Property Rights and Strategy: Market Structure and Competition in the Brazilian Soybean Seed Industry

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Abstract – Recent studies indicate that strong systems of property rights are not a necessary condition for the operation of the soybean seed market in the Americas (Wright; Pardey, 2006; Endres; Goldsmith, 2007). These studies are based on a dichotomy. The North – represented by the U.S. – is a strong institutional environment in which agrobiotechnology firms adopt an optimal strategy, setting technological rates charged at the time of acquisition of the seed. The South – represented by Argentina – corresponds to a weak institutional environment in which firms adopt a sub-optimal strategy. Nevertheless, the operation of the seed market in Brazil is based on a different, more complex scheme of collecting royalties from seeds. In face of the institutional differences among the U.S., Argentina, and Brazil, the multiplicity of schemes for the collection of royalties from seeds suggests that strategic decisions in this industry are not trivial. This research assumes that agrobiotechnology companies do not face a choice between optimal and sub-optimal strategies. Firms, in fact, have to choose from a constellation of strategies which are influenced by the quality of the institutional control. The study aims to answer the question: How property rights influence firms' strategic choices in the seed industry?

Keywords – property rights, strategy, institutional environment, seed

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1. Introduction

In his presidential address to the American Economic Association in 2009, Dixit notes that:

If the government does not protect property rights, at least not as well as the owners require, many alternative private arrangements arise to meet the owners' needs.

Building on Dixit (2009)'s proposition, this paper aims to show how the quality of the institutional controls may influence the mode of governance of property rights on GMO soybean seeds. In doing so the paper places itself in the interface between the property rights economics, the strategic analysis, and the assessment of the institutional environment.

According to Foss and Foss (2004), despite the fact that the economic theory has continuously informed much of the thinking in the strategy field, the theory of property rights (Coase, 1960; Alchian, 1965; Demsetz, 1967; Cheung, 1969; Barzel, 1994, 1997) has been explicitly applied to the analysis of strategy in only a few studies (Foss and Foss, 2000; Kim and Mahoney, 2002).

In contrast, much has been written about the relationship between the institutional environment and strategy (Henisz and Williamson, 1999; Oxley, 1999; Henisz and Delios, 2002; Peng, 2002; Javorcik, 2004; Yadong, 2005, Gaur et al., 2007; Dunning and Lundan, 2008; Peng et al., 2008). This literature has two main features. Firstly, the institutional environment is an independent variable (i.e., shifter parameter). [1] Secondly, the focus of the analysis is the influence of the institutional environment on the governance structure of the firm (or group of firms) that performs international operations. In general, this literature examines the firms' strategic decisions related to the mode of entry in foreign markets (green field, local partnerships, etc), and the performance of international operations.

This paper is similar to this literature by analyzing the institutional environment as a shifter parameter. However, it differs on one crucial aspect: we analyze how a specific transaction in the interface of the firm with its customers – collection of royalties on

[1] This paper does not analyze the broad literature that examines the efforts of agents on changing the institutional environment (e.g. Holbum and Vanden Bergh (2002), and De Figueiredo and De Figueiredo (2002)).

GMO soybean seeds – is structured in different contexts. It is assumed that an asset is composed of multiple attributes and that different agents may share the property rights associated with each particular attribute of a given asset (Barzel, 1997; Dixit, 2004). The analysis shows then that there is an interaction between the ownership pattern of the different dimensions of an asset, the strategic actions undertaken by the firm, and the quality of the institutional controls.

The paper is divided into five parts apart from this introduction. The next section presents the model that guides the analysis. Section 3 applies the model to a particular case, the collection of royalties on GMO soybean seeds. Section 4 performs a comparative analysis on the mechanisms of royalty collection in the U.S. and Brazil. Section 5 is a discussion on the results and section 6 presents the conclusion.

2. Theoretical framework

The theory of property rights provides an explanation of how firms can define organizational arrangements in order to exploit a given asset. As Barzel (2003: 43) notes: *"the development of property rights theory has its roots both in questions related to the origin of property rights, and in the organizational forms asset owners use to exploit their assets"*. This section explores the creation of organizational arrangements within the theory of property rights and discusses how strategic aspects and the institutional environment may be explicitly incorporated into the analysis.

