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Diffusion and appropriation of knowledge in different organizational structures¹

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Introduction

Innovation has traditionally been viewed as a mechanism for acquiring quasi-rents, either temporal (Schumpeter 1934) or permanent (Schumpeter 1942), and as a key element in economic development. These ideas have older roots than conventionally perceived and may be found in some pre- and post-Smithian authors in the last four centuries (e.g., Serra 1613; Steuart 1767; List 1841; Sombart 1928) who had already discussed the relevance of productive and commercial specialization profile in economic development (Reinert 1999). The role of knowledge in the economy was also explored by Arrow (1962) and Nelson (1962) and revisited by neo-Schumpeterian and evolutionary thinking in the last 20 years (e.g., Freeman 1994; Nelson and Winter 1982; Dosi et al. 1988; Metcalfe et al. 2003). The latter have enriched the analytical framework by highlighting the importance of knowledge in networks, local systems and institutions in the framework of technological, organizational and institutional change (Langlois 2003).

These issues have been central to the experience of different countries and scholars in the last centuries, in particular: [i] the non-vulgar mercantilist thought - a key role of a specialization focused in products with increasing returns to scale and therefore decreasing costs (e.g., Serra 1613); [ii] the Italian thought before and after Adam Smith as well as the policy prescriptions associated with it through state intervention that promotes increasing returns activities, discourages decreasing returns activities, and attributes importance to investments in education, science and innovation (Reinert, S. 2005); and [iii] the German school in Economics since the Cameralists in the 17th century, going through the Historical school in the 18th and 19th centuries and the impact of Sombart on Marx and Schumpeter (Reinert, E. 2005). The same ideas have been posed by classical development authors (e.g., Rosestein-Rodan 1943; Singer 1950; Nurkse 1952; Lewis 1954; Hirschman 1958) who support the idea of the central role of imperfect competition, increasing returns to scale and excess labor not absorbed by the productive system, as well as elasticity of the labor supply to explain why economic development is such an uneven process, especially in developing countries. In this context, Reinert (1994) distinguishes two ways in which the benefits of technical progress spread across society: i.e., either in the *classical* way as lowered prices (in a regime of perfect competition) or in the *collusive* way as increasing profitability and higher salaries (in a regime dominated by barriers to entry produced by increasing returns and/or Schumpeterian imperfect competition).

For firms and other organizations, the technological revolution has underlined two central issues: [i] the endogenous character of knowledge in economic activities, and [ii] the growing importance of intangible assets in the

generation of dynamic competitive advantages in the context of imperfect markets. Likewise, the loosening of organizational structures associated with the new technological paradigm stresses the importance of the conversion of individual firms to schemes that place competition in the framework of local systems, global chains, clusters and production networks.

Established literatures on knowledge have made substantial attempts focusing on these topics from the point of view of firms and sectors. Except perhaps for a few cases (Cohendet et al. 1999; Ernst and Lundvall 1997), it is rare to find contributions linking the development of production networks with knowledge generation or the building of competitive advantages and associated market structures in developing countries. A significant part of these earlier discussions has focused on differentiating codified from tacit knowledge (Cowan et al. 2000; Johnson et al. 2001) and on identifying and characterizing the different dimensions of knowledge for the purpose of capturing its complexity (Nightingale 2003). Only a few discussions have included the factors involved in the process of knowledge transformation (Nonaka and Takeuchi 1995) and some have only marginally dealt with aspects connected to its generation (Ancori et al. 2000; Nonaka and Takeuchi 1995; Nonaka and Toyama 2002). In even fewer cases has the role of demand been introduced into the discussion as a key factor to explain knowledge metabolism and the prevailing type of technological regime (Malerba and Orsenigo 2000). Finally, some authors have made contributions linking the development of production networks with knowledge generation or the building of competitive advantages and associated market structures in developing countries (Cohendet et al. 1999; Ernst and Lundvall 1997).

In this sense, the literature about knowledge has made an important effort to explain the processes behind the creation of competencies, working on the distinction between tacit and codified knowledge, of learning mechanisms and the generation of competitive advantages in individuals, organizations and productive systems.

From different perspectives, most of the subsequent contributions have agreed on recognizing the tacit and codified dimensions of knowledge and thus enriching the previous notion which simply equated knowledge with information (e.g., Lundvall 1996; Ernst and Lundvall 1997; Antonelli 1999; Nooteboom 1999; Ancori et al. 2000; Cowan et al. 2000; Malerba and Orsenigo 2000; Johnson et al. 2000; Nonaka and Toyama 2002). This wide literature has focused on, among other things, ways of learning, types of knowledge, and the transformation of one form into another, which explains the creation of new knowledge and the development of competitive advantages. Moreover, works produced in other disciplines and fields,

such as anthropology (Bloch 1991; Goody 1977) and the cognitive sciences (Brown and Duguid 2000; Rogers 1962) have made it possible to reinterpret the abovementioned literature by emphasizing the existence of the logic specific to each knowledge dimension and which, in turn, conditions the possibilities of [i] transformation and diffusion, opening up the discussion on knowledge creation by including the development of cognitive capacities, and [ii] exclusion and appropriation sustaining competitive advantages.

The existence of a different logic to each form of knowledge implies complementarities among the different types rather than processes of conversion. In this sense, the problems derived from the processes of transformation of tacit into codified knowledge and vice versa show that the characteristics of knowledge are partly responsible for defining the limits of their diffusion. It is expected that the more codified the knowledge generated by the diverse organizational forms, the greater the diffusion and, therefore, the higher the risk of not appropriating quasi-rents derived from the development of cognitive capacities. Thus, the circulation of knowledge inside organizations or productive systems depends both on the degree of complexity of cognitive capacities and on the type of protection that can be constructed based on the same capacities. Consequently, the idea of knowledge as a public good is relativized. In one extreme, we find that where barriers to entry are low, less cognitive skills are required for de-codifying the knowledge and information necessary to undertake production. At the other extreme, knowledge circulates only inside the network or epistemic community that produces it, being a 'club good'. As a consequence, the possibilities of appropriating economic profits that this knowledge generates will depend on the efforts carried out by the agents to restrict their circulation beyond the limits of the organizational form in question (Erbes et al. 2006a).

