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THE ECONOMICS OF IP IN THE CONTEXT OF A MIDDLE INCOME COUNTRY

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The Economics of IP in the context of a Middle Income Country[*]

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This essay looks at innovation and intellectual property rights from the perspective of a small middle-income country. Characterized by an open economy, and based on natural resources, Chile has an incipient level of technological capabilities aiming at reaching sustainable growth and development by adding value to natural resources through innovation. In contrast to other economies that deeply rely on natural resources, Chile as other middle income countries have, has achieved a moderate level of advanced human capital formation and infrastructure stock, but surprisingly has some world class exporting industries such as copper, wine and salmon.

There exist a reasonable consensus among specialists that in order to achieve higher levels of economic growth, innovation and its related activities should play a major role. Moreover, it seems that the way that the country has achieved its current level of development would not be the same for the incoming phase. However, figures are not that promising in showing that the country is effectively investing more in innovation.

As the rest of its neighbors, Chile has a low level of R&D effort mainly financed with public resources. Moreover, there is limited use of the patent system, human capital is weak at all levels, and linkages among firms and other institutions have been historically scarce and weak. Issues also shared with the region and most developing countries.

There are, however, some issues that are not common to all developing countries. Among them, its small domestic market size (16 m. people) and the inmense geographical distance to all developed economies and to most of the world's population.

In this context, we discussed several innovation-related issues relevant to countries under this situation. By considering how IPR provide an incentive or deter innovation, and how if at all, the new innovation paradigm is present in Chile modifying the relationship between IPR and innovation.

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Before moving forward it is useful to give an idea about the Chilean innovative effort. As stated, the level of R&D spending is relatively weak, i.e., 0.4% of GDP in 2008 (Minecon, 2009), contrasted with 2.28% in OECD (without Chile) countries or 1.77% in the EU27 countries in 2007 (OECD, 2010b). Out of this, only 43.7% is financed by the private sector, with most of it coming form the government, in contrast with around 72% financed by the private sector in OECD countries and 65% en EU27 countries (OECD, 2010c).

The composition of R&D expenditure has important implications for the type of research that is undertaken. Government funding has usually been oriented to knowledge supply (*i.e.* universities and research centers), not necessarily linked to market and social needs. The low level of expenditure and the limited private contribution, limit research activities that are conducted in terms of scale, risk, and return period, as well as the focus of the research efforts and types of results sought (Anlló, 2009). The Chilean and other Latin American governments have recently changed their policy orientations and started redirecting R&D resources to knowledge demand, i.e., they are funding private sector innovation.

Notwithstanding the low level of private investment in R&D, Chilean firms do innovate. The sixth National Innovation Survey (Minecon, 2009) indicates that 24,8% of all firms had introduced some kind of innovation during the years 2007 or 2008. Restricting the firm universe to the OECD standard, the figure is 31%, compared to 38,8% in the EU27 countries (Eurostat, 2009; Minecon, 2009). It is important to mention that innovations introduced by European firms are probably of a much higher technological complexity on average, so that the difference in the "amount" and importance of innovation is not really captured by these numbers. Most of the innovative firms (over 80%) report introducing some kind of technological (product or process) innovations in the period. In contrast with most non-technological innovations, these in principle are patentable.

However, there is a surprisingly low use of the patent system: the previous innovation survey shows that out of the firms that reported innovations, only 4,8% of them has applied for any patents at all (Minecon, 2007), in contrast with approximately 26% and 33% of process innovations being patented in Europe and the US respectively. The figures for product innovations are 44% and 52% respectively[1] (Arundel y Kabla, 1998). The sectors in which patenting is more common in Chile are mining (14,3% of innovative firms apply for patents) and manufacturing (with 11,3%). On the opposite extreme are electricity, financial services, and agriculture with 0%, 0,8% and 2,9% respectively (Minecon, 2007). Figures are similar for patent titularity, with an average of 8,7% of innovative firms in posession of at least one patent. New data from the sixth innovation survey shows that only 2,9% of innovative firms, and 1,2% of all firms are in posession of at least one patent or other IPR instrument (excluding trademarks). It should be noted that Chile has a solid legal framework and trustworthy institutions, thus a higher use of patents would be expected. The low use of patents could partly be explained by the finding originally by Levin et al. (1987), that patents are only relevant for sectors where appropriability is an issue, such as in chemical industries.

