPIN serve as a medium where knowledge and technologies are combined with routines, norms, rules, regulations and mutual understandings to facilitate the process of interactions and to have efficient exchange of information between network actors. They allow for PPIN to survive and act in high changeable and uncertain informational and technological system, by safeguarding the mutual relationships and securing the flow of knowledge and technologies between different actors and determining the factors that may impact on fostering or constraining the innovation processes.

Institutional adaptation includes wide varieties of practices which are provided by public institutions, private institutions or from individuals. They might comprise funding organizations (banks, venture capital companies, 'business angels', public funding agencies, etc.), law companies (especially those specialized in property rights issues) and regulation entities (standardization committees, ethical commissions, etc.) (Hamdouch, 2009).

SUMMARY

We have developed a conceptual framework that used as a "comprehensive mechanism" for producing and diffusing technological innovation in traditional PPIN. This mechanism is built through the cooperation between public and private actors in a complex, dynamic, social and interactive network structure. Innovation output is produced through dynamic interaction processes between the public and private actors along the network life cycle. In each stage various interactions occur and different modes and quantities of knowledge and technological resources are exchanged reinforced by the flowing social capital. The association between product life cycle model and SNA shows how is the structure of PPIN in each stage of life cycle and reveals crucial information about how public and private actors' roles are embedded through network life cycle, which leads to a successful innovation output.

Organizational and institutional

changes are important for efficient constructing of PPIN. They will facilitate the initiation of collaboration between PPIN actors, the exchange of knowledge and competences in all stages of network life cycle and to avoid any prospect conflict between heterogeneous preferences and competences of network actors.

NOTES

[1] *Weber (2009) proposed network life cycle from three stages: 1) prototype-industry, 2) commercialization and entrepreneurial, 3) consolidation and firm growth.*

REFERENCES

Agapitova, N. (2003), The Impact of Social Networks on Innovation and Industrial Development: Social Dimensions of Industrial Dynamics in Russia, Paper presented at the DRUID Summer Conference 2003 on Creating, Sharing and Transferring Knowledge: The Role of Geographical Configurations, Institutional Settings and Organizational Contexts.

Arechavala-Vargas, R.; Diaz-Perez, C.; Holbrook, J.A., 2009. Globalization of innovation and dynamics of a regional innovation network: the case of the Canadian Fuel Cell Cluster, Science and Innovation Policy, Atlanta Conference, 1-7.

Belussi, F., and Arcangeli, F. 1998. A Typology of Networks: Flexible and Evolutionary Firms. Research Policy, 27:415-428.

Cantwell, j., and Santangelo, G., 2006. The boundaries of firms in the new economy: M&As as a strategic tool toward corporate technological diversification, Structural Change and Economic Dynamics, 17, 174-199.

Chesbrough, H.W., 2004. Managing Open Innovation', Research Technology Management, January-February, 2004, pp 23-26.

Cowan R., Jonard N., and Ozman, M., 2004. Knowledge Dynamics in a Network Industry. Technological Forecasting and Social Change, 71, 469-84.

Doreian, P., 2002. Events sequences as Generators of social Network evolution, Social Networks, 24, 93-119.

Edquist, C., ed 1997. Systems of innovation. Technologies, Institutions and Organizations. London and Washington: Pinter.

Freeman, R.,1984. Strategic Management: A stakeholder approach. Boston: Pitman.

Freeman C., 1987.Technology Policy and Economic Performance. Lessons from Japan. London; Pinter.

Freeman C., 1988. Japan: a new national system of innovation? In Dosi G; et al. (Eds.) Technical Change and Economy Theory, Londres - New York, Pinter Publishers, pp. 330-348.

Freeman, C., 1991. Networks of innovators: a synthesis of research issues. Research Policy (October), 499–514.

Freeman, C., 1995. `The "National System of Innovation" in Historical Perspective', Cambridge Journal of Economics,19(1).

Garcia,P., and Nohria, N., 2002. Local versus global mimetism; the dynamics of alliance formation in the automobile industry, Strategic Management Journal, 23, 307-21.

Gertler, M., and Wolfe,A., (eds) 2002. Innovation and Social Learning: Institutional Adaptation in an Era of Technological Change. Basingstoke, UK.

Gipouloux, F., 2000. "Network and Guanxi: Towards an Informal Integration through Common Business Practices in Greater China." Pp. 57-70 in Chan, Kwok Bun (ed.) 2000. Chinese Business Networks: State, Economy and Culture. Singapore: Prentice Hall and Nordic Institute of Asian Studies.

Granovetter, M., 1985. Economic action and social structure: the problem of embeddedness, American Journal of Sociology, 91, 481-510.

Gulati, R.,1999. Network Location and Learning: the influence of network resources and firm capabilities on alliance formation, Strategic Management Journal, 20, 397-420.

Hamdouch A., 2009. "Networking, Clustering and Innovation Dynamics in the Global Economy: Features, Challenges and Open Issues", Journal of Innovation Economics, n° 4, December, p. 5-13.

Iacobucci, D., 1996. Networks in marketing. Thousand Oaks: Sage.

Jackson, M.O. and Wolinsky, A., 1996. .A Strategic Model of Social and Economic Networks,.Journal of Economic Theory, vol 71, No. 1, pp 44.74.

Jovanovic, B., MacDonald, G.M., 1994. The life cycle of a competitive industry. Journal of Political Economy 102: 322-347.

Joy, E., 1964. The Concept of Field and Network in Anthropological Research. Man, 177,137-9.