Within this framework, the central question of this paper is: what are the forces that determine the continuum negative relationship between knowledge diffusion³ and appropriation in the context of the new techno-productive paradigm? In connection to this question we will make reference to the following issues: [i] How does new knowledge spread in a capitalist economy and how is this issue related to a collusive or classical spread of the benefits of technical progress?; [ii] Does the underlying logic specific to tacit and codified forms of knowledge have a bearing on diffusion and appropriation dynamics?; [iii] Can the creation of cognitive capacities at the

³ In this paper, the term diffusion is applied to the leakages of key knowledge necessary to create competitive advantages in a certain organizational form.

organizational level be understood as a relevant form of protection in the economy of the knowledge era?

There are also other questions related to the central issues discussed in this paper. The literature on technological change has emphasized the role of technological regimes and of different market forms to characterize the sector's competitive environment in which firms go about their businesses. Is it then relevant to think also of a knowledge management regime which underlines the knowledge creation process and the development of cognitive capacities independent of the two other regimes identified? To what extent can knowledge diffusion and appropriation processes be understood from the interaction of these three dimensions? How does this interaction manifest itself in the wide spectrum spanning from individual firms, where relations are circumscribed solely to a mercantile interchange, through networks in which there are strong interactions and knowledge flows amongst the agents? And finally, what specificities do these questions have in less developed countries where specialization profiles are less knowledge intensive?

From a methodological point of view, the questions posed in the three dimensions considered (technology, knowledge and competition) are visualized as regimes. The notion of regime refers to a systemic approach which incorporates a set of norms and rules that explain and give consistency to agents' behaviour. It is underlined in evolutionary and neo-Schumpeterian thinking such as path dependency, indetermination, multiple equilibria and lock-in effects (Metcalfe et al. 2003).

The objective of this paper is to discuss the connection between knowledge diffusion and appropriation as construction of competitive advantages in different kinds of organizational structures. The main hypothesis is that the inverse relationship between diffusion and appropriation depends strongly on the simultaneous interaction of technological specificities, knowledge management, and prevailing market structures. We believe that the creation of competitive advantages rests on the development of agents' cognitive capacities, which enable them to appropriate a larger portion of the knowledge they generate in terms of quasi-rents. As a consequence, the development of these cognitive capacities allows the management of tacit and codified knowledge and acts as a barrier to decodification, thus raising the minimum thresholds needed for its appropriation and as such restricting the entrance of new firms.

The first section proposes a taxonomy of firms based on the relative importance given to knowledge as a source of competitive advantages on different organizational forms of production. There will be an evaluation of each type in terms of technology and knowledge management and market struc-

ture. The presentation and discussion of the taxonomy makes it possible to explore two central ideas of this paper: the existence of different logics between tacit and codified knowledge, on the one hand, and the idea that not only must technology be considered from the perspective of certain sectoral specificities (as elements of coherence within each sector), but also from the perspectives of knowledge and competition, on the other. The second section analyzes the connections between knowledge diffusion and appropriation as a result of the simultaneous interplay amongst the three regimes. Finally, the third section draws the conclusions and presents some policy recommendations.

1. Knowledge and different organizational forms: Effect of technology, knowledge, and competition regimes

We have already mentioned the existence of different logics underlying each type of knowledge. This stresses the idea that the development of cognitive capabilities at the organizational level is more closely linked to the kind of integration between both forms of knowledge than to the predominance of one of them. It is in this framework that we can explain the dynamics of diffusion and appropriation of knowledge.

Some scholars have made important contributions to the development of typologies related to technology (Malerba and Orsenigo 2000) and to regimes of competition (Metcalf et al. 2003) in order to explain innovation dynamics and the way they appear in different sectoral and institutional contexts. In this section, the idea of knowledge regime is introduced to explain how the inverse relationship between knowledge diffusion and appropriation works. In this sense, the principal hypothesis is that the generation of cognitive capacities in individual agents or in networks is associated with the creation of quasi-rents which depend on the kind of technology, competition and knowledge regimes.

We have developed a taxonomy of agents which combines both the importance of the interactions and articulations between agents, and the importance of knowledge as a source of differentiation.⁴ Thus, four extreme cases can be identified: firms in knowledge production networks; firms in networks where knowledge is not a key source of differentiation; firms that

⁴ Ocampo (2005) has carried out a similar exercise. He proposes a sectoral taxonomy for developing countries using two dimensions: the innovation process associated with learning and the complementarities (linkages, agglomeration economies and specialization and spillovers) among the agents that in the virtuous cases generate dynamic economies of scale. According to him four groups can be built: [i] Deep (strong learning processes and complementarities); [ii] Shallow (weak learning processes and complementarities); [iii] Labor Absorbing (weak processes of learning and strong complementarities); and [iv] Short Breath (strong processes of learning and weak complementarities).

do not operate in networks but whose knowledge is based on endogenous competences; and isolated firms independent of the importance of knowledge (see Table 1). It is a heuristic device that, through the identification and characterization of certain ideal types, enables us to test the idea that competitive advantages are acquired in a framework where the three regimes (technology, knowledge and competition) interact.

Table 1
Firms' taxonomy according to the importance of knowledge and of production networks

Importance of production networks	Importance of knowledge as source of firm's differentiation	
	Low	High
Low	Isolated firms	Knowledge islands
High	Bureaucratic production networks	Knowledge production networks

Source: Own elaboration

(i) *Isolated firms*. These firms do not operate in networks. The knowledge they generate and help to circulate is reduced. The relationships with other agents are limited to commercial transactions. These transactions do not always take place amongst the same agents and thus are not recurrent in time. This pattern limits the development of linkages that favour the circulation of knowledge and the emergence of transfer processes. Therefore, there are no collective learning mechanisms. Saxenian (1994) calls this type of firms 'independent'. They have limited capacities for innovation because they work in a closed context where interactions with other firms and institutions are weak. Their limited innovation capacities are also associated with technological and competition specificities.

(ii) *Bureaucratic networks*. These networks are made up of firms which attach little importance to the generation and circulation of knowledge produced at the local level. Whereas technical progress is incorporated in capital goods, there tend to be little 'knowledge' connections between subsidiaries and headquarters. For example, in the case of the automobile sector, several authors qualify as 'weak' the existing networks in developing countries, where commercial type relations are dominant (Novick and Gallart 1997; Motta 1999; Cimoli and Constantino 2000; Albornoz and Yoguel 2004). Marin and Bell (2005) define a similar category to identify an important group of subsidiary businesses of multinationals in developing countries (the 'shallow' type in Ocampo 2005).