Barzel (1994, 1997, 2003) develops a model of economic analysis of property rights. His main contributions are to introduce the concept of asset as a bundle of attributes and to claim that a more efficient analysis may be obtained if one examines the ownership of attributes instead of the ownership of the asset itself (Foss and Foss, 2001a). The model is built on two concepts besides the notion of 'asset as a bundle of attributes', they are: the definition of public domain, and the concept of economic property rights.

Public Domain. According to Barzel (1997), the notion of public domain relates to the idea of value dissipation. An attribute belongs to the public domain when the resources required for its acquisition are not directed at anyone. Eggertsson (1990) provides more ground to Barzel (1997)'s definition by identifying three elements that guide the ownership structure of a resource towards the communal property and the open access; they are: (a) high costs of exclusion, (b) high costs of internal governance where rights

are shared, and (c) the establishment by the state of the rule of free access. Dixit (2004) also emphasizes the cost of exclusion as the basis of the public domain; according to this author, an attribute is located in the public domain if its possession is not specified or can not be achieved. In general terms, we consider that the public domain is fundamentally characterized by difficulty of exclusion resulting in dissipation of value when agents try to acquire the attributes assigned in the public domain.

Economic Property Rights. Barzel (1994, 1997) establishes a fundamental distinction between legal property rights and economic property rights. The first is what the state assigns to a person. The second refers to the individual's ability, in expected terms, to consume the goods or services associated with a given asset. [2] Because an asset is composed of different attributes, economic property rights can be assigned for each attribute that encompasses the asset. [3]-[4]

As a general principle, individuals try to maximize the value of their economic rights through consumption or exchange. However, every maximization effort is potentially constrained because the mere existence of the public domain means that the economic ownership may be restricted to the extent that the cost of excluding others from the consumption of certain attributes of the asset is prohibitively high. When attributes escape to the public domain, they are subject to capture. In this sense, the efficient pattern of ownership on the attributes of an asset is one that minimizes the capture of attributes. The important point is that the pattern of ownership itself corresponds to an organizational arrangement whose *raison d'être* is the restriction of the capture. Thus, an organizational arrangement within the theory of property rights is one that seeks to mitigate the capture of imperfectly defined property rights, or conversely one that seeks to maximize the value of the economic rights.

As noted by Barzel (1994), the keyword in the definition of economic property rights is ability. The definition is concerned not with what the agents are legally entitled to do

[2] The term "consume" originally used by Barzel (1994, 1997) is not interpreted narrowly. The term is interpreted as "to appropriate value".

[3] Alchian (1965) also examines this notion when he argues that property rights on a resource are usually partitioned.

[4] According to the Coase Theorem, the initial partition of property rights does not influence the allocation of resources when all rights are freely transferable and transaction costs are null. However, when transaction costs are positive, the role of the state can have a crucial effect on the allocation of resources (Eggertsson, 1990).

but with what they believe they can do. In this sense, legal rights are neither a necessary nor a sufficient condition for the existence of economic rights. [5] Even so, consistent with Foss and Foss (2001b), one may note that although the definition of economic property rights is logically disconnected from legal considerations, it is implied that the agent's ability to consume the services of an asset depends on his ability to exclude others from the consumption of the same asset. This ability, in turn, depends partly on the legal protection. As a result, the delineation of economic property rights is a function of the protection granted by the state, of other people's capture attempts, and of the individual's own protection efforts. Accordingly, Barzel defines transaction costs as the costs of transfer, capture and protection of (economic) property rights.

Foss and Foss (2004) introduce a strategic dimension to Barzel's analysis by defining capture as a deliberate, resource-consuming activity of appropriating economic property rights from others without compensating them. Capture in this sense means the attempt to control certain transaction-related attributes, where control is understood as the agent's freedom to handle an attribute without making side payments to other agents (Barzel 1997). Capture attempts include, among others, activities of imitation, reverse engineering, adverse selection, moral hazard, and hold up. In general, a successful capture implies that the cost of capture is not prohibitively high and that some economic property right is not perfectly defined.

Conversely, protection means a resource-consuming activity that aims to reduce the possibility of capturing economic property rights. Protection efforts include the use of the legal system, the establishment of private ordering (Williamson 1996), the design of contracts and governance structures (Williamson 1996), and the establishment of mechanisms that make it costly to others to imitate resources (Wernerfelt 1984; Rumelt 1987) (Foss and Foss 2004).