[1] These measures are not directly comparable with the Chilean 4,8%, but they illustrate the magnitude of the difference in propensities to patent.

As López and Orlicki (2007) conclude, Latin American firms do not seem to rely on patents for appropriability, with close to 10% of innovative firms using patents, much less than their developed countries couterparts. Even if, as in the rest of world, patent applications in Latin America have increased during the last decades, this increase (as the bulk of the patents) is due to foreigners' applications, rather than residents'. (*Ibid*.)

With respect to other NSI agents, for example universities, even though they have been historically the most relevant actors doing research, patents only started being an issue in recent years, with some of the most important research institutions devoting significant efforts at creating IPR departments and training IPR professionals. These have been mostly public universities, as few private universities are involved in research. Public research organizations play a very minor role in the Chilean Innovation System.

Two other structural characteristics have a profund effect on the innovative potential of the economy: the low levels of human capital and linkages. As an indication of this problems, Chile is far below the OECD average in the PISA 2006 exam, with 13,4% of OECD students achieving the highest profficiency levels in mathematics, while only 1,5% of Chilean students get to this level (OECD, 2010a). In 2007, Chile graduated 0,1% of doctorates in the relevant age cohort, while the OECD average is 1,5%. (OECD, 2010a)

With respect to linkages, 15,6% of innovative firms cooperate in innovation-related activities with suppliers, but only 3,8% do the same with the competition, 5,0% with universities, and 2,2% with public institutions (Minecon, 2009). The last two are especially low, comparing for instance with the 9% and 6% repectively in EU27 countries (Eurostat, 2007). Regarding knowledge-related relationships, only 6% of innovative firms have at least one know-how related agreement in force, as well as 1,5% of non-innovative firms (Minecon, 2007). Out of all the firms, only 15% received ideas from clients, and less than 4% have contracts with research institutions. (Benavente, 2005)

Historically, R&D has been associated to universities, with little involvement and investment from private firms. Moreover, firms have very little experience collaborating among themselves, and this results in problems of coordination and trust when there are attempts to engage in collaborative agreements. Firms need not only highly qualified engineers and researchers, but professionals and managers who understand that innovation is as a systemic, collaborative effort. As this is not the case for most Chilean firms, they don't collaborate, and without trust or experience collaborating, and without demonstration effects generated by successful examples of collaboration, the situation is in a deadlock. With respect to IPRs, the lack of experience collaborating means also lack of experience in dealing with them in a collaborative setting, and if IP rules are not clear, IPRs may become another factor that inhibits collaboration[2].

One last thing to note in the case of Chile is its developmental stage. Even if the economy is still highly reliant on commodities and other natural resource-based industries, it is on a stage of transition, aiming for a qualitative leap to innovation based growth.

[2] However, we do not have empirical support for this, but it is open for further research.

Some sectors, such as wine and salmon, are becoming more technology-intensive, with significant R&D activity and growing importance in world markets. These sectors have also achieved higher levels of cooperation among firms and between private firms and research institutions. But the general lack of cooperation described above is still present in most of the economy. An important challenge that most countries in this stage of development face is the need to increase collaboration among firms and other private and public institutions; to configure regional and national innovation networks, properly connected to the global ones. As it will be discussed later, experience shows that in practice this can be extremely difficult.

In what follows, some issues that are of special interest to the current Chilean context will be discussed, and then their relationship with the new global innovation reality will be considered. Finally, some general recommendations for economists and policy makers will be proposed.

The first important point to discuss is the fact that sectors do matter when thinking about IPR. The use of these –and other appropriation mechanisms- varies significantly across sectors, thus a country's productive structure will have an influence on which are the relevant issues and the way to deal with them.

There has been important research comparing patents with other appropriability mechanisms, including the seminal paper by Levin et al. (1987) and others like Cohen et al. (2000) or López and Orlicki (2007) for Latin America. The main problem with this literature is that it is usually restricted to manufacturing industries in the developed world.

What evidence shows is that in some industries, such as chemicals machinery or biotechnology, there is compelling evidence that patents are broadly used and considered important for appropriation (Cohen et al., 2000, Arundel, 2001, and others). But on other industries, "strategic", non-legal appropriation mechanisms such as lead time advantages, exploiting the learning curve, offering post-sale services, secrecy, among others, are preferred.