(iii) *Knowledge islands*. Although these firms do not operate in networks, their competitive advantages are based on the transformation of knowledge through an important accumulation of endogenous competences (innovative and entrepreneurial capabilities) Their isolated character neither lets them get synergies from the environment they belong to nor do they generate strong spillovers. This kind of firm is quite similar to those what Ocampo (2005) refers to as 'short breath'. Some advanced software and biotechnology firms in developing countries belong to this group (Erbes et al. 2006b).

(iv) *Knowledge networks*. This group is made up of firms operating in networks in which the importance of the generation and circulation of knowledge and the technological interrelations and complementarities among agents are key factors for the production of increasing returns, dynamic competitive advantages and quasi-rents (Cimoli 2005). In this sense, these firms create their own markets where buying and selling relationships are accompanied by significant flows of knowledge. The utilization of the knowledge generated allows them to compete from an oligopolistic position. Saxenian (1994) defines this organizational form as an industrial network-base system, and associates it with the businesses of Silicon Valley and Route 128 in Boston (Power and Lundmark 2004).⁵

In the following sections each of these groups is characterized in terms of: [i] the technology regime (see Table 2); [ii] the knowledge regime (see Table 3); and [iii] the competition regime (see Table 4). From a given configuration of a technological regime, the knowledge regime conditions the learning processes needed to generate dynamic competitive advantages. As opposed to the idea of the well-known paradigm of structure-conduct-performance, the joint action of the first two regimes conditions the capacity of the different organizational forms to operate in a market structure that facilitates their appropriation of quasi-rents.

Technology regime

Following Malerba and Orsenigo (2000), by **technology regime** we understand the set of characteristics that refer to the accumulativeness, appropriability, opportunity and knowledge base that define a technology. The combination of these characteristics configures a pattern of sectoral behav-

⁵ The open source software or free software community can also be thought of as a knowledge network. In this case, thousands of agentes (firms and individual programmers) use the free source code available in the Internet on the bases of their own capacities and competences. In this sense, this code is a club good developed and appropriated by a community where barriers to entry are defined by cognitive capacities.

ious in the case of developed economies under the assumption of intragroup homogeneity. In terms of the technological regime, two different behaviours associated with a Schumpeterian perspective can be found in the literature. Both the isolated firms and those belonging to the islands of knowledge group develop in a context close to a Mark I pattern. Thus, there are different gradients of free entrance of businesses, constantly challenging the incumbent agents in the market. In such a pattern, the continuous changes in production, organization and distribution cause the destruction of quasi-rents. In the opposite extreme, both the knowledge and bureaucratic production networks, with a key role of large multinational and big national businesses, operate in a context where the characteristics of Mark II regimes are dominant. In this case, high barriers to entry prevail (i.e., based as much in market regulations as in the development of cognitive capacities), and thereby limiting the participation of new agents. In this case, there are functions of decreasing costs as a result of a curve of learning determined by technological cumulative factors, the development of externalities and complementarities among agents (Cimoli 2005).

For isolated firms, the accumulativity⁶ is reduced because of the limited knowledge integration process that can be developed outside of the limits of the firms. This is a consequence of a scarce accumulation of knowledge and the absence of formal and informal networks. In this sense, the accumulation of knowledge is expected to be derived mainly from incorporated technology and licenses. On the contrary, in knowledge networks there is a high accumulativity derived from important endogenous efforts in the construction of competences. In these networks, there are many significant linkages within and outside firms; these linkages connect organisations with technological and scientific systems. This pattern explains the virtuous character of these kinds of networks. The strong knowledge accumulativity, reinforced, at the same time, by the incorporation of capital goods gives rise to radical and incremental innovations.

In the less virtuous extreme, the appropriation appears quite weak, since market structures in which these firms operate do not protect innovations from copies. On the contrary, knowledge networks are characterized by a high appropriation of the innovations by the agents that belong to the network.

In terms of technological opportunity⁷, the performance of isolated firms is reduced and only centered upon static competitive advantages, coming fun-

⁶ Accumulativity refers to the existence of a path in the accumulation of knowledge carried out by a firm belonging to a certain sector. The implicit issue in this idea is that the present learning is the result of prior efforts that permitted the construction of a knowledge base.

⁷ This dimension reflects the capacity to innovate in terms of the productivity performance of R&D expenditures.

damentally from natural resources, location advantages and the exploitation of internal markets. Therefore, in this kind of firms there are little stimuli to the development of innovations based on R&D activities. In the case of knowledge networks, technological opportunity is derived from the exploitation of scientific knowledge of great complexity drawn from endogenous developments and interactions among very heterogeneous agents that relate through complex mechanisms of translation. In this sense, these dynamic opportunities are constantly renewed.

Finally, in the case of isolated firms, the knowledge base⁸ is characterized as firm specific and has low complexity because the firms operate in contexts in which neither the knowledge nor the production networks are prominent factors. In the opposite extreme, given the complexity of the innovations carried out, the high specificity of the knowledge base is emphasized. Nevertheless, in this case, generic knowledge is also relevant because it allows the firms to share structures and activities with other firms in terms of networks.

Beyond these extreme situations, there is an array of intermediate cases in terms of the characteristics assumed by the appropriability, accumulativity, opportunity and knowledge base for the development of innovations. The first of these intermediate groups (bureaucratic networks) is characterized by an average accumulativity acquired by means of external technological flows coming almost exclusively from multinational firms' headquarters located in developed countries; lower-middle appropriability as a result of a specialization pattern based on non-differentiated goods; average opportunity in terms of the productivity generated by non-radical innovations; and generic knowledge base of average complexity transmitted through hierarchical network structures. Finally, in the islands of knowledge what predominates are: high accumulativity (which comes from external sources such as basic science); average appropriability (and, therefore, limited possibilities of imitation); high technological opportunity (as a result of the use of scientific knowledge), and; a base of specific and generic knowledge of high complexity.

A complementary issue related to the idea of technological regime, which additionally characterizes each group, is the focus of technological activity. In the case of isolated firms, it is centered on the reduction of costs. They are mainly mature industries where there are very few possibilities of introducing innovations, which often relate to processes and improvements in

⁸ The knowledge base refers to the key dimensions of knowledge that are relevant for the development of the innovative activity of an industry.

machinery and equipment. In this case, innovations are developed in other sectors identified by Pavitt (1984) as suppliers. In the opposite extreme (knowledge networks), the objective of technological activity is also to increase the mark-up through higher speed of innovation and to reduce costs not just in individual firms but in the network as a whole. Between these two extremes, two intermediate situations mentioned above also appear. On the one hand, bureaucratic networks undertake technological activities in order to develop products that make it possible to compete in dynamic markets. In terms of sectoral presence, what stand out are mature sectors and some basic industries (petrochemical, steel industries, etc.), with little importance given to quality, design and the price of the product. On the other intermediate situation (knowledge islands), the focus of the technological activity is centered on both enlarging the market share and generating extraordinary benefits.