Since protection efforts are never perfect, capture attempts can always occur (Barzel 1997). The severity of the capture problem, however, varies from case to case and it is not uniform across different attributes of the same asset. As a result, different protection efforts may be associated with the same asset, depending on the attribute that one intends to protect. Even so, the general rule always applies: an individual undertakes

[5] Barzel (1994: 394) notes that *"the title holder of a car is its legal owner, but thief has rights to it since he might drive it, derive income out of it, or even sell it"*.

protection efforts in order to raise his appropriated value in the face of capture attempts undertaken by other players. This kind of competitive dynamics emphasizes the importance of agents' bargaining power (Foss and Foss 2004).

The bargaining power, however, does not exist in a vacuum. Protection efforts and capture attempts can be influenced by both the technological environment and the institutional environment. In accordance with Transaction Costs Economics (Williamson 1991, 1996), it follows that protection and capture of economic property rights are embedded in the technological and institutional environments which correspond to shifter parameters on the strategic equilibrium.

In sum, the discussion above suggests that economic analysis of property rights is built around three basic inquiries: (i) Given a particular asset, which are the valuable attributes that shape the asset? (ii) For each valuable attribute, which factors influence the ability of the individual in appropriating the created value? (or, which elements throw the attributes in the public domain?), and (iii) What are the protection strategies associated with each valuable attribute? In the next sections we apply this analytical framework to a particular case: the collection of royalties on the GMO technology of resistance to glyphosate in soybean seeds.

3. Capture and protection in GMO soybean seeds

Until the 1980s, income gains in agricultural production derived mainly from the mechanization and the application of agrochemicals to cultivable areas. From the 1990s, further gains came about as a result of the manipulation of plants' genetics, opening a period that is known as the Genetic Revolution.

The Genetic Revolution, through the application of innovative technologies, converted the seeds into a technological platform composed of different characteristics not normally attainable by the species under natural conditions. In the present day one can think of a seed that is simultaneously tolerant to a given pesticide, resistant to certain types of pest, and filled with certain nutritional attributes. Since the genes that produce

each of these characteristics can derive from R&D efforts made by different firms, each firm may get a property right on a specific attribute of the seed. [6]

While the joint set of genetic traits incorporated in a seed is a source of additional value, there is no reason to suppose that each firm is able to appropriate an equal amount of the value generated by the purchasing of the seed. The economic property right on each attribute of the seed is a function not only of the biological characteristics of the seed, but also of the quality of the institutional controls and the organizational capacity of the firm. In what follows, we analyze the case of GMO soybean seeds.

The GMO soybean seeds marketed in Brazil incorporates the gene that creates tolerance to the herbicide Roundup Ready, whose active ingredient is glyphosate. [7] Among the reasons for the use of GMO seeds are the reduction in production costs – due to lower consumption of agrochemicals – and the small price difference between GMO soybeans and conventional ones. On the other hand, the use of GMO seeds involves the payment of royalties to Monsanto, the company that holds the technology. [8]-[9]

Although royalties represent the return associated with the innovation, firms in general lament the fact that other players get a higher return compared to the company that made the initial investment (Teece 1986). In the case of soybeans, the existence of self-reproducibility (i.e., transmission of genetic traits between generations) [10] makes this issue even more emblematic because farmers can reuse a grain crop as seed for the next

[6] To all intents and purposes, a seed corresponds to a good example of an asset in the sense that its multiple attributes are easily described and that its ownership can be partitioned among different agents.

[7] The soybean tolerant to Roundup Ready (RR soybean) allows the application of glyphosate for most of the life cycle of the harvest. The impact of this innovation should be noted: before the advent of RR soybeans the producer could only apply glyphosate (a pre-emergent herbicide highly efficient) before the emergency (i.e., germination) of the soybean plant. The RR soybean, on the other hand, is resistant to glyphosate. This resistance means that post-emergent herbicides (i.e., those whose application can occur after germination of the plant) can be replaced by pre-emergent herbicides. Accordingly, (i) the herbicide-tolerant seed is complementary to the pre-emergent herbicide, and (ii) the bundle [seeds tolerant to + glyphosate] is a substitute to the bundle [conventional seed + post-emergent herbicide].