Klepper, S., 1996. Entry, Exit, Growth, and Innovation over the Product Life cycle, American Economic Review, American Economic Association, 86, 562-83.

Klepper, s., 1997. Industry life cycles. Indust. Corporate Change 6(1) 144–181.

Kline, D., 2003. Sharing the Corporate Crown Jewels, MIT Sloan Management Review, Spring 2003, 89-93.

Koenig, S., Battiston, M, . Napoletano, F., Schweitzer:F., 2007. On Algebraic Graph Theory and the Dynamics of Innovation Networks, Networks and Heterogeneous Media.

Lane, D., and Maxfield, R., 1997. Foresight Complexity and Strategy', in: W.B. Arthur, S. Durlauf and D.A. Lane (eds.), the economy as an evolving complex system II. Redwood City, CA: Addison Wesley.

Lane, D., and Maxfield, R., 2005. Ontological Uncertainty and Innovation', Journal of Evolutionary Economics, 15.

Li, J., 2005. Unleashing Innovation: A socio-Cognitive Approach, DRUID Tenth Anniversary Summer Conference: Dynamics of Industry and Innovation: Organizations, Networks and Systems.

Lundvall, B., 1988.Innovation as an Interactive Process: from User-. Producer Interaction to the National System of Innovation', in Dosi et al. (eds) Technical Change and Economic Theory, London and Washington: Pinter.

Lundvall, B.-A. (ed.), 1992, National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning, London: Pinter.

Messica, A., 2007. Innovation Networks taxonomy and Efficiency-Toward Innovation Engineering. The Center for Entrepreneurship and Innovation Management, Holon Institute of Technology.

Nelson, R., 1988. Institutions Supporting Technical Change in the United States, in Dosi et al. (eds) Technical Change and Economic Theory, London and Washington: Pinter.

Nelson, R.R. (ed.), (1993), National Innovation Systems. A Comparative Analysis, Oxford : Oxford University Press.

Podolny, J. M., Stuart, T. E., & Hannan, M. T. 1996. Networks, knowledge, and niches: Competition in the worldwide semiconductor industry, 1984-1991. American Journal of Sociology, 102(3): 659-689.

Powell, W., Koput, K., and Smith, D., 1996. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology, Administrative Science Quarterly, 41, 116-145.

Pyka, A., 1999. Innovation Networks in Economics. From the Incentive-based to the Knowledgebased Approaches, SEIN-Working Paper , #1, April 1999.

Pyka, A., Schon, B., Triulzi, G., Windrum, P., Filiou, D., Frenken, K., Sundbo, J., Sceuer, J., and Fuglsang, L., 2010. Cooperation for Innovation in Services: Taxonomy of Innovation, Cooperation, and Networks in Service Industries, Servppin project, European Commission, FP7.

Rossi, F., Russo. M., Sardo. S., and Whitford, J., 2009. Innovative interventions in support of innovation networks. A complex system perspective to public innovation policy and private technology brokering, Department of Economics 0619, University of Modena and Reggio E., Faculty of Economics "Marco Biagi".

Rycroft R., 2003. Technology-based globalization indicators: the centrality of innovation network data, Technology in Society, 299-317.

Salavisa, I., 2009. Enterpreneurship and Social Networks in IT Sectors: the Case of the Software Industry in Portugal, Journal Innovation Economics, 4.

Samli, A., and Bahn, K., 1992. The Market Phenomenon: An Alternative Theory and Some Metatheoretical Research Considerations Journal.

Sawhney M., Prandelli E., & Verona G., 2003. Innomediation: exploiting the power of mediated innovation. Sloan Management Review, 44, 77-82.

Schweitzer, F., Fagiolo, G., and Sornette, D., 2009.Economic Networks: What do we Know and What do we Need to Know?,Advance in Complex Systems, 12, 407-422.

Thijssen, J.P.T., and Vernooij, A.T.J., 2004. Bridging the Gap between Academic Degrees and Life-long Learning Processes: Designing Life-long Learning Processes. In: Educational Innovation in Economics and Business IX, Breaking Boundaries for Global Learning, R.T. Milter, V.S. Perotti, and M.S.R. Segers, eds., Springer, Dordrecht, pp. 137-156.

Todtling, F., and Trippl, M., 2005. One Size Fits all?: Towards a Differentiated Regional Innovation Policy Approach, Research Policy, 34, 1203-1219.

Tushman, M., 2004. From Engineering Management/R&D Management, to the Management of Innovation, to Exploiting and Exploring over Value Nets: 50 Years of Research Initiated by IEEE-TEM. IEEE Transactions on Engineering Management, 51, 409-411.

Tushman M. et Anderson P., 1996. Technological discontinuities and organisational environments », Administrative Science Quarterly, 31.

Uzzi, B., 1997. Social structure and competition in interfirm networks: The paradox of embeddedness, Administrative Science Quarterly, 42, 35-67.

Valley, K., Neale, M., and Mannix, E., 1995. Friends, Lovers Colleagues, Strangers: the Effects of Relationship on the process and Outcome of Dyadic Negotiations, in Lewicki R and Sheppard B.(dir), Research on Negotiation in Organizations, 5, 65-93.

Wasserman, S., & Faust, K., 1994. Social network analysis: methods and applications. Cambridge, England: Cambridge University Press.

Watts, 2003. Six Degrees: The Science of a Connected Age. Norton, New York.

Weber, M., 2009. Public Private Innovation Network in Transport, ServPPIN project, European Commission, FP6.