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Intellectual Property Rights and their Impacts in Developing Countries: An Empirical Analysis of Maize Breeding in Mexico

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Abstract

There is little empirical evidence on the effects of intellectual property rights (IPR) on developing countries. Complete enumeration of the Mexican maize breeding industry showed that, contrary to the hypothesis that IPR would provide incentives for R&D and innovation, IPR play no role for the industry in general, but that they are important for certain breeders' categories. The importance of the institutional setting and of transaction costs related to IPR protection. We conclude with a discussion of the implications for the development of biotechnology inventions and the improvement of IPR theory.

Keywords: Intellectual property rights; Developing Country; Empirical Evidence; Transaction costs; Mexico; Maize.

1. Introduction

Intellectual property rights (IPR) are generally considered an efficient institution to stimulate innovation. Strong IPR should provide incentives for innovation and expand investment and technology flows to developing countries (Maskus 2000). Although granting monopoly rights on an invention would impede its dissemination, under-provision of protected goods and monopoly distortions are usually considered acceptable costs in order to promote the creation of new knowledge and the increase in societal welfare that it brings (Gaisford et al. 2001).

Growing numbers question this position and maintain that IPR do not play an important role in stimulating innovation in developing countries (CIPR 2002) and that the strengthening of IPR benefits industrialized countries while hurting developing countries (Panagariya 1999). There is considerable uncertainty on the effects of strong IPR in developing countries (Tansey 2004).

This paper examines the impacts of IPR on a technologically advanced developing country, Mexico, to identify their role for the different stakeholders of the industry. Little empirical evidence exists on this subject and the conclusions are often uncertain. IPR are meant to support research and development (R&D), so interviews with maize breeders were carried out to gather information concerning their impacts: breeders should be the first actors to perceive their impacts.

Complete enumeration of the industry showed that IPR are not important in general, but that they are important for certain breeders' categories. Even though they exist on a formal level, IPR are in most cases ignored by breeders in their day-to-day activities. Therefore, IPR do not provide incentives for R&D. The analysis indicates that the quality of the institutional environment, the confidence in the judiciary system and the importance of transaction costs related to obtaining and securing protection are important factors affecting IPR use and the development of the biotechnology industry. Now that the regulatory framework allows for the unrestricted selling and planting of genetically modified (GM) varieties, improving the functioning of the market for licenses and information could be instrumental for the development of biotechnology capacities.

In the next section I present IPR and their expected impacts, followed in section 3 by background information on the Mexican maize breeding industry. In the fourth section I present the methodology used and in the fifth, the results of the interviews. I then discuss the findings and derive implications for the relevance and role of IPR in developing countries and conclude in section 7.

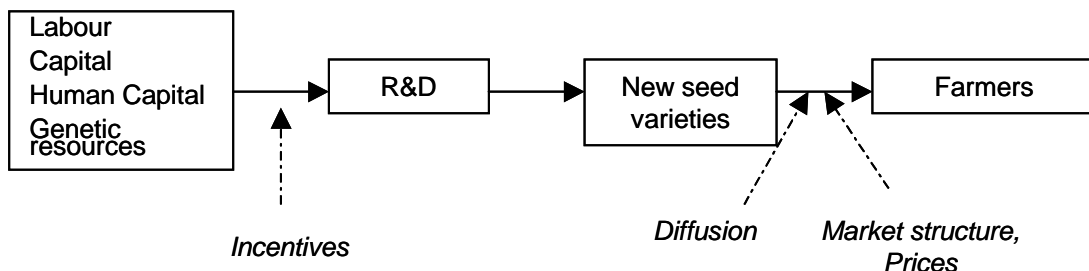
2. Intellectual Property Rights and their Impacts

2.1. Knowledge as a Public Good

Knowledge is a public good, non-rival in consumption and non-price excludable. From economic theory, such goods will not be provided at an optimal, socially desirable level. A common intervention¹, to correct for this undersupply, consists in the definition of property rights that will allow private investors to harvest the profits generated by their effort rather than share those with free-riders. The internalisation of externalities will provide incentives for further innovation (Demsetz 1967). The new knowledge produced by agricultural R&D is not always a pure public good: know-how related to breeding techniques is non-rival, while the seed produced is. Similarly, a maize hybrid variety, i.e., not breeding true, is excludable, while an open pollinated variety is not.

Figure 1 illustrates the roles and impacts of IPR in the research and seed industry research and production process. With IPR arises the dilemma of “access versus appropriability” (Alston, Norton and Pardey 1995). By granting temporary exclusive rights on inventions, IPR are intended to allow right-holders to price their products above marginal cost, and hence recoup their initial research investment. Such exclusive rights create incentives for the performance of R&D leading to innovation, but cause monopoly inefficiencies and could restrict the dissemination of new technologies and innovations. However, inventors have to disclose the details of their inventions in order to obtain protection. Finally, IPR tend to support the concentration of the industry but some innovations can also have deconcentrating effects (Lesser 1998). In all cases, the theory does not offer clear indications as to which effect dominates: it is clearly an empirical question.