[8] Lemarié and Marette (2002) note that not all farmers are potential consumers or equally benefit from GMO seeds, because some producers do not face significant problems of plant protection or the use of traditional agrochemicals generates higher returns. Accordingly, traditional methods of protecting plants tend not to be completely replaced by the spread of GMO seeds, a fact that is associated with a new market configuration.

[9] The impacts of adoption of GMO seeds on farmers' decisions and costs have been studied by Alexander et al. (2003) and Alston and Marra (2003).

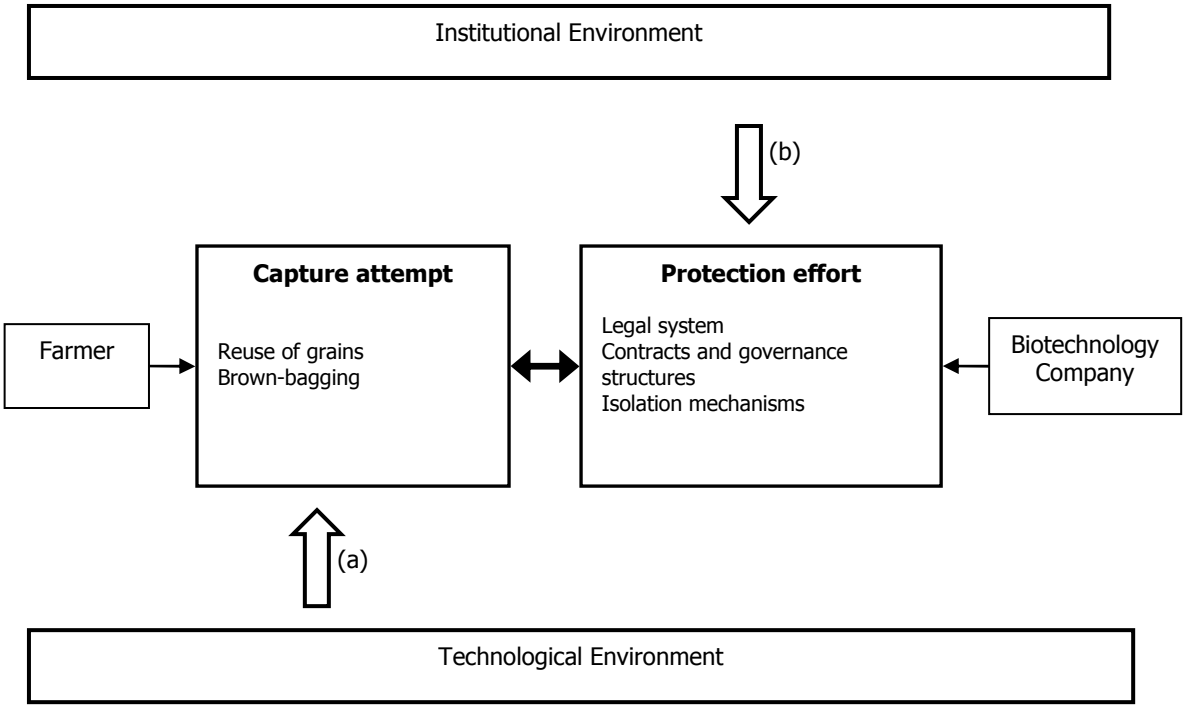
[10] Seeds characterized by self-reproducibility are called variety seeds. On the other hand, hybrid seeds are those in which transfer of genetic traits to future generations does not occur or occurs only in a limited way. Corn seed is an example of hybrid seed.

season. In effect, the existence of self-reproducibility makes the cost of capture of property rights on technological innovations greatly reduced. Farmers capture economic property rights through the reuse of a grain crop as seed for the next season or the purchase of brown-bagged seed (i.e., seed in the black market).

The possibility of capture reduces the ability of the firm in appropriating the value created by the biotechnological innovation. The economic property right over the attribute "return on GMO technology" is thus imperfectly shaped, even if the legal claim on the technology is perfectly defined. As a result, firms undertake protection efforts. The basic hypothesis of this research is that such efforts vary depending on the quality of the institutional controls in a given region or country. Biotechnology companies make an effort to maximize its economic property rights subject to institutional constraints. The analysis also implicitly assumes that changes in the technological environment affect only the capture opportunities, while changes in the institutional environment influence only the protection possibilities. Accordingly, the cases where the firms are able to undertake technological changes that affect the self-reproduction of soybean seeds are disregarded. [11] The analysis assumes that the technological environment is fixed, which means that the capture opportunities are unchanging. The figure below summarizes the concepts presented.