Table 2
Taxonomy of firms and technological regime

Attributes	Type of firms related to the importance of network and learning process			
	Isolated Firms	Bureaucratic Networks	Knowledge Islands	Knowledge Networks
1. Technological regime	Mark I	Mark II	Mark I	Mark II
1.1 Accumulativity and origin of technology	Reduced, Idiosyncratic and external	Medium, Mature sectors	High	High, External and internal sources
1.2 Appropriability	Reduced	Low-Medium, Standard goods	Medium	High
1.3 Opportunity	Reduced, static advantages, low incentives to innovate	Medium	High	High, Dynamic advantages, high incentives to innovate
1.4 Knowledge base	Firm specific, low complexity	Generic, sector specific	Generic and specific, high isolated complexity	Generic and specific, high complexity as part of a non hierarchical system
1.5 Main focus of technological activity	Reduction of costs	Reduction of costs in the network	Development of new products and process	Increase the mark-up through higher speed of innovation

Source: Own elaboration based on Malerba and Orsenigo (2000)

The collective action of the five attributes taken into account by this regime in each organizational form will define a positive relationship between knowledge diffusion and risk. In this sense, while in firms characterized by a Mark I regime the major diffusion of knowledge is associated with a greater risk; in those in which the predominant regime is Mark II, the diffusion beyond the immediate network is less risky. This pattern can be explained as a by-product of significant developments of cognitive capacities and the predominance of club goods. Therefore, the risk of appropriation of knowledge by means of external agents is also more reduced.

Management knowledge regime

The second dimension, the **management knowledge regime**, explains how the knowledge produced by an organization constitutes an entry barrier and becomes a source of quasi rents. The relevance adopted by knowledge as an entry barrier will depend on [i] the sources of knowledge, [ii] the source and modality of the learning process, [iii] the organization's absorption capacity, [iv] the integration between tacit and codified knowledge as determined by the cognitive capacities reached by the firm; and [v] the way economic benefits of knowledge are appropriated.

In isolated firms, the management knowledge regime shows blockades in the integration between different levels of knowledge codification. This can be the result of the joint action of: [a] a very rigid organizational structure, [b] difficulties in appropriation, [c] less complex learning sources, and [d] informal and idiosyncratic learning process. The absorption capacity in these firms is low and it is limited to the acquisition of capital goods and limited efforts associated with learning by doing, producing and using. In isolated firms, the driving force is the reduction of costs due to competitive pressure.

At the other end, in knowledge networks, the learning process does not present obstacles in knowledge generation and circulation because of the hypertext organizational structure (Nonaka and Takeuchi 1995; Nonaka and Toyama 2002). This kind of structure has a very high absorption capacity, which is not restricted to the incorporation of capital goods but also takes advantage of advances in basic and applied science. Absorption processes can also be the result of takeovers. Some of the firms belonging to knowledge networks usually become involved in merger and acquisition processes with knowledge islands. In this way, knowledge networks can reduce the R&D costs incurred by the firm commanding the network and increment the success innovation probability, via uncertainty reduction and decentralization of innovative activity in multiple starts-ups, which increases the diversity and unleashes more efficient selection mechanisms than the market. In addition, these merger and acquisition processes allow knowledge

islands access to quasi-rents derived from innovations. The management knowledge regime of these networks can be called 'intern-extern flex', because it not only develops high endogenous competencies but also coordinates and absorbs developments made by other firms in other networks and institutional systems. Thus, the advantage of having highly developed organizations with resources and departments specializing in legal issues enables bureaucratic networks to advance in the utilization of these resources with greater capacity than isolated firms. In turn, in knowledge networks, the development of learning processes appears to be in continuous innovations and the possibility of excluding by means of displaced code books that are incomprehensible to other competitors in the market. This kind of network can be assimilated to an epistemic community. The learning process is generated fundamentally from research and formal development and combines different types of learning with special emphasis on the development of networks themselves.

Bureaucratic networks have a hierarchical knowledge management-style since most of the learning process is dominated by the nucleus. The remaining firms in the network have less freedom in their strategic choice. In the case of developing countries, these networks can be identified with multinational businesses and often the processes of learning stem from their headquarters. The capacity of absorption is high in the nucleus and attempts at improving processes, management and technologies. In the remaining network firms, the capacity of absorption is induced by the nucleus and peers' competitive pressure.

Table 3
Firms' taxonomy and knowledge management regime

Attributes	Type of businesses in terms of the importance of networks and learning processes			
	Isolated Firms	Bureaucratic Networks	Knowledge Islands	Knowledge Networks
2. Management knowledge regime	Weak	Hierarchical	Flexible internal	Flexible internal-external
2.1 Organizational structure	Hierarchical	Bureaucratic	Post-fordist	Hypertext a/*
2.2 Learning sources	Technology incorporated	Knowledge generated in the business nucleus	Interactions inside the firm	Interactions inside the network and with the national system of innovation.
2.3 Learning styles	Learning by doing, and producing	Learning by using, producing and interacting	Learning by doing, producing and using	Complex knowledge generation processes and complex translation
2.4 Absorption capacity	Low and limited	High in the nucleus, average or low in remaining firms	Very high	Very high, including take-overs
2.5 Integration among tacit and codified knowledge which generates different levels of cognitive capacities	Limitations to integrate and to develop know-how	Adaptation of codified knowledge provided by headquarters	Integration supported in personal networks; Only to level business	Complete; So much inside the business and the network
2.6 Appropriation styles	Idiosyncratic	Secret and incremental innovations	Patent and/or sale of the businesses	Patent, displaced codes book, continuous innovation

Source: Own research

*Note: The 'hypertext a/' organizational structure alludes to the existence of three simultaneous levels in the organization (hierarchy, project teams and knowledge base that facilitate what Nonaka and Takeuchi [1995] call the metabolism of knowledge).

In knowledge islands, there are horizontal structures that allow a complete development of the knowledge integration process and different forms of learning that can be used simultaneously. For this reason, this type of knowledge management can be called 'internal flexibility', since knowledge islands have reduced informal bonds with other businesses and institutions. In this sense, there is a predominance of a post-fordist organization style and the sources of learning are, fundamentally, internal R&D and the interactions which take place inside the organization. In addition, knowledge islands learn from the developments of basic science, 'blueprints' and informal interactions with clients and other agents in the institutional system. The need to maintain secretly its developments can be thought to reinforce the isolation of these firms before the commercialization of their products.