For the Chilean economy, industries where patents are more important are not specially relevant. There is a manufacturing sector, but most of it is relatively low-tech, associated to natural resources exploitation and food production. Sectors that are relatively more developed in terms of technology, such as wine, correspond to industries where patents are not the preferred appropriability mechanism.

And evidence seems to support this. Except for the mining sector, where patents are broadly used, these don't appear to be an important appropriation mechanism in Chile, just as in most of Latin America (López and Orlicki, 2007). In contrast, trademarks –an IPR mechanism that has received far less attention than patents by researchers– are much more used, even more than in developed economies (*Ibid.*). This could be explained because competition is based o differentiation rather than innovation (*Ibid*.), or because of the types of sectors that are relevant for these economies. In Chile, for example, the food industry is very important, and in this sector prestige and branding is clearly an important concern for firms.

Sectorial differences can also be important when considering knowledge dynamics; there are examples of cases where the lack of IPR enforcement has fueled impressive technological advancements and regional development, as in Silicon Valley (Blank, 2007). But there is no reason to extrapolate and think that this kind of dynamics will automatically emerge on other technologically less intensive sectors, such as the natural resource-based ones that are relevant for the Chilean economy.

Another relevant issue for an economy like the Chilean one is that of the importance of process innovations, and the negative aspects of the secrecy usually preferred to protect them. The bulk of exports are commodities (copper, cellulose, fruits) which leaves product innovations out by definition. Therefore, process innovations acquire a key role in determining the country's productivity and economic growth. Looking at the results from the last National Innovation Survey, the more relevant export related sectors innovate more in processes than products, for example, in agriculture, 14,6% of firms introduced process innovations, but only 5,4% of them report product innovations. For mining, the numbers are 24% and 14% respectively (Minecon, 2009).

There is strong evidence that for process innovations secrecy rather than patents is preferred (Levin et al. 1987; Cohen et al. 2000; Arundel 2001, amongst others). This makes perfect sense, as processes are much more prone to be kept secret than new products, which are disclosed at the time of their release to the market. At the same time, the disclosure requirement of patents is avoided, and there is evidence showing that this is precisely one of the reasons why firms sometimes prefer not to patent (Levin et al. 1987; Arundel 2001). The result is that secrecy is a better appropriation mechanism than patents for most process innovations.

Nevertheless, secrecy does have costs associated to it. On the one hand, the very costs incured to keep the innovation secret, that can take many forms (non-disclosure agreements and other types of contracts, encryption technologies, among others), and on the other, there are the social costs of keeping inventions secret –patents are not only intended to provide an incentive for invention, but also to promote technological difussion. The worst problem could be the disincentive for cooperation that secrecy entails. When the appropriation strategy is secrecy, collaboration with the competition is the last thing a firm would want. And not even the competition, but there could also be a disincentive to cooperate with customers and suppliers, because of eventual indirect spillovers (Vanhaverbeke et al., 2007; Goya et al., 2010). "Selfishness", rather than collaboration, is preferred when process innovations are kept secret. Considering that one of the weaknesses of the Chilean National Innovation System is the lack of linkages, and the relevance of process innovations for the national economy, the disincentive for cooperation that secrecy entails is an issue that should be considered by policymakers.

Another issue that is strongly felt in Chile and some developing countries is the small size –and purchasing power– of the domestic market. As experience clearly shows[3], most innovators "test drive" their new products and serviced in their own domestic markets, because of their knowledge of local consumers' idiosyncratic characteristics and of the rules and workings of the local markets and institutions. But when the market is small and has limited purchasing power, the sunk R&D costs and all expenditures

[3] Personal conversation with the head of FONDEF.

associated to IPR's have to be distributed among a relatively small number of units, resulting in a higher unit cost. Eventually, this high unit cost could prevent entry to the market, or result in commercial failure of a product that could otherwise have been highly successful. When thinking about actually exporting the product, Chile has another important handicap: geographical distance to all developed countries and their high-income consumers.

The purchasing power, and especially the size of the domestic market are effectively exogenous variables to IPR policy, but costs associated to it are not. Searching, appliaction, and eventual litigation costs associated to IPRs can be very high, and result in prices that drive otherwise succesful innovations out of the market. This is even more pressing for credit-constrained SMEs (Lopez y orlicki, 2007; Arundel, 2001).