[11] For example, introduction of a gene (*gen terminator*) preventing the self-reproduction of soybean seeds. This type of technology, however, is characterized by intense controversy and it has not yet been adopted.

Figure 1 – Analytical Framework



4. Comparative analysis

Based on the analytical framework described above we examine in this section a specific transaction, the collection of royalties on GMO soybeans. We perform a comparative institutional analysis taking into account two countries, the U.S. and Brazil. For each country, we characterize the regulatory framework governing the protection of biotechnological innovations in agriculture and investigate the strategies of protection of property rights.

4.1 U.S.

The U.S., through the enactment of the Plant Patent Act (PPA) in 1930, was the first country to offer a specific intellectual protection for plants. The act allows the provision of patents for new varieties of asexually reproduced plants (except tubers). Individuals have the exclusive rights to reproduce, sell and use the patented plant and its progeny for a limited period of time.

In 1970 the Plant Variety Protection Act (PVPA) extended the intellectual property protection to sexually reproduced plant varieties (cultivars). The PVPA states that plant

varieties that meet the criteria of novelty, distinctness, uniformity, and stability [12] become eligible to receive a Plant Variety Protection Certificate through which the breeders' rights are safeguarded. Originally the PVPA allowed the farmers to save seeds and to negotiate the saved seeds with other parties. This configuration lasted until 1994, when an amendment to the act removed the right of farmers to sell saved seeds provided that the plant is protected by a Certificate. Under the new act, however, producers have the right to save seeds for their own use (farmers' exception).

In the 1980s an important change in the protection of intellectual property took place when the granting of utility patents for firms in the biotechnological sector became possible. A utility patent is granted to new, non-obvious products or processes which perform useful functions. It lasts for 20 years.

The grant of utility patents for biotechnological firms dates back to two different moments. In "Diamond vs. Chakrabarty" (1980), the Supreme Court concluded that a particular bacterium generated through genetic engineering efforts could be patented because it represented the result of human research and not the discovery of a "natural species". In "J.E.M vs. Ag. Supply Pioneer Hi-Breed International" (2001), the same logic was applied to the case of a GMO plant, resulting in the extension of patent protection for plants obtained by genetic engineering.

The main change introduced by the above decision is the possibility of granting patents not only for seeds or plant varieties, but also for specific genetic traits and biotechnological tools. In view of that, a GMO seed or cultivar presents three components capable of protection: (i) the plant germplasm (i.e., the seed or cultivar itself), (ii) the sequences of genes or genetic traits that result in a specific change in a given organism, and (iii) the research tools necessary for incorporating the new genetic trait in the plant cell (UNCTAD, 2006). This fact is relevant to the extent that the Genetic Revolution has transformed the seed into a technological platform composed of different attributes. Currently a single seed can tie up a number of patents each of which protects a specific attribute that may be the result of the R&D efforts of a particular firm.

[12] These criteria aim to ensure that the new plant is characterized by a progeny having the same characteristics as the original plants. Note that these criteria are expendable in the case of asexually reproduced plants because in this case the original genetic material is transmitted directly to future generations.

It is worth noting, however, that the granting of a patent on a genetic trait is only the first step in the effort to protect property rights. As previously discussed, the design of economic property rights is a function not only of the protection granted by the state but also of the capture attempts and the protection efforts.

Because soybean is characterized by self-reproducibility, the cost of capturing property rights on technological innovations is small. Farmers capture rights by reusing the grain crop as seed for the next season or by purchasing brown-bagged seeds. In the face of it, the U.S. biotechnology firms structure their protection efforts around two elements: the establishment of contracts in the form of technology agreements and the use the legal system.

Technology agreements are used by most biotechnology firms. [13] In general, each purchasing of GMO seeds involves in a contract that basically restricts the use of the seed to a single crop and prohibits saving the harvest for future planting. Contracts stipulate prices, agronomic recommendations, penalties, and incentives to a particular culture or seed. In most agreements, the companies inform the record numbers of their patents and the laws that ensure its protection. The agreement provides a limited using license which means that the firm allows the use of the gene by the producer, but does not hand over its possession to him.