The six (6) attributes of knowledge management regimes describe an inverse relation between risk and development of cognitive capacities. A weak type is associated with a low development of cognitive capacities and, therefore, to high risks. Subsequently, an 'internal flexible' regime can be considered. This kind of regime implies the development of complex cognitive capacities yet circumscribed to one firm or to a limited number of organizations and thus difficult to become integrated with the remaining science and technique systems as well as with other similar organizations – upstream or downstream. The associated risks of this type of regime are smaller than those of the weak but clearly superior to those of the hierarchical, where development of cognitive capacities transcend the organizational level, but are of low complexity. Finally, in the internal-external flexible regime, the creation of advanced capacities at the level of networks is associated with a reduction of risks through the circulation of knowledge under the form of 'club goods'.

Competition regime

The **competition regime** makes a great contribution to the differentiation of firms operating under different organizational structures. This regime is associated with the sector the firm belongs to (Pavitt 1984; Reinert 1994). According to the firms' taxonomy already presented, the possibility to affect the working environment of the firms differs significantly among the considered types.

As a consequence, this view of competition regimes is opposed to the conventional view of markets defined by the paradigm 'structure, conduct and performance'. In this framework, where the behaviour of an economic agent is determined by the market structure, the options are reduced basically to pure types (perfect competition, monopoly, and monopsony) that determine firms' economic performance. Therefore, given the structure, the behaviour and the performance are defined using the common hypothesis of perfect information and rationality of agents, which leads to the existence of identical agents.

In opposition to a world of pure structures, rationality in the performance of agents and absence of uncertainty, these firms go about their business in an innovative environment characterized by the uncertain nature of technological change. The specificities adopted by the technological and knowledge regimes in different kinds of firms affect the environment where they interact, causing diversity even within the groups.⁹ This diversity, which is

⁹ Nelson (1991) showed how mainstream economics was opposed to business experts' thoughts, whose own existence derives from the idea that similar firms are able to develop very different strategies. In other disciplines such as anthropology or geography, there is a more advanced discussion related to the advantages and problems to emphasize or to eliminate the differences among agents.

an essential characteristic of firms, has a strong influence on: [i] the differential capabilities for innovation, [ii] the firm-specific search processes associated with the particular technological paths derived from firms' own organizational history, and [iii] the business strategies (in terms of the nature of investment, decision of prices, R&D, etc.) that guarantee a diversity of behaviours. Likewise, diversity is not only present at the organizational level, but also at the level of the linkages among organizations. Contrary to conventional perspectives where economic relations are limited to buying and selling, in an evolutionary environment, linkages allow the reduction of uncertainty and generate learning processes that lead to the development of cognitive capabilities. In this direction, linkages developed by different groups define the way they face the competitive pressure to which they are exposed.

This diversity of patterns faces selection and learning mechanisms¹⁰ that validate the specific paths of individual firms and of whole production networks. The mechanisms of selection allow different organizational forms with specific innovative capabilities to achieve differential results in terms of profits and market share. The mechanisms of learning (derived from the knowledge regime) supply the temporary dimension and are able to affect outside competition. In this sense, the regime of competition conditions the kind of barriers to entry to the market according to the competitive advantage each organizational form is able to build, which is manifested in specific comparative advantages and costs. At the same time, the construction of these advantages will depend both on the differential capacities to capture technological interrelations and the generation of economies of scale, as well as to incorporate collective learnings from the interaction and distribution of know-how (Cimoli 2005).

Isolated firms have a classical competitive scheme which, in the extreme, can be associated with the pure type of perfect competition. In this case, barriers to entry are reduced and the elasticity price of the demand is very high. The products these firms make are of low or zero differentiation, and thus the type of competition that evolves is price competition. Barriers to entry are thus associated with static advantages. Given the characteristics of these firms – both in terms of technology or of knowledge management regimes – they make limited innovative efforts (many times linked to the adoption of technologies incorporated in capital goods) to be circumscribed to cost reduction. In this case, the benefits of technological progress can be seen in price reduction in agreement with classical thought (Reinert

¹⁰ As learning processes play a key role, evolutionary theory is more associated with Lamarckian than Darwinian theories, where the random mutations are the diversity creation mechanisms.

1994). The predominant size of agent is that of the SME's, which is associated with a low market concentration. This can be interpreted as a consequence of the difficulty of these organizations to generate and maintain quasi-rents for a long period of time.

The remaining groups are associated with oligopolistic market forms with either greater or smaller degree of competition in each case. Particularly, bureaucratic networks can be associated with oligopolistic or monopolistic market forms with low level of competition. They are made up of firms that usually operate in mature sectors, where the innovations by differentiation are limited and the degree of standardization is high. In the present organizational and technological context, firms tend to relocate production plants, expanding the reach of global networks with the primary objective of reducing costs. In this way, the origin of quasi-rents is centered on the scales of production, the regulations in the target countries, and the learning processes transferred from headquarters. In bureaucratic networks, the development of a quasi-market permits the nucleus to reduce uncertainty through the operation of networks with a strong stability in the hierarchy and a low rate of entrance.

In the knowledge islands group, a competitive market form is predominant. Firms need to overcome a significant knowledge barrier to enter this market. The agents that dominate this group are of small and medium size, often start-ups, and show an average market concentration. These firms tend to be absorbed by the fusion and acquisition processes carried out in knowledge networks. In this sense, remaining market time is reduced, either because they are absorbed by more successful firms or because of bankruptcy. These companies are exposed to a high degree of uncertainty because they operate in very dynamic sectors with high volatility, which is perceived in the temporary character of the quasi-rents generated from innovation processes.