As was described previously, there are "strategic", non-legal alternatives to IPRs as appropriation mechanisms, such as lead time and secrecy. But the final objective of patents is not appropriability per se, but stimulating innovation. And for achieving this goal there are also alternatives: different types of direct (such as subsidies and prizes) and indirect (such as tax incentives) public policy mechanisms can be used to encourage firms to invest in R&D. These do not act increasing appropriability, but reducing the cost of innovation for the firm.

There are several reasons to consider other complementary methods to encourage innovation: patents don't seem to be stimulating innovation that much (as noted before, most of the innovative firms don't apply for patents), and although not conclusive, evidence suggests that increasing patent strength does not produce more innovation (Boldrin and Levine [2008, chapter 8] review the empirical evidence). Moreover, the patent system has a series of negative aspects, and the alternative mechanisms considered have certain advantages.

Subsidies, for example, can be used to drive innovation in sectors of strategic importance, where pure market incentives won't achieve optimal levels; and they allow for more flexibility in their design and use, vis-à-vis patents, that in general do not adapt much to different sectors' characteristics, and are constrained in their design by international agreements[4]. Moreover, it is a policy objective now to encourage associativity and collaborative research. Patents are not expected to increase collaboration between firms[5].

On the other hand, besides the known social cost of monopoly pricing, there are growing concerns about possible negative effects of patents on the dynamic aspect of innovation, which is by far more important than the static one in terms of its contribution to growth and development (Kline and Rosenberg, 1986; Baumol, 2010). For example, there can be problems of blocking sequential innovations, as in the classical example of the steam engine described by Boldrin and Levine (2001), or "patent thickets", *i.e.* sets of patent rights that make it necessary to obtain licenses from a series of diferent patentees to commercialize an innovation (Shapiro, 2010), eventually discouraging innovation. It has been argued that when innovation is

[4] While these also limit how much can be done in terms of IPR policy, it is always posible to change the emphasis of policies away from the dominant 'strong IPR' view.

[5] Eventually they could, through patent pools, but this is not the norm. Besides, this can result in clashes with antitrust authorities.

sequential and complementary, patents could reduce innovation and social welfare (Bessen and Maskin, 1999). There are mechanisms to avoid problems like patent thickets, such as cross-licensing and patent pools, but these imply transaction costs and can also result in problems with antitrust authorities (Shapiro, 2001).

In a middle income country that wants a fast transition to innovation-based growth, the question is how patents and other mechanisms complement each other, and which is the optimal policy design, combining these different incentives for innovation.

As was discussed above, even if still weak on some areas, there is a significant body of literature regarding alternative appropriability mechanisms. On the other hand, even though the importance of understanding the relative impact of patents vis-à-vis other innovation incentives is of the utmost importance for policy, there is surprisingly little research on the matter.

Most of the literature in the subject is theoretical, such as the works of Wright (1983), Romano (1991), or Gallini and Scotchmer (2002). Wright back in 1983 stated that *"situations in which a practical patent system dominates other feasible alternatives may be narrower than is commonly believed"*, while Gallini and Scotchmer (2002) conclude that for IPRs to be helpful, it is necessary that innovators can easily enter into agreements for rearranging and exercising these rights. A recent paper by Darai et al. (2010) compares patents and subsidies in laboratory settings and find similar effects from both, but to the best of our knowledge there have been no serious, large scale empirical studies on the matter. Some of the issues that difficult empirical studies, and might in part explain the lack thereof, are that there does not exist a common categorization of public policy instruments, that are very different across and within countries (OECD, 2010a), and the fact that in practice there are no counterfactuals to the existence of patent systems.

No matter the lack of theoretical and empirical understanding of the relationship between patents and other incentives, there is one very general idea that can prove useful when thinking about their effectiveness: patents act by increasing appropriability, while most other incentives, like subsidies and tax incentives, act reducing the cost of innovation. Thus, if the problem is appropriability, strengthening patents seems like a reasonable thing to do. But if the problem is not appropriability, but, for instance, credit constraints, reinforcing patents should not be expected to stimulate R&D spending.

And Chilean firms see high costs as the most important obstacle for innovation (Minecon, 2007). The next most important factors are lack of government incentives and difficulty obtaining financing for innovation-related activities. Ease of copying by other firms is on the list, but on the eleventh position. From these answers, it seems like cost, and not appropriability, is currently constraining innovation. Even if patents are a form of government incentive, firms don't seem to see them as such, and they are expecting other mechanisms (perhaps tax incentives, that did not exist by the time of the survey). On the other hand, it could be argued that if the patent system were not in place, ease of copying would be the first obstacle for innovation. But considering the percentage of innovations that go on to a patent application, this doesn't appear to be the case. The conclusion from this is that cost-reducing incentives can be expected to have a much more important effect on firm's innovative behaviour than reinforcing IPRs.

There is an important factor that has not been considered yet: collaboration. As pointed out by Arundel (2001) and Sattler (2005), when collaboration is involved, propensity to prefer patents vis-à-vis secrecy increases. And the existence of knowledge-related cooperation agreements is expected to be more and more often the case. Presumably, the preference for patents in this scenerio is because when several actors are involved, it becomes important to have formal arrangements indicating how benefits from innovative efforts are going to be distributed. There is a clear example of this in Chile, the case of innovative "consortia".

One of the new policy instruments used in Chile during the second half of the past decade were innovative consortia. The objective of this policy is not only to share risk in innovation-related projects and to foster interactions between firms and science and technology institutions, but also to improve management and marketing abilities, to increase competitiveness in certain industries (Álvarez et al., 2005). An evaluation of this and similar programmes in other Latin American countries showed the difficulties and long time periods needed to get the projects started, due to the participants' little previous experience in associative agreements (*Ibid*.). In some of the Chilean consortia, actual collaboration took years to be achieved, even after the public funds promoting those alliances had long been obtained. This lack of experience was manifest in firms, research institutions, and government agencies. None of them had much experience with IPR negotiations, and attempts to formalize IPR issues in the first stages of the projects resulted in blocking the development of the whole project. Trust was not easy to establish, and the different participants did not know how to conduct IPR negotiations.

In these circumstances, IPR-related issues caused enourmous transaction costs, difficult to overcome. In this stage it is government institutions that could help partners to coordinate, but they also lacked expertise. After the first experiences, government institutions started promoting IPR negotiations in later stages of the projects –after participants become acquainted, learn to work together, and trust develops– and research institutions that had participated in previous consortia, showed an increased ability in negotiating when the time came.

There is an important matter of timing here: property rights, through high transaction costs, can indeed be a binding constraint on innovation efforts, especially in situations where collaboration is needed and there is no previous experience. In this scenario, a more flexible approach is needed, and government agencies must be prepared to help face these issues and facilitate cooperation, while at the same time avoiding burdensome bureocracy (*Ibid*.). Only after all actors gain experience in collaborative agreements and negotiating with IPRs, do these become an enabling –and promoting– factor of innovation, with "consortia" and IPRs effectively complementing each other. Because, as mentioned above, when several actors are involved in the innovation process, it becomes important to clarify how benefits are going to be distributed.

With respect to other innovation subsidies in Chile and their interaction with IPRs, some policies that can be highlighted besides Consortia are FONDECYT (oriented to basic scientific research) and FONDEF (supporting early stage R&D activities)[6]. In

[6] Untill 2005 there existed the FONTEC programme supporting R&D activities at the firm level. FONDECYT and FONTEC evaluations can be found in Benavente et al., 2007a; 2007b.

general, in both of these programmes, the main objectives have been to reduce financial, and mostly, technical uncertainty. On the one hand, appropriability has not been a fundamental issue in their design or implementation. In fact, FONDECYT rules include a clause that says that firms that patent the results of FONDECYT-funded research should reimburse the public funds. In practice, this clause has never been applied, meaning the programme does not discourage patenting. However, the fact that the clause exists shows that promoting patenting was never in the spirit of the fund. On the other hand, FONDEF allows IPR agreements between the research institution and the supporting firm. However, FONDEF regulations establish that the research institution has preferential rights over the results of the project.

With these funds, something similar to what was described for the Consortia has been observed. In the beginning, without much experience, firms worry about technical and financial feasibility. IPRs might become an issue after projects produce results[7]. But as firms acquire experience and realize that these difficulties can be overcome, they start thinking more about profitability. When this happens, IPRs become more relevant in the first stages of the innovation projects, and not something to be considered after having results. At this stage of experience innovation subsidies and IPRs might become complements. This, however, is our perception of the situation, no study has been conducted to empirically assess the complementarity between the two mechanisms, at least in Chile. It is important to remember that government agencies go through similar learning processes, as the mistaken initial conception of the FONDECYT and the experience of the Consortia shows.

This is the argument by Teubal and Justman (1986): in its early stages, R&D policies must be flexible, to cope with the lack of experience. Firms and public agencies will learn by doing, and as their experience increases, public instruments can become more focused. In this context, what needs to start being flexible and become progressively more focused is the IPRs related aspects of the support schemes.

More generally than the consortia case, the change of focus of public policies from funding knowledge supply (i.e. scientific output) to funding knowledge demand (i.e. firms' technology requirements) has made evident the lack of legal and institutional experience regarding IPRs, given the historical low levels of use of the system. As demand-oriented funding will necessarily have commercial application, appropriability of benefits becomes a relevant issue. As similar changes in the focus of public funding are currently taking place in most of the region, special attention should be paid to these issues.

Although Chilean innovation policies were always market-oriented, in practice, the first periods were dominated by knowledge supply. Only in recent years funding has been more explicitely oriented to firm's requirements, after significant experience and learning by doing by firms, government agencies, and more recently, universities. Government agencies need not worry as much as before about technical feasibility, and can look instead at the economic prospects of projects.

There is another important problem related to the lack of experience with the patent system: firms, especially smaller ones, as well as individual inventors, still don't

[7] The fundamental difference is that for Consortia, IPRs can stop projects from getting started altogether. In the case of FONDEF and FONDECYT, they may appear as a problem in latter stages.

understand the details of the patent system and don't know how to use it. It is common to find firms that do not know whether their inventions are patentable or not, or poorly written patent applications, that in practice do not provide protection (and make the firm and the patent agency waste resources in the application). Anothert important issue that Latin American firms do not exploit the patent system as a learning mechanism (López and Orlicki, 2007).

Summing up, even if non-patent mechanisms could be more important in stimulating innovation, patents –or similar IPR mechanisms– might be complementary to them and play a key role when there are knowledge agreements involved, or demand-oriented government funding. Otherwise, socially beneficial research and collaboration risks not being undertaken. At the same time, it is important that all actors know and understand the patent system, otherwise it could become a barrier to innovation, or at best not have an effect at all.

Several issues related to IPRs and innovation that are important in the particular context of the Chilean economy have been discussed, most of them also relevant to other middle income countries with similar characteristics. Has the new innovation paradigm had a role in the way this problems have developed, or is it expected to have an important role?

Hitherto, the changing innovation paradigm has not manifested itself strongly in the Chilean economy, presumably, for the following reasons:

First and foremost the structure of the economy; the change in paradigm has been much more profund in certain hi-tech industries dominated by the industrialized countries, where Chile and most of the developing world play a minor role. Moreover, when thinking about the increased collaboration and importance of markets for technology, Chile is in a weak position mainly for two reasons: low absorptive capacity in its firms, and a weak history and capacity of cooperation.

Even if there has been progress in primary and secondary education coverage, and in advanced human capital, Chile is still far beyond industrialized countries in terms of the quality of its human capital and the amount of researchers, especially the ones associated to private firms (only 5,1% percent of the less than two thousand researchers holding doctorates [Minecon, 2009]). This is an unsurmountable barrier for collaboration with industrialized countries' firms, as well as a barrier in terms of importing more advanced technology, as it is difficult to learn how to use it, let alone adapt it to local problems.

The problems with collaboration and the lack of experience with it in all participants on the National Innovation System were already discussed at length. Some characteristics of the local economy, such as the relatively high importance of process innovations, make the problem even worse and more difficult to face. As innovation surveys show, internacional cooperation is rare among Chilean firms, and obviously for this to change it is needed first that firms start working together at the domestic level, and gaining experience in collaboration agreements.

How is the current situation expected to change? Regardless of the relative importance of the new paradigm across industries, the associativity problems are an important

bottleneck in the Chilean National Innovation System. And this is not an issue discussed only by academics and policymakers, survey results show that over 30% of firms consider the lack of cooperation between them to be an obstacle for innovation. And to make improvements in this regard, knowledge about and experience with the different IPR instruments is a necessity, as was discussed before.

Two other processes affect the way in which the new innovation paradigm will be or not relevant for the Chilean economy: the way the paradigm permeates other sectors, and the speed at which the different sectors in the local economy converge to and eventually catch up with the technological frontier.

For instance, patenting might become more and more important in sectors beyond the traditionally associated to patents, because of strategic –not related to appropriability– patenting (Cohen et al. 2000; Blind et al., 2006; Duguet and Kabla, 1998). Knowledge is also becoming more important in additional economic sectors, and with it the importance of global research networks in those sectors increases. With respect to the local developments, for sectors in which the country is lagging behind, licensing foreign-developed technology will be increasingly important, but for this it is necessary to improve human capital and the ability of firms to negotiate with IPRs. For sectors in which Chile reached the technological frontier –and where the new paradigm is the norm– it will become impossible to stay there without joining global research networks and technology markets.

But to participate in this global innovation system, Chile needs to increase its firms' absorptive capacity, currently restricted by human capital; develop experience working with IPRs, at firms, research institutions, and government agencies; and develop a culture of collaboration, not only increasing associativity, but thinking differently about these relationship, as important long-term assets fundamental for succesful and sustained innovation, rather than one-shot isolated events. Knowing how to deal with IPRs can be determinant in the success of these relationships, and in the effectiveness of government funding programmes oriented to knowledge demand.

There is one important caveat regarding the use of IPRs with the results of government funded research: the potential dynamic problems of the patent system. For example, a firm granted monopoly power over an invention might not have the capacity to properly serve its global demand, and for different reasons, might be unwilling to issue licenses. This is something that is commonly observed in Chile. While this is an important issue in itself, the problem is much more pressing when there are public funds involved. How should rights be distributed among sequential innovators, when some of them were supported by public funds? When a firm develops a new technology with public funds, should it be granted the same monopoly powers as if it developed it with own funds, or should it, for instance, be forced to grant licenses under preferential conditions? There is a pressing need to design good mechanisms for intertemporal financing of innovations and granting of IPRs, more complicated than simply granting the same monopoly powers for all innovations.

In summary, the new innovation paradigm is currently not very relevant to the Chilean economy, but eventually this could change, as both the new paradigm becomes the norm in more sectors and the local industries make advances in several key areas (notably human capital, and experience with IPRs and associativity, in other words,

improve their competitive and innovative abilities). In this context, IPRs can play an important part in several ways. First of all, they are a central part of the new innovation paradigm. But beyond this, their use should be mastered both to facilitate collaborative agreements and to increase the effectiveness of the new knowledge demand oriented policy instruments. With repect to the latter, it is important to consider eventual dynamic inefficiencies when designing them.

Recommendations for further research are straightforward, and the general direction was already indicated by López (2009): there is a lack of solid evidence in many subjects, and more empirical work is needed. Some of the areas that should receive more attention are the relative importance of IPRs and other appropriability mechanism in developing countries, in non-manufacturing industries, and instruments different than patents, such as trademarks. Another broad area that should be further studied is the interaction between patents and other public policy mechanisms used to encourage innovation, and the effectiveness of the different types of incentives.

With respect to policymaking, the first important recommendation is rather a reminder: Economies go through a learning process with its R&D policies, and this should be considered when designing instruments to promote innovation. Middle income countries, in periods of transition between different stages of development of their R&D policies, should be wary of this when introducing new instruments. For example, when policies intended to increase collaboration, or more generally, policies oriented to funding the demand for knowledge are put in place, IPRs negotiations will play an important role. Policies should be designed to allow for enough flexibility until firms and government agencies acquire enough experience.

Another topic where policymakers should be careful is the dynamic aspect of IPRs allocation, especially when there are public funds involved. While the problems of the patent system with the dynamic aspect of innovations is still a topic of debate, there are some situations where special arrangements, such as compulsory licensing, should be considered. For instance, to allow follow-on innovations, or to allow firms other than the one that started exporting a new product –developed with public funds– to participate in foreign markets.

A final recommendation is related to patent offices. In contrast with developed economies, in most developing countries they are unknown, obscure agencies, that do not work towards making the patent system a source of information. Recently, the Chilean agency was completly redesigned, and one of the important changes was making knowledge difussion one of the agency's main objectives. It should not be forgotten that a fundamental part of the whole patent system is the disclosure requirement, that prevents duplication of efforts, and more importantly, allows incremental innovations to be built on top of previous inventions. Without a patent office that is effective in disseminating knowledge, "open innovation" can hardly develop.

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