Figure 1: IPR in the Seed Industry Research and Production Process



Source: Adapted from Léger (2001)

¹ Other interventions may consist for example of the creation of new public and private sector R&D institutions, enhanced incentives for private involvement and the provision of public funds for publicly or privately executed R&D.

Whether the assumptions of IPR theory are justified for developing countries is subject to debate (Jaffé and van Wijk 1995). Technological capacities differ widely among developing countries: not all of them are able to assimilate technologies from other countries, let alone develop their own technologies. In such cases, the dynamic gains due to IP protection supporting indigenous innovation would not take place, and the static (monopoly) costs of IPR summed to the costs of implementation of the system would lead to a net negative effect. In order to identify the impacts on a technologically advanced developing country, the following hypotheses are investigated:

1. IPR provide incentives for private R&D and innovation;
2. PR restrict breeders' access to protected germplasm and inventions;
3. IPR foster the concentration of the industry and an increase in seed prices.

2.2. Strengthening of Intellectual Property Rights

Historically, national patent systems were developed to support domestic industrial development but the increase in international trade, and the advent of information-based products and services, led multinational companies (MNC) to request international policies that would help protect their proprietary information. The WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs) sets minimum standards for IP protection in WTO member states. Regional trade agreements also include IP requirements: As a member of the North American Free Trade Agreement (NAFTA), Mexico was one of the first developing countries to effectively strengthen its IPR legislation.

For the case of plant breeding, strengthening of IPR consisted of: i) Making patent protection available for all inventions in all fields of technology – plants and animals being exceptions; ii) Providing for the protection of plant varieties, for example using Plant Breeders' Rights (PBR); iii) Allowing for the protection of undisclosed information (Trade Secrets); and iv) Ensuring the adequate enforcement of the rights. Other types of IPR (e.g., trademarks) act as marketing tools rather than means to support technological advances (Perrin 1994) and have not been considered in the study. Definitions and examples of uses for maize breeding are given in Table 1.

3. Maize in Mexico: Background

3.1. Actors and Transactions

The Mexican maize breeding industry is considered well-developed: research capacities are relatively high, breeding is performed by MNC and local companies as well as the public sector, and

breeders develop hybrid and open-pollinated varieties, which are subject to different types of IP protection. This industry is most likely to show changes following IPR strengthening.

Figure 2 illustrates the roles and interactions between the different actors of the industry, following germplasm flows between seed providers and farmers. MNC supply commercial farmers with hybrid varieties and perform sophisticated breeding programs. Local seed companies use germplasm from the public sector to develop and commercialise their own varieties. Some cases of local companies selling MNC varieties under license have also been observed. Small-scale farmers obtain modern varieties from local companies, cooperatives/ NGOs or the public sector, and their traditional materials are precious inputs in the R&D process of the breeding industry. Public research organizations comprise: i) INIFAP, the applied agricultural research institute, developing agricultural products; and ii) the universities, performing mainly basic research: new varieties are only by-products of their activities. Lastly, CIMMYT² is an important source of germplasm for the industry: Its materials were used in 33.3% of the cultivars released by public organizations between 1966 and 1997, and in 81.3% of varieties released by the private sector in 1997 (Morris and López Pereira 1999).

Table 1: Intellectual Property Rights for Maize Breeding

IPR	Function	Example
Patent	Excludes others from imitating, manufacturing, using or selling a product or process for commercial use for 20 years.	Genetic modification
Plant Breeders' Rights (Act of 1978) ^a	Excludes others from producing or commercialising material of a specific plant variety. Two exceptional uses of protected varieties are allowed: <ul style="list-style-type: none"> - <i>Research exemption</i>, allowing to use the protected materials to create new varieties or perform research; - <i>Farmers' Privilege</i> allowing farmers to save and re-use the seed obtained from the cultivation of protected varieties. 	New maize variety
Trade Secret	Legally enforceable protection against unauthorized disclosure of proprietary information through commercially unfair means.	Parental lines of a hybrid variety

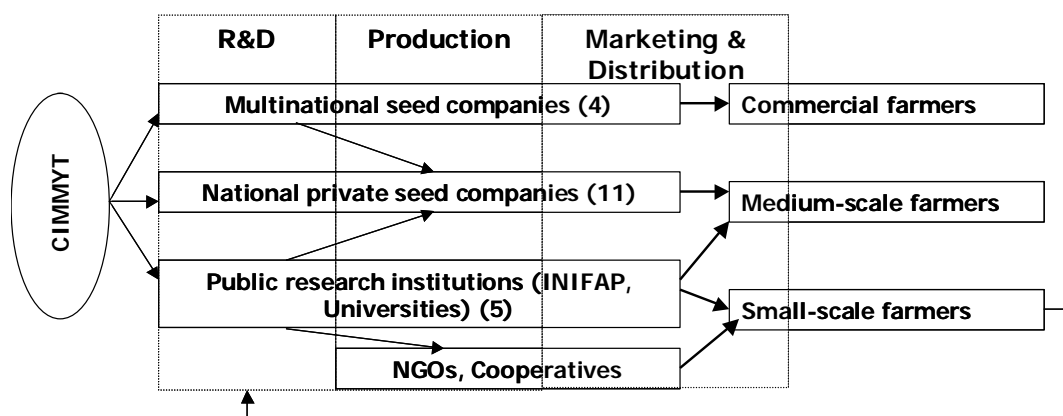
a) There are two versions of the Act of the International Union for the Protection of New Varieties of Plants (UPOV): the Act of 1978 encompasses more flexibility in terms of the Farmers' Privilege and Research exemption than the Act of 1991. Source: CIPR (2002) and Maskus (2000)