Table 4
A taxonomy of firms and competition regimes

Attributes	Type of businesses in terms of the importance of networks and learning processes			
	Isolated Firms	Bureaucratic Networks	Knowledge Islands	Knowledge Networks
3. Competition regime	Competitive, low barriers to entry	Oligopolistic, high barriers to entry, high fixed cost	Competitive, high knowledge barriers to entry	Oligopolistic, high epistemic communities and high barriers to entry
3.1 Firm size	SMEs	Big	SMEs	Big
3.2 Market concentration	Average	High	Average-high	Very high
3.3 Stability	Scarce stability with agents that travel toward bureaucratic networks	Very high	It is reduced. Firms tend to be absorbed by knowledge networks.	High, combination of accumulation and creative destruction
3.4 Quasi-rents stability	Reduced	High	Temporary	High
3.5 Quasi-rents sources	Advantages static, natural or locating.	Regulations	Innovation	Club goods development
3.6 Surplus distribution	---	Hierarchy	---	Distribution of surplus as incentive to innovation

Source: Own research

Finally, in the case of knowledge networks, the predominant market form is oligopolistic. There are high barriers to entry and knowledge circulates under the forms of epistemic communities and club goods. This allows all firms in the network to take advantage of technological interrelations, knowledge complementarities, and increasing returns. The nucleus firms are predominantly large with high continuity in markets of high concentration but in continuous dispute by new radical innovations that emerge from a combination of accumulation and creative destruction. As a consequence, the degree of stability of the quasi-rents generated by the processes of knowledge integration is greater than in the previous groups. Although they operate in sectors of strong technical progress and instability, these firms – working in networks – are able to decodify to a large degree the uncertainties of the environment. These networks are characterized by different forms of surplus distribution. In most ‘democratic’ cases the distribution of gains associated with the innovative capacities of each firm prevails.

The competition regime determines the position of organizations along a positive relation between the amount of development of cognitive capacities and the possibilities of knowledge appropriation. This relation will be determined by two extreme situations: one linked to competition and free entrance, and the other to the predominance of imperfect market forms with high barriers associated with the concentration of capital and with the accumulation of competences and cognitive capacities. It is important to point out that, both in bureaucratic and in knowledge networks, there are hierarchies and rules of governance. These are shown in the existence of high heterogeneity among agents and in an uneven distribution of quasi-rents.

2. The relationship between knowledge diffusion and appropriation as a result of the joint action of technology, competition, and knowledge regimes

The objective of this section is to show how the inverse relationship between the appropriation of quasi-rents generated from the development of cognitive capabilities, on the one hand, and the diffusion (leakages) of knowledge derived from the interaction among the regimes previously presented, on the other.

The form adopted by the three regimes taken as a whole contributes to an explanation of the different possibilities of access to permanent quasi-rents derived from the generation of cognitive capabilities,¹¹ which is associated with the possibility of implementing protection mechanisms that avoid both the imitation and the reduction of excess profits. It is important to emphasize four basic forms of protection: [i] property rights, [ii] technological restrictions, [iii] the application of technological packages, and [iv] the speed of innovation that (in some cases) leads to the generation of cognitive capabilities for the purpose of an efficient articulation of tacit and codified knowledge. All the above organizational forms can use in different ways each of these four mechanisms of protection. However, in the extreme case of the knowledge networks, there is a prevalence of the third and fourth forms in comparison with the remaining groups.

The idea of diffusion makes reference to knowledge leakages originating in individual agents or in networks. This knowledge represents a central source of their competitive advantages. A conventional conception of risk is used in the analysis: it is made up of a gradient of situations that show the probability of business failure associated with the emergence of imitators capable

¹¹ As indicated in the previous section, some quasi-rents of the rent-seeking type may be derived from regulations, as in the case of bureaucratic networks.

of limiting the appropriation of quasi-rents. The development of cognitive capabilities at the organizational level depends on two factors: the interaction between the creation of individual cognitive devices, on the one hand, and the path of the company, the sectoral specificity and the set of factors already considered in the definition of the management of knowledge regime, on the other. Finally, appropriation alludes to the possibility of obtaining quasi-rents derived from the cognitive capabilities developed by agents.

Diffusion should not be taken as a dual situation. On the contrary, it is necessary to interpret it as a non-continuous gradient of situations corresponding to different possibilities of appropriation associated with the contextual parameters considered in the three regimes. The diffusion process might turn knowledge into a public good – its consumption being non-rival and non-excludable. To consider knowledge as a public good implies that all the agents either possess or can develop the necessary cognitive capabilities to apprehend knowledge. On the contrary, when the circulation of knowledge remains within a group (an organization or an epistemic community) the members of such a group or community develop cognitive barriers that affect external agents. This situation allows uncertainty reduction and therefore the risks of imitation and loss of quasi-rents. In the first case – knowledge as a public good – it usually acquires a codified form; whereas in the second, it combines codified and tacit elements that are effective vehicles of circulation inside the group but are perceived as tacit by external agents. This situation can be compared to a ‘displaced code book’ and ‘epistemic community’ as defined by Cowan et al. (1999).

Between these extreme situations, there are intermediate positions of diffusion. The barriers to entry that derive from the use of previous cognitive capabilities make decoding possible and also reduce risks. As it becomes a public good, the barriers to entry diminish because of a reduction of cognitive requirements. Knowledge is compiled in a code that is more and more widely accepted and, therefore, the understanding of this code increases the imitation and the level of risk.

Diffusion and appropriation

The inverse association between knowledge diffusion and appropriation in terms of quasi-rents arises as a result of the three relations linked to each of the regime considered in the previous section.¹² Besides, this relation works in different forms in the four types of organizations discussed throughout the paper (see Figure 1).

¹² All these relationships can be conceived in terms of a series of points that describe the relations between the dimensions rather than as some continuous variables.

The first quadrant reflects the technological regime, which emerges as a positive relation between diffusion and risk. The points nearest to the origin correspond to a Mark II regime type, since they imply a low level of risk derived from little knowledge diffusion outside the organizational form. From the organizational point of view, this corresponds basically to knowledge networks and, less relevantly, to bureaucratic networks. In opposition to this situation, the most remote points correspond to a Mark I regime, which is characterized by high levels of risk and the use of knowledge as a public good.