In the specific case of GMO soybean seeds sold by Monsanto, the agreement facilitates the firm's investigation of the farmer's activities. In particular, the agreement allows Monsanto to review information collected by the Farm Service Agency (FSA) for any area cultivated by the farmer, including the analysis of aerial photographs and receipts for purchase of seeds and agricultural chemicals. [14] Access to such information helps the company to determine how many bags of seed a farmer has purchased and how many acres of land were planted with a particular type of culture (CFS, 2005). The agreement also contains a provision that allows Monsanto to examine and copy any records and receipts that may be relevant for monitoring the performance of the producer.

More generally, the limitation of the use of the seed to a single crop and the prohibition of saving the harvest for future planting are not free of tension. UNCTAD (2006), for

[13] Maxwell et al. (2004) present a summary of the main features of the technology agreements used by leading companies in the agrobiotechnology field.
[14] 2009 Monsanto Technology/Stewardship Agreement.

instance, identifies three points of dispute between biotechnology companies and farmers; they are: the principle of exhaustion, the extension of the scope of intellectual protection, and the inconsistency between legal rules. [15]

Most schemes of intellectual property include a general principle called the "doctrine of exhaustion for sale" or "doctrine of first sale." According to this principle an intellectual property right is typically exhausted by the first sale or the marketing of the assets subject to protection. Based on this principle, American farmers argue that when they buy GMO seeds the control of the biotechnology company on the genetic trait ceases which makes any restriction on the act of saving seed invalid. The courts, however, state that the general rules of patent exhaustion do not apply in these cases because the transaction is governed by a technology agreement through which the biotechnology firm allows the use of the gene by the producer, but does not give it to him.

Another line of reasoning maintains that the biotechnology firm, by means of the restrictions imposed by licensing agreements, is capable of expanding the scope of patent protection. The firm regulates not only the use of the genetic trait originally protected, but also the germplasm (i.e., the seed itself). The logic of the argument is simple: although the company holds the exclusive right to a particular genetic trait, it can not regulate other features of the seed. This argument, however, has also been rejected by the courts. In Pioneer vs. Ottawa (2003) [16], for example, the court concluded that a restriction against resale of patented seed represents an assertion of exclusive rights granted by the patent law, and not an attempt to increase the scope of the patent.

Finally, restrictions associated with the licensing of patents may contravene the provisions of the Plant Variety Protection Act. In particular, restrictions on saving seeds conflict with the exception of the farmers. In this respect, the Federal Circuit [17] sustained that patent owners may impose prohibitions on the act of saving seed even where such restrictions contradict some aspects of the PVPA.

What the discussion above tells us is that the courts have consistently upheld the property rights of biotechnology firms. This finding highlights the second element that

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[15] The description below is based on UNCTAD (2006), pp. 20.

[16] *Pioneer Hi-Bred Int'l, Inc. v. Ottawa Plant Food, Inc*., 283 F. Supp. 2d 1018, 1031-33 (ND Iowa 2003).

[17] McFarling I, 302 F2d 1291 (Fed Cir 2002); McFarling II, 363 F3d 1336 (Fed Cir 2004).

supports the protection of economic rights in the U.S.: the use of the legal system. If the technological conditions are such that the costs of capture are sufficiently high, a law favorable to the biotechnology firms (supported by an active, stable judicial system) is expected to reduce the protection efforts of firms. Given the high cost of capture and the effectiveness of the judiciary, capture attempts occur less frequently and, as a result, less protection efforts are required. Nonetheless, since the cost of capture in the case of soybeans is small, the biotechnology companies must make use of more complex schemes of monitoring and enforcing technology agreements. Monsanto, for example, created a department composed of 75 officials and that consumes USD 10 million annual whose sole purpose is to ensure the protection of property rights (Enders and Goldsmith, 2007). This is interesting because it reveals that the recourse to the legal system neither represents a simple set of fuzzy legal actions, nor takes the form of an omnipresent threat that, by itself, automatically reduces the intensity of the capture attempts. *The protection of economic property rights requires an organizational structure*.

In the case of Monsanto, the operation of such organizational structure has resulted in the filing of 112 legal claims involving 372 farmers and 49 small associations from 1997 to 2007. [18] As described in the table 1, up to October/2007, approximately 51% of the legal claims resulted in the recognition of damage to Monsanto, 21% resulted in agreements, 12% were rejected (no indication whether any damage was recognized) and 16% had not been completed. In the case of condemnation of the farmer (i.e., recognition of damage to Monsanto), compensation ranged from USD 5,000.00 to USD 3 million. The average penalty was approximately USD 385,000.00 (CFS 2007).

[18] Data refer to court cases opened by Monsanto against U.S. farmers under the claim of saving seed and/or purchase seeds from unauthorized resellers (brown bagging). Note that the legal actions are not just related to soybean seeds, including also canola and cotton seeds.

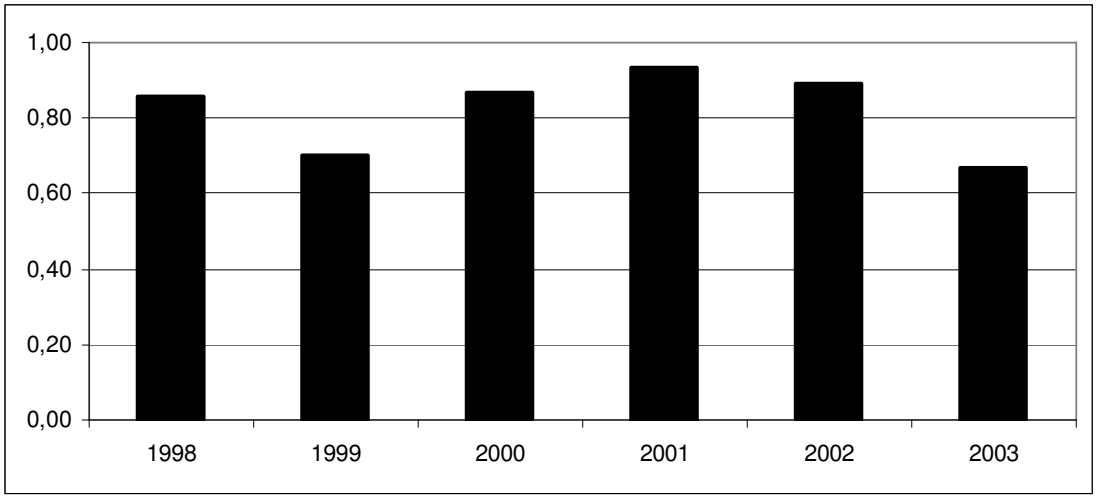
Table 1 – Lawsuits filed by Monsanto against farmers under the claim of saving seed, U.S., 1997-2007.

	Number of lawsuits	**%**
Recognition of damage to Monsanto	57	50,9
Agreement (confidential)	24	21,4
Dismissal (no indication of recognition of damage)	13	11,6
Not concluded (up to October /2007)	18	16,1
Total	**112**	**100,0**

Source: Center for Food Safety (CFS 2007)

From a dynamic perspective graph 1 presents the "net rate of success" of Monsanto in its legal actions. This rate is the proportion of convictions and agreements in relation to the total of completed legal cases between 1998 and 2003. As indicated in the graph, the success rate was always above 65%, being 95% in 2001.

Graph 1 – Net rate of success in legal actions, Monsanto, USA, 1998-2003

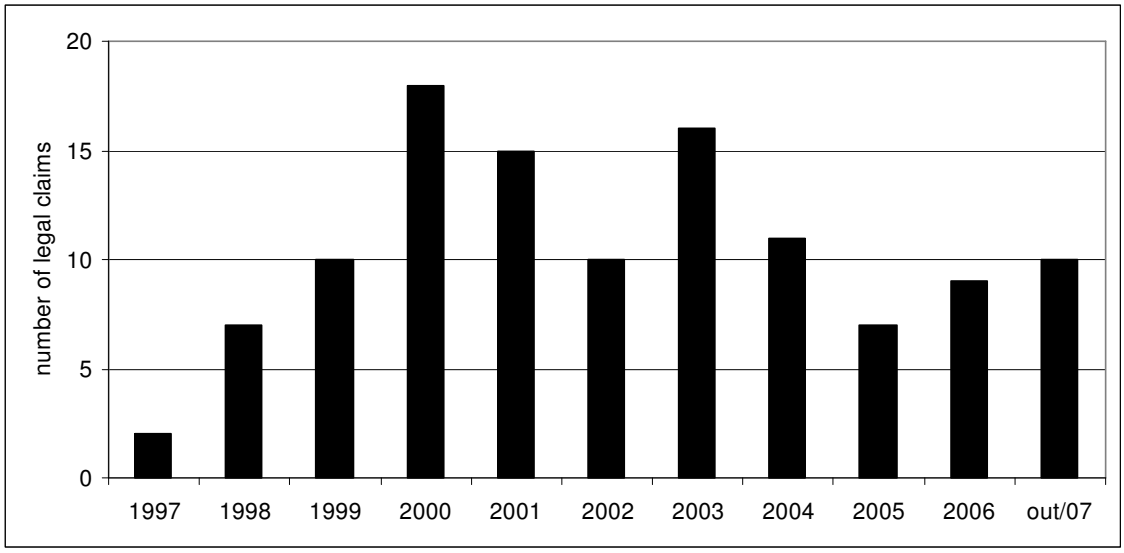


Source: Center for Food Safety (CFS 2005) – prepared by the authors.

While legal claims against farmers indicate a breach of contract, the associated loss is small and isolated when considering the scale of the industry of GMO plants in the U.S. (Enders and Goldsmith, 2007). The 57 claims described above which resulted in the recognition of damage to Monsanto generated legal compensation of USD 21.5 million (CFS, 2007) which corresponds to only 3.05% of Monsanto's total turnover with the

marketing of GMO soybean seeds in the U.S. in 2008. [19] In actual fact, the filing of claims against farmers follows the logic of maximizing the protection efforts. Such logic stresses the importance of expectations to the detriment of the general punishment of all producers who engage in the capture of property rights. [20] This second-order effect is reinforced by the fact that Monsanto goes to court in 27 different states (CFS, 2007) and adopts a policy of systematic legal action. As described in graph 2, Monsanto has filed an average of 10 claims per year from 1997 to 2007.

Graph 2 – Time trend: lawsuits filed by Monsanto against farmers under the claim of saving seed, U.S., 1997-2007



Source: Center for Food Safety (CFS 2005, 2007) - prepared by the authors.

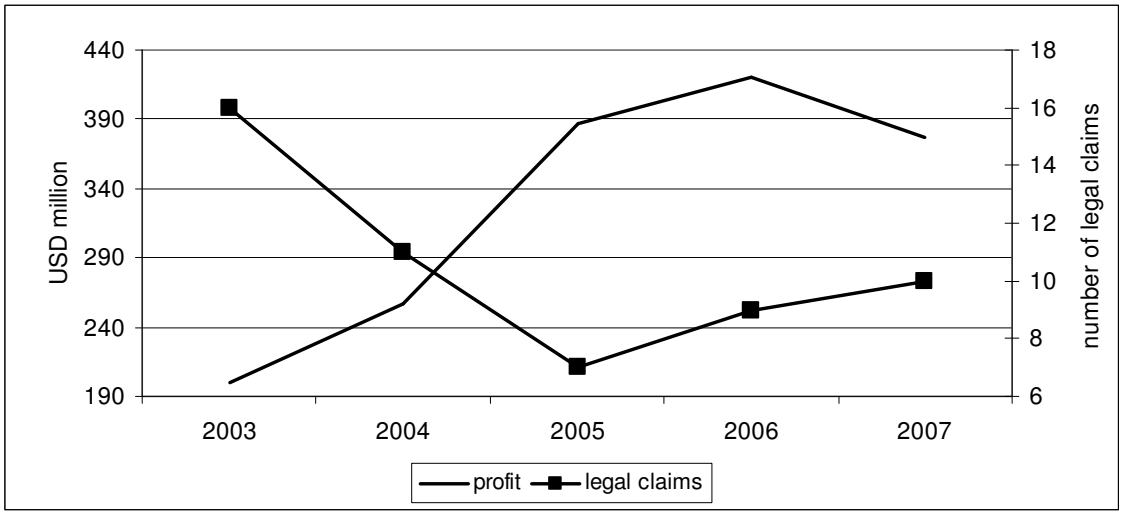
Regarding the success of the protection strategy, little evidence is available. What is known is that the firm has adopted a systematic policy of suing farmers under the claim of saving seed for over a decade (graph 2). If the strategy was not successful, its persistence over time would not be so pronounced. Additionally, it is interesting to note