Even though the Mexican industry is perceived as well developed, the number of companies involved in breeding, and not only in multiplication and distribution of varieties, is still low. Only

² The International Maize and Wheat Improvement Centre (CIMMYT from its Spanish acronym) is one of the International Agricultural Research Centres.

eleven local companies would then be involved in maize breeding. They however present very different characteristics: products developed, resource endowment, technological capacities, organizational structure, etc. These actors' groups are likely to identify different impacts IPR have on their activities and on the industry.

Figure 2: Structure of the Maize Breeding Industry and Germplasm Flows



Source: Adapted from López Pereira and Filipello (1995). Note: Number of companies in brackets

These transactions can be costly. Among firms and research organizations, contracts covering exchanges of materials and techniques are subject to information costs, e.g. for identifying a suitable partner and product. Negotiations costs are also incurred, for example to define the activities covered and the associated price. *Ex post*, other transaction costs relate to the implementation of the transaction, and to its monitoring and enforcement.

Breeding companies also interact with IPR regulatory agencies³ to obtain IP protection. They encounter information costs to access the knowledge to abide the laws and understand IPR procedures. Other costs are related to the certification of the rights, their monitoring and enforcement. Since transaction costs in developing countries are often very high (Collier 1998), and that their magnitude may vary for different actors, we take them into account in the analysis.

3.2. Policy Environment and Hypotheses

IPR strengthening started in 1991, in anticipation of NAFTA requirements, followed in 1997 by a second wave of reforms, through which the country introduced PBR and committed to ensure effective enforcement procedures. These changes brought Mexican laws in line with the TRIPs

³ Léger (2001) describes and discusses the role and characteristics of Mexican IP regulatory agencies.

Agreement. The implementation of NAFTA, in the early 1990s, triggered several other policy changes, for example a domestic agrarian reform including a new seed law allowing the full participation of the private sector in the seed industry: Private sector activities were before closely monitored.

Based on the institutional structure of the maize breeding industry, a fourth hypothesis can be added to the three developed following IP theory:

1. IPR provide incentives for private R&D and innovation;
2. IPR restrict breeders' access to protected germplasm and inventions;
3. IPR foster the concentration of the industry and an increase in seed prices; and
4. IPR play different roles for different breeders' groups.

4. Data and Methods

In the fall of 2000, interviews with a total of 25 breeders from 18 maize breeding companies and public institutes were conducted. All companies and public organizations performing maize breeding in the country were surveyed except for two: one breeder in a remote area never responded and one company did not have a breeder at the time of the survey. The breeders interviewed were in general the main breeders of their company: the assumption was that such breeders would have a better overview of R&D programs and would possess the knowledge required to answer all questions. The questionnaires used⁴ were designed to allow testing the hypotheses.

There are two main ways of quantifying the impacts of IPR on R&D and knowledge creation (Jaffé and van Wijk 1995):

- R&D inputs, e.g., investments, number of research programs and researchers; and
- R&D outputs, e.g., number of new varieties developed and agricultural productivity.

Although respondents were very cooperative, they were in general reluctant to provide precise quantitative information while for some organizations, the information was simply not available. I use the information on R&D inputs as indicators of the trends in the industry, but could not perform statistical analysis with the data. Given the time needed to develop new varieties (average of 7 years), indicators related to R&D outputs were not considered.

⁴ The questionnaires are comparable to those used in similar studies (Butler and Marion 1983; Jaffé and van Wijk 1995) and are available from the author upon request.

5. Breeders' Perception of Intellectual Property Rights: Results

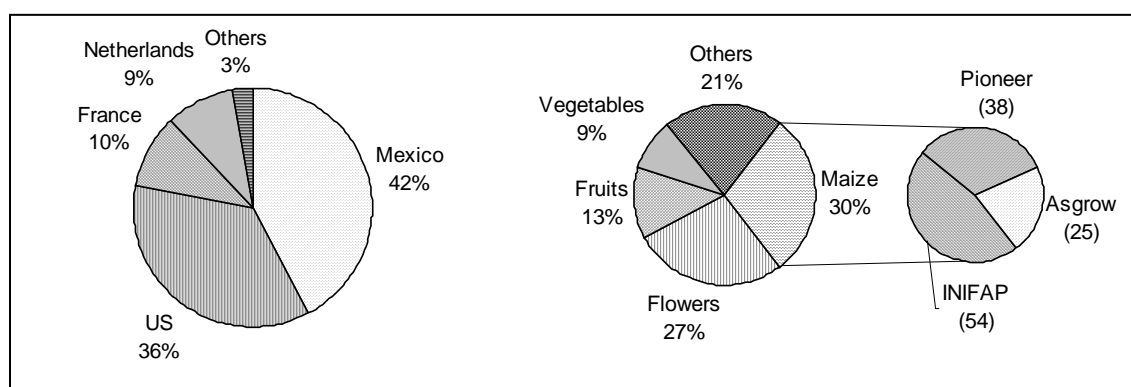
5.1. IPR Use in Mexico

Since they perform different activities and serve different markets, the interviewees are separated into three actors' groups: local companies, MNC, and public sector. Such grouping allows investigating hypothesis 4, that IPR play different roles for different actors' groups.

At the time of the research, the PBR system was not completely functional in Mexico, but applications had already been received. Most applications originated from Mexican companies (42%) while other applications came mainly from the US, France and the Netherlands (see figure 3). Most applications were received for maize (30%), with three organizations having filed applications: INIFAP (46.1%), Pioneer (32.5%) and Asgrow (21.4%), two MNC.

It is a surprising outcome and contradicts hypothesis 1: IPR are meant to provide incentives for private breeding and its main user is a public research institute. Moreover, the varieties developed by the two MNC are hybrids, for which PBR protection is superfluous given their biological characteristics. The interviewees revealed that PBR protection of all new varieties was imposed by the high management/ headquarters, irrelevant of the real need for protection. It was not clear if such policy was applied to all crops: If so, the importance of Mexican applications could reflect mainly INIFAP's activities. These patterns of use support hypothesis 4, according to which IPR play different roles for diverse actors' groups.

Figure 3: Plant Breeders' Rights Applications by Country of Origin and by Crop



Source: Servicio Nacional de Inspección y Certificación de Semillas (2000).

Although the total number of patent applications in the country has increased over time, the number of applications filed by Mexican inventors decreased. Out of 4,144 patent applications in 1978, 787 (18,9%) originated from Mexican inventors, whereas in 1999, the total number of ap-

plications had raised to 12 110 and Mexican applications were down to 447 (3,9%) (IMPI, 2000). Patent applications related to genetically modified maize were scarce: In October 2000, only 5 had been filed, by MNCs involved in the life sciences industry (IMPI, patent search, 2000). Two local breeders have however declared owning patents, which contradicts this information and could indicate confusion between using a patent under license and holding a patent. In this case also hypothesis 4 is supported by the patterns of use.

Finally, from their nature trade secrets are not registered, data on their use are therefore not available. From the interviews, they seem to be mainly used in the private sector for establishing contracts and alliances, but the concept is in general not well understood.

The level of knowledge concerning IPR was generally low, but varied among breeders' categories. MNC breeders were well aware of IPR, while some local and university breeders did not know much about it and needed background information to answer the questions. This supports hypothesis 4 and reflects, the relative novelty of these tools for the industry and their lack of relevance for the activities performed, but also the information costs prevailing in the industry. This lack of knowledge and relative indifference has also been observed in other Latin American countries and supports the conclusion that IPR were not introduced following pressures from the industry, but rather to comply with trade agreements (Jaffé and van Wijk 1995).

5.2. Impacts of IPR: Breeders' Perceptions

Table 2 summarises the results from the interviews, by actors' groups, in order to highlight their potential divergences of opinions and perceptions. The different aspects investigated are discussed in greater detail in the following sub-sections.

5.2.1. Incentives for R&D and Knowledge Creation

Only a minority of breeders considered that IPR provided incentives for maize breeding activities, while approximately half thought IPR had no influence. The same opinion prevailed concerning the impact of IPR on private investments, even though almost half of the breeders believed that IPR would be more important for foreign companies and could provide them with incentives to develop products adapted to the Mexican conditions. Local company breeders agreed that, in theory, patents would be useful and important in providing incentives for innovation, yet they believed that the current patent system definitely needed to become more efficient.

For most breeders, PBR did not provide incentives for innovation, and they were not familiar with trade secrets and therefore could not evaluate their impact.

Table 2: Perceptions of IPR impacts: Summary

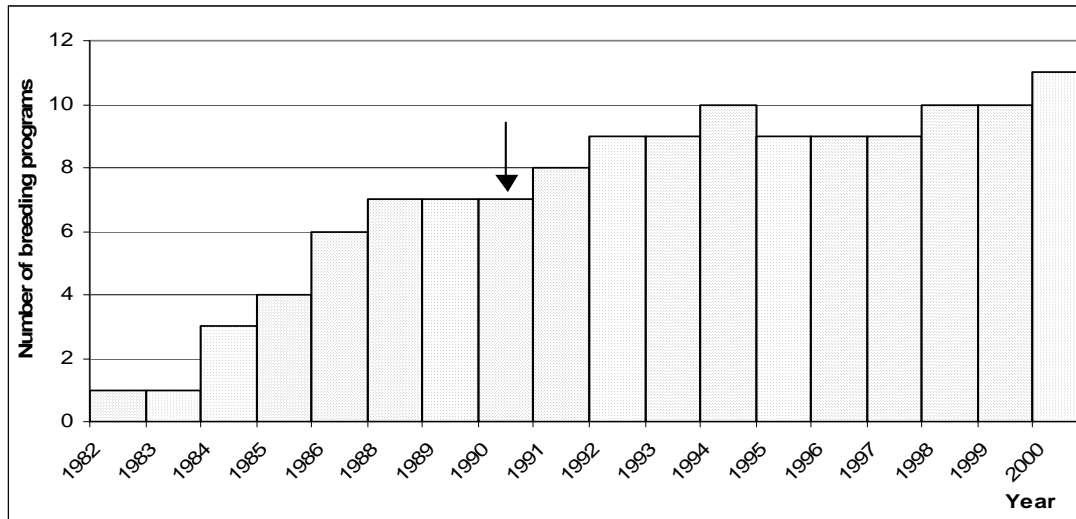
	MNC (4)	Local (11)	Public (5)
<i>Incentives for R&D and Innovation</i>			
PBR	?	0	0
Patents	+	+	0
Trade Secrets	0	?	?
Provide incentives for private investments?	?	0	+
Provide incentives to international firms for local innovations?	+	0	+
<i>Diffusion : Information and Germplasm Flows</i>			
PBR	0	+	-
Patents	-	?	-
Public-private information/ germplasm flows	-	-	-
<i>Market Structure and Prices</i>			
Supporting private breeding	+	+	+
Seed Prices	0	0	+
Supporting the concentration of the Industry	0	0	+

Legend (opinion of the majority): +: positive impact/in favor; - negative/against; 0: no impact; ?: do not know
Source: Interviews

A quantitative indicator of the impact of stronger IPR is the creation of new private breeding programs. Figure 4 shows that breeding programs from the surveyed companies started at the beginning of the 1980s. The arrow indicates the occurrence of the first IPR strengthening, in 1991. The end of the 1980s indeed witnessed a high number of companies starting breeding programs, but it is difficult to relate it to the changes in IP law, since several policy changes took place in 1991, among others a domestic agrarian reform and the enactment of a new seed law removing restrictions to private sector participation.

A second quantitative indicator is the number of breeders involved in maize breeding (see figure 5, presented by type of organization and level of education). The number of breeders increased between 1990 and 1999, for each type of organization. The number of highly educated breeders also rose with time: while technicians were the most important group in 1990, MSc breeders dominated in 1994 and 1999. The interviewees mentioned that the availability of breeders had limited the development of the industry, and indicated that the number of graduates had increased in the last years.

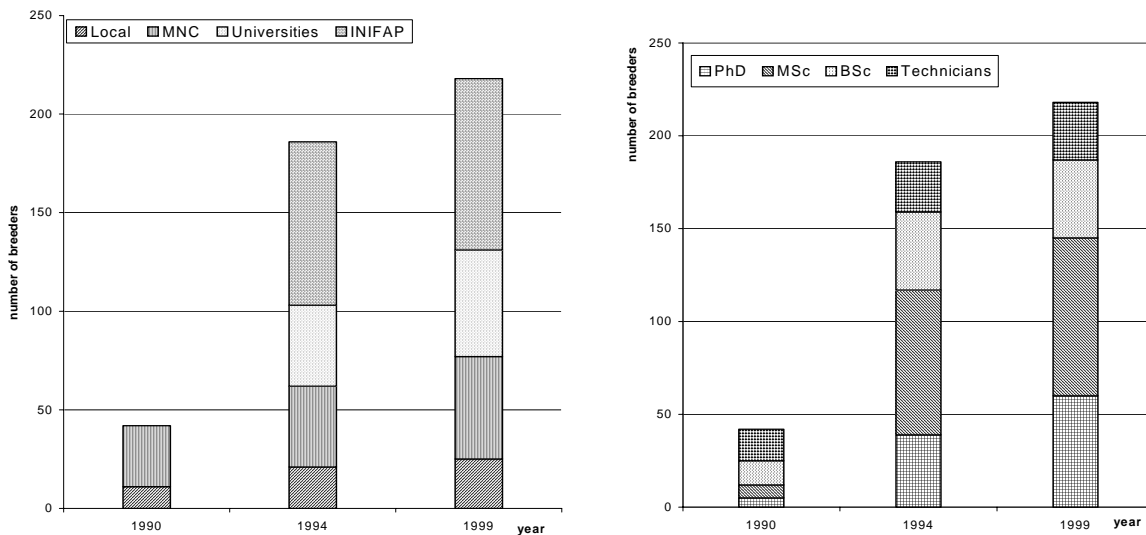
Figure 4: Number of Breeding Programs over Time



Source: Interviews with maize breeders

Finally, the information on R&D investments indicated that these had not increased over time, but rather decreased in real terms: In the public sector, budgets stayed the same in nominal terms since 1985, even though the financial crisis of 1994-1995 led to a severe devaluation of the Peso. Local companies in general maintained a budget to sustain a constant level of innovative activity, while MNC had seen their budgets reduced.

Figure 5: Number of Breeders, by Sector and by Level of Education



Source: Interviews with maize breeders. Note: Data not available for public sector for 1990

The evidence gathered does not support the hypothesis that IPR provide incentives for innovation and R&D. In general, transaction costs and corruption in the legal system affect the efficiency of the system: Several breeders thought that stronger IPR would, in theory, support innovation but that, in the Mexican institutional environment, they could not play their role. *Ex ante* information costs seemed to be so high that they impeded access to knowledge on IPR. *Ex post*, the importance of certification costs would render protection irrelevant, and the deficient enforcement, related to the corrupt and flawed legal system, makes protection inefficient in reality. Finally, quantitative indicators – number of breeding programs, number of breeders – cannot be related to the strengthening of IPR. Other changes, such as the enactment of the new seed law and the increased availability of educated breeders, are much more likely to have had an impact.

5.2.2. *Diffusion: Information and Germplasm Flows*

Local breeders generally considered PBR to favour access to maize materials, while public breeders thought it would restrict it and MNC breeders did not identify any impact. Some of the local breeders considered PBR more like a marketing device and as such, perceived it would facilitate the transfer of information and diffusion of varieties. Patents, on the other hand, were perceived by MNC and public breeders as potentially reducing their access to genetic materials and technologies, while most local breeders could not forecast an impact.

According to the interviewees, the germplasm flows between public and private entities were not affected by the new IP laws, nor were international flows. Yet the MNC were the only companies involved in international material transfers – from their headquarters – the other breeders were hence not speaking from experience. Quantitative data on germplasm and varieties movements were not available, given these transactions' private character.

The information gathered on the diffusion of germplasm reflects the different protection levels offered by the types of IPR. For PBR, a weaker form of protection, the “diffusion of information” effect would dominate, while patents would reduce access to technology and germplasm. However, on basis of the little data on information and germplasm flows and technology transfer, it is impossible to determine the general impact of IPR on diffusion of information and materials.

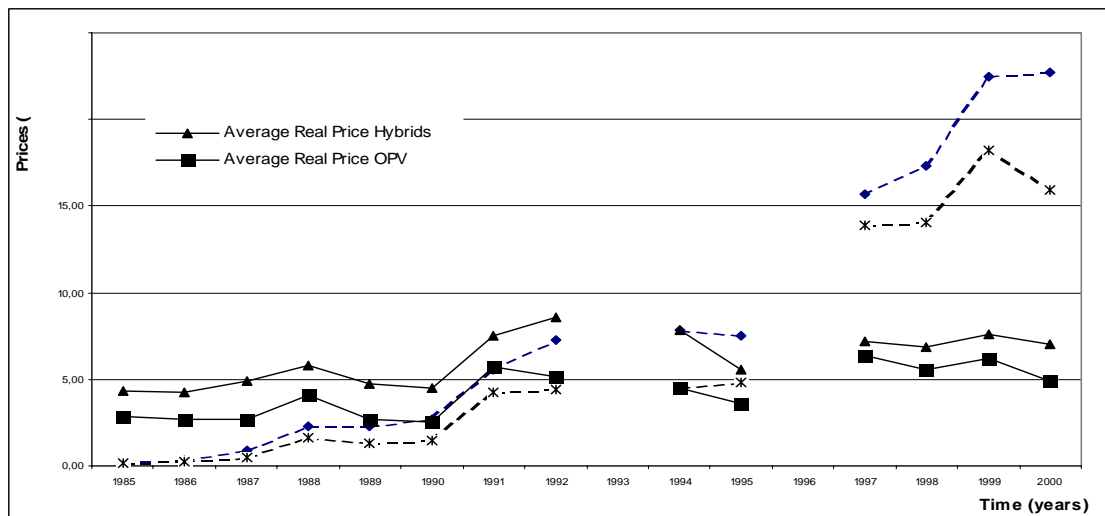
5.2.3. *Market Structure and Prices*

Most respondents thought that private companies had become more important in the performance of breeding. Public breeders also thought, contrary to private sector breeders, that IPR had con-

tributed to increasing the concentration of the industry. A new seed law, enacted in 1991, allowed full participation of the private sector in the industry, making it difficult to distinguish the impact of stronger IPR. Yet at the international level several mergers and takeovers have occurred between the companies of the “life science industry”, which also affected the number of companies operating in the Mexican market⁵ but was not related to the national strengthening of IPR.

Public sector breeders believed that the strengthening of IPR had contributed to the increase in seed prices over time. However, real seed prices⁶, for both open pollinated and hybrid public varieties, stayed more or less constant over time (see figure 6). Given the changes that occurred in the 90s in the country (e.g., policy reforms, exchange rate fluctuations) it was difficult for the breeders to relate the phenomena to a given cause. Conversely, these changing conditions make evaluating the impact of a policy change equally difficult. In the Mexican context, the industry became less concentrated than it was, therefore the information gathered does not support hypothesis 3 that IPR would support the concentration of the industry and increases in seed prices.

Figure 6: Evolution of Maize Seed Prices over Time



Source: PRONASE and SECOFI (2001). Note: Data for 1993 and 1996 not available.

⁵ Byerlee and Fischer (2000) discuss mergers and acquisitions in the biotechnology industry.

⁶ The prices of private varieties were not available from the breeders, and the government does not compile it. Even though public and private varieties are usually sold in different markets and cannot be considered perfect substitutes, prices of public varieties provide an indication of the evolution of seed prices during this period.

6. Discussion

6.1. Summary of the Results

The results do not confirm the general expectation that IPR would play a role for innovation in a technologically advanced developing country. The evidence gathered does not support the hypotheses under study, except for the last one: IPR play different roles for the diverse actors' groups. Table 3 summarises the results.

Breeders did not perceive stronger IPR as providing them with incentives for maize breeding, nor did they invest more in these activities due to their presence. The main user is a public institute, while IPR should provide incentives for **private** breeding, and data on R&D budgets and number of breeding programs and breeders did not offer strong support for hypothesis 1.

Table 3: Summary of the Results

	Hypothesis	Breeders' perceptions	Evidence
1	IPR provide incentives for private R&D and innovation	<ul style="list-style-type: none"> - IPR do not provide incentives for maize breeding - IPR do not support higher investments in R&D 	<ul style="list-style-type: none"> - Main user is a public organization - Evidence from number of breeding programs, number of breeders and R&D budgets not supportive - Other changes (e.g. policy, availability of educated breeders) might have had greater impact
2	IPR restrict access to germplasm, new varieties and inventions	<ul style="list-style-type: none"> - IPR reduce transaction costs and favour access to maize materials - Patents reduce access to germplasm and technologies 	<ul style="list-style-type: none"> - No evidence
3	IPR foster the concentration of the industry and an increase in seed prices	<ul style="list-style-type: none"> - IPR favour MNC and private sector - IPR foster the concentration of the industry - IPR support increases in seed prices 	<ul style="list-style-type: none"> - Number of companies involved in maize breeding increased - Prices stayed constant in real terms
4	IPR play different roles for diverse breeders' groups	<ul style="list-style-type: none"> - IPR favour MNC - Public breeders: IPR on plant unethical - MNC believe IPR are necessary for the development of the industry 	<ul style="list-style-type: none"> - Only MNC possess patents - MNC second and third most important PBR owners

Source: Authors' compilation

The agrarian reform and the introduction of the new seed law, along with the increased availability of educated breeders have played important roles in supporting breeding activities. The role of IPR is difficult to identify with so many changes taking place simultaneously. A critical point mentioned by the respondents concerned the transaction costs related to IPR protection, more specifically information, certification and enforcement costs. These perceptions, along with the

lack of confidence in the legal system, can explain the low level of IPR use and the negative perceptions prevailing in the industry.

Local breeders identified different impacts for PBR and patents: PBR reduce information costs in transactions between breeders while patents, on the other hand, reduce access to germplasm and technologies. The unavailability of data did not allow identifying impacts and therefore supporting or rejecting hypothesis 2.

The evidence gathered indicates less concentration in the industry and a slight increase in real seed prices, contradicting hypothesis 3. Yet given the number of policy changes in the 90s, it is difficult to associate these impacts to stronger IPR. Breeders however thought that both seed prices and concentration of the industry had increased. The inflation/devaluation of the peso in the 90s, the approval of private participation in the seed industry and the mergers and acquisitions at the international level might have influenced these perceptions, even though they are not related to the domestic strengthening of IPR.

Finally, the only hypothesis supported by the results is that IPR play different roles for diverse breeders' groups. This is first illustrated by the patterns of use: only MNC possess patents in the country, and along with INIFAP, MNC are the only users of PBR for maize. They also perceive their impacts differently.

These differences can be explained by the level of awareness of the breeders' groups, their resource endowment but also their interests and the products they develop. MNC breeders knew in general a lot more about IPR and their impacts and were more familiar with their use. These companies possess more human and financial resources and develop high-quality, modern products for bigger markets. On the one hand, the international activities provides economies of scale that can make the transaction costs less important than for local companies. On the other hand, they develop innovative products that are worth protecting. MNC have an interest to protect their knowledge and reap all the benefits associated to it, while other breeders would rather keep the materials and technologies unprotected, and benefit from the knowledge spillovers. This reflects the situation at the international level that led to the implementation of the TRIPs Agreement.

6.2. Discussion

The importance of IP protection has to be put in perspective: in most countries, viable maize breeding industries have existed before the presence of enforced IPR. They are hence not a necessary condition for the performance of maize breeding. Yet the case of maize is a special one

since hybrid varieties have an “in-built” protection – and commercial breeding focuses almost only on hybrid varieties. However, similar results were obtained in studies looking at the impact of PBR on innovation for wheat, an open pollinated crop, in the United States (Alston and Verner 2002), and on all crops in Argentina (Jaffé and van Wijk 1995). More empirical evidence is needed before generalizing these results to other countries and crops, but the similitude for hybrid and open-pollinated crops and developing and industrialized countries are worth being noted.

Transaction costs, more specifically information, certification and enforcement, appear to seriously hinder the functioning of the IPR system and could in certain cases be high enough to hamper the incentive effects. Comparing the effects of IPR and hybridisation on private plant breeding investments and innovation rate leads to this conclusion: The impact of IPR is not strongly supported by the data, whereas hybridisation’s role is (Léger 2001). The main difference between these two ways of appropriating returns from innovation is that hybridisation does not involve the transaction costs legal forms of protection are subject to. It also provides the same level of protection across countries, and therefore does not depend on the legal system in place.

Breeders’ perceptions were consistent with this reality: Several thought that stronger IPR would, in theory, support innovation but that, given the Mexican institutional environment, they could not play their role. This reveals the importance of the regulatory and institutional environments for the protection and enforcement of IPR and innovation, as supported by the empirical evidence of Alfranca and Huffman (2003).

However, the relatively short time period between IPR strengthening in Mexico and the study has to be taken into account. Plant breeding, and R&D in general, are long-term processes and the impacts of a new incentives scheme would probably take more time before it is identifiable.

Finally, the “real-world” effects of IPR are difficult to evaluate in the context of several simultaneous adjustments and policy changes. The low level of IPR use in the industry did not offer strong support to refine the theory and determine the dominating effects. The study however provides early evidence of the impacts of IPR in a technologically advanced developing country and finds that they do not play an important role.

6.3. Implications for Biotechnology

At the time of the study, the sale and planting of genetically modified (GM) maize was subject to a moratorium. These activities have been recently permitted without restrictions: these market opportunities should favour and accelerate the development of final products. The MNC, having

experience with technology transfer, and owners of the only patents granted for maize (at the time of the study) have a head start: Products and technologies have already been developed by their headquarters or associated firms. Their privileged links with technology providers imply lower transaction costs than for independent companies, favouring access to the technology and products of interest and accelerating the coming of these products on the Mexican market. Furthermore, MNC have more resources, financial and human, to face the transaction costs, in comparison with their rivals. Most commercial maize breeding produces hybrid varieties, which, as was previously mentioned, have an in-built protection and for which legal transaction costs are hence not as important.

For local seed companies, the access to GM varieties is likely to be more challenging. Most major players in the biotechnology industry have acquired multinational seed companies, which gives them a channel to bring their products to farmers. They could license their technologies or products to other companies, especially in the context of a segmented market such as Mexico.⁷ Yet licensing to competitors in the same market would not make economic sense.

Obtaining licenses from universities and public research institutes involved in biotechnology (for example, CINVESTAV) would be a more plausible alternative and would give local companies the possibility to supply differentiated products to the market, responding to local needs and characteristics. However, the market for licensing would be, based on the evidence gathered, subject to high transaction costs, and enforcement of contract clauses would be difficult, which reduces the profitability of such agreements for both parties, and could threaten their realisation.

Obviously, the height of transaction costs represent an important obstacle to the effective functioning of the IPR system, and potentially for the development of the local biotechnology industry. In general, the functioning of the legal system, and in particular, of the IP regulatory agencies, has to improve. The information needs to be available, the costs of the certification process have to become low enough to ensure that protection of proprietary products is profitable, and the confidence in the legal system has to improve, in order for the enforcement to be realisable.

These changes take time to be implemented and their effects will not be observed before several years. To favour the development of a national biotechnology industry, two basic aspects have to be considered: breeders have to have access to technologies to pass on to farmers, and there needs to be a profitable market for the final products. Given their resource endowments and current

⁷ See Byerlee and Fischer (2002) for a proposal concerning market-sharing and public-private partnerships in the biotechnology industry.

market presence, MNC are in a good position to supply the market. For local companies, policies and investments facilitating public-private partnerships and technology transfers are an important aspect of the equation. By developing differentiated products adapted to local needs and conditions, they would have a chance to compete with MNC in the market of the commercial farmers.

7. Conclusion

There is little empirical evidence concerning the effects of intellectual property rights (IPR) on a technologically advanced developing country. Complete enumeration of the Mexican maize breeding industry showed that, contrary to the hypothesis that IPR would provide, in a technologically advanced developing country, incentives for R&D and innovation and stimulate diffusion of new knowledge and information, IPR play no role for the industry. This can be explained by the short time period between IPR strengthening and the study, but especially by the high information, certification and enforcement costs related to IP protection.

From the results and discussion above, qualifications to IPR theory and policy can be formulated for the case of developing countries. The all-positive assumptions at the basis of the TRIPs agreement (e.g., Article 7) should be put in perspective and characteristics of the countries should be taken into account in evaluating the role stronger IPR could play for their economy. The quality of the institutional environment is an important aspect to take into account. The presence of efficient and reliable institutions is key to the proper functioning of IPR and it is a weakness in several developing countries.

Reducing transaction costs in the market for licenses and information could also be instrumental in supporting the development of a national biotechnology industry. Given the relatively good score of Mexico on these critical factors, IPR are likely to play an even smaller role for other developing countries, and the development of local biotechnology capacities to be more challenging.

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