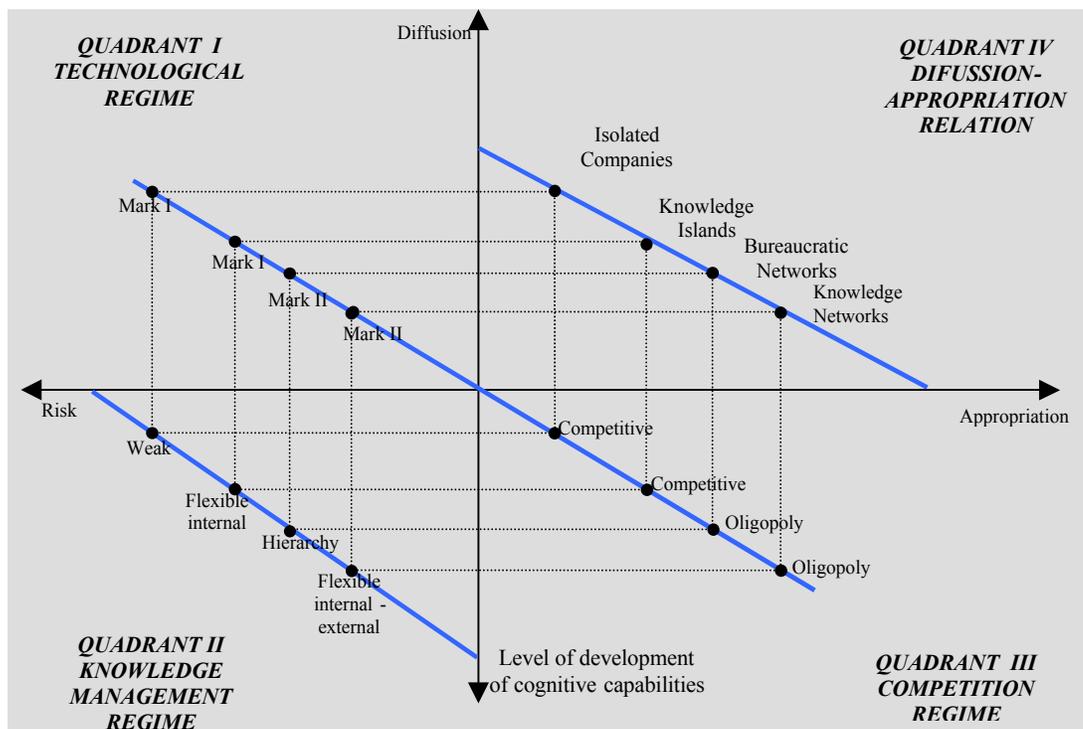
The second quadrant describes the regime of knowledge management through a negative relation between risk and development of cognitive capabilities. The points nearest to the axis 'y' are related to flexible internal-external kind, and to positions of low risk and high cognitive capabilities. The movement of the curve towards the opposite end corresponds to the appearance of the hierarchic, flexible border and weak forms; each one implies larger degrees of risk and a limited development of cognitive capabilities.

The third quadrant depicts the competition regime, where the points nearest to the origin correspond to situations near free entrance, with low development of cognitive capabilities and reduced appropriation possibilities (i.e., classical way of spread of the benefits of technical progress). On the contrary, at the end of the curve, the importance of imperfect market forms increases, with a regime that has opposite characteristics to those previously mentioned (i.e., collusive way).

As a consequence, the inverse relation between diffusion and appropriation is derived from the relations shown in quadrants I, II and III. The four types of firms can be located along this curve. In an extreme, the use of knowledge of greater diffusion and smaller appropriation corresponds to the isolated firms characterized by technology regimes Mark I: weak forms of knowledge management and competition regimes with low barriers to entry. The opposite situation corresponds to the knowledge networks characterized by a technological regime Mark II: a flexible internal-external knowledge regime and a market structure close to oligopoly or monopoly. In the latter case, the smallest diffusion and the greatest appropriation of the knowledge generated within the network are reflected in quasi-rents that are superior to those associated with the rest of the types of firms, which are distributed between the agents depending on the governance characteristics of the network. This situation reflects what Reinert (1994) has labelled as a high position in the quality index of economic activities. In knowledge networks, a consequence of the collusive spread of technical progress is higher prices and wages for producers and workers, respective-

ly. On the contrary, the first situation is associated with a position near to the bottom of the quality index. In these cases, the classical spread of technological progress is depicted by lower prices and wages while the fruits of technological progress go to consumers.

Figure 1. Scheme of relations



Source: Own elaboration

Curve displacement

Two kinds of movements may be differentiated. On the one hand, there are movements along the curve associated with changes in the specialization pattern and, on the other, there are curve displacements affected by changes in: [i] the technological paradigm, [ii] the national and local systems of innovation, and [iii] the institutional system (intellectual property, regulations, antitrust law).

As different authors have indicated (Rosenberg 1982; Reinert 1994; Rodrik 1999), the kinds of goods and services produced define a set of dimensions associated with: the importance of knowledge, the type of scale returns, the generation of competitive advantages and the predominant market forms.

It is possible to think that a turn in the specialization profile of a country or region towards more knowledge intensive activities is associated with a movement towards the right along the relation we have shown in the first, second and third quadrants. At the same time, improvements in the technological paradigm, in the national and local innovation systems and in the institutional system (e.g., in terms of property rights) move each curve to the right. As a result of these changes, the diffusion-appropriation curve moves outside, denoting greater levels of appropriation for the same level of diffusion. At the same time, changes in the opposite direction in each one of the quadrants produce displacements of the relation towards the left, diminishing the appropriation with an equal level of diffusion.

For example, for the same level of development of cognitive capabilities, there can be a higher appropriation, if it is supported by specific instruments or institutions (technical restrictions or intellectual property rights). This can be thought of as a displacement of the curve of the competition regime towards the right (quadrant III). Specific market forms can vary in the long term or in the short term with profound transformations in the technological and productive paradigms. Market institutions define property rights and legitimize its application so that the appropriation of non-rival and non-excludible goods is admitted. Also, a profile of productive specialization linked to the new techno-productive paradigm implies that the relation of the first quadrant moves towards the right. Consequently, at the same level of diffusion, there is a smaller risk associated. Finally, changes in the local and national systems of innovation are shown through a movement in the relation between the development of cognitive capabilities and risk. Thus, for instance, systems of greater level of complexity that favour the development of cognitive capabilities in different organizational forms imply a displacement towards the right. In this sense, with the same level of development of cognitive capabilities, agents must deal with lower risks.

Although each of these changes responds to different causes, alterations cannot be conceived in isolation. Thereby, as a result of the displacements proposed in the three quadrants, a diffusion-appropriation relation would normally move towards the right in developed countries. This allows these countries a larger degree of appropriation for equal levels of diffusion. Nevertheless, it is important to consider the existence of intra-sectoral heterogeneity that goes beyond the level of development of the countries and between countries that arises as a consequence of differences in organizational types. This heterogeneity is evinced in the presence of bureaucratic networks that coexist with knowledge islands and knowledge networks, as it happens in the case of chemicals or pharmaceuticals, where technological regimes of kinds Mark I and II coexist. This issue appears in different activities in countries of unequal development, where bureaucratic networks predominate.

These heterogeneities can be found in three layers. In the first place, they appear in varying profiles of productive specialization in countries with different levels of development. Secondly, they are reflected in different degrees of complexity within sectors. And finally, they acquire greater absolute and relative importance in knowledge islands and knowledge networks of developed countries.

As a consequence of significant differences in the profiles of productive specialization between developed and developing countries, in the former there is a predominance of knowledge networks integrated with national systems of innovation; whereas in the latter this category is practically non-existent (Reinert 1994). In contrast, in developing countries, bureaucratic networks predominate in dynamic industries within the framework of the specialization profile of the regions. In these countries, the knowledge islands represent a set of isolated companies dedicated to the production of knowledge intensive goods (i.e., software, biotechnology). In general, these firms do not constitute a critical mass of agents capable of changing a country's specialization profile. Another example where key organizational differences exist is in the automotive sector, which includes knowledge networks in developed countries and forms akin to bureaucratic networks in developing countries. This difference can be explained by the weak technological and productive frameworks established by the subsidiaries of multinational companies installed in underdeveloped countries. These feeble frameworks end up generating bureaucratic networks that are significantly far from the knowledge intensive networks that exist in developed countries with a substantial production infrastructure and technological base.

In any case, there are two kinds of displacements necessary in a catching-up process. On the one hand, a displacement is necessary in the original curve towards a point linked to a major knowledge appropriability associated with a much more complex specialization pattern. On the other hand, it is also necessary to move towards a new curve associated with the processes of technical change. The displacement of the original curve – associated with new products linked to the new paradigm – might be a window of opportunity (Perez 2004) for developing countries to carry on some more complex catching-up processes leading to a strong and non-incremental change in the specialization pattern. These processes have to be carried out continuously in order to avoid falling in the quality index mentioned above (Reinert 1994) and therefore have a minor appropriability of knowledge, lower prices and salaries.

3. Conclusions

This paper has focused on specific questions associated with the debate on knowledge by presenting a conceptual exploration which hinges on the

inverse relation between knowledge diffusion and appropriation of quasi-rents in different organizational forms. This methodological contribution considers the interrelation between three central themes (technology, the nature of competition, and knowledge management) structured as regimes.

The idea of knowledge regime permits the integration of different issues discussed in the first section of this paper, where we emphasized the existing complementarities between the different types of knowledge, rather than the transformation processes. This presupposes the existence of different logics underlying tacit and codified knowledge. Also, we have analyzed the way in which the sources and modalities of learning are manifested, the capacity of absorption, the complementarities between tacit knowledge and codified knowledge and the appropriation of the economic benefits in the different organizational forms (isolated companies, bureaucratic networks, knowledge islands, and knowledge networks). In this way, different kinds of knowledge regimes (weak, hierarchic, flexible internal and flexible inside and outside) are associated to different points in the existing negative relation between the degree of development of cognitive capabilities and risk.

The idea of a competition regime has allowed us to see the problem of competition and of creation of quasi-rents in a systemic way. For this purpose, we have considered the firm's size, the concentration and firm's time in the market, the source and stability of the quasi-rents and the way of distributing quasi-rents in different organizational forms. The interaction of these factors will determine diverse kinds of competition regimes that in turn will be located along different points in the existing positive relation between the level of development of cognitive capabilities and knowledge appropriation.

Finally, we have analyzed the form in which the technological regime performs in terms of opportunity, cumulateness, appropriability, knowledge base and main focus of technological activity in diverse organizational forms, which are reflected in different points of the existing positive relation between diffusion and risk, thus determining situations of types Mark I and Mark II.

Altogether, these three regimes determine an inverse relationship between knowledge diffusion and appropriation of quasi-rents. From a dynamic perspective, this relation can move before changes in the regimes. Thus, advances towards technological regimes Mark II, towards knowledge regimes flexible inside and, towards oligopoly and monopolistic competition regimes imply movements throughout the curve with an appropriation level and a minor diffusion level.

From all these elements, we have discussed the specificities that adopt the knowledge generation processes in different organizational forms, as well as in the relation between knowledge creation, generation of dynamic competitive advantages and market forms. We have also tried to examine the form under which these processes in countries of diverse levels of development manifest themselves, with differences in the profile of specialization, institutions, market forms and structural heterogeneity. Underlying the analysis we find that all these factors condition the importance of knowledge in the development of productive activities, as well as the importance of linkages in networks. Whereas knowledge networks predominate in developed economies, knowledge islands and bureaucratic networks appear with more frequency in developing countries. In spite of these differences, in both types of countries there are heterogeneities, although they are greater in developing ones. These heterogeneities manifest themselves in the possibility of finding bureaucratic networks and knowledge islands in developed countries and incipient knowledge networks in developing countries – yet these situations tend to be an exception, not the rule.

Finally, developing countries face the challenge of moving in the curve diffusion-appropriation towards positions with greater levels of appropriation for equal degrees of diffusion. Yet, for this to happen it will have to be the result of displacements towards technological regimes Mark II which are not independent of changes produced in the specialization profile. This implies moving towards markets in which the agents are price-formers rather than price-takers and where the development of cognitive capabilities becomes a key factor in competition. This movement will require industrial and technological policies since a free market would consolidate the specialization pattern rather than modify it. The design of these policies, however, requires operating in a space in which public knowledge increasingly becomes a club good. In that sense, interventions should go beyond the idea of solving market failures. They should also aim at generating dynamic failures making it possible to follow a path of structural change (Castaldi et al. 2004). From the development of the cognitive capabilities of agents, what is needed is to generate a virtuous circle of variety, selection and regeneration of that variety, based on the development of processes of complementing codified and tacit knowledge.

As Reinert (1994) has proposed, it is possible to identify uneven development and developing countries from a neo-Schumpeterian approach when: [i] the country does not appropriate any fruits of innovations (a classical spread) and [b] the country may be specializing in an economic activity where there is no innovation. In both cases it is easy to specialize in being poor in the international division of labour. If the specialization pattern is focused in products where innovation processes are mainly exogenous, the discussion about appropriability does not make any sense. The growing

path of this type of countries would strongly depend on having high international prices in those products belonging to the specialization basket and not on their endogenous capabilities (depending on the latter would lead them to innovate and to make a strong appropriation of the knowledge generated). From the perspective of developing countries, appropriability becomes the name of the game. In this sense, appropriability means taking advantage of windows of opportunity by choosing the right technology, and the appropriate knowledge and competition regimes, which would be associated with the right production network. But, these windows of opportunity are moving targets (Perez 2004; Reinert 2006), and they depend on the industrial structure and the initial position in the three mentioned regimes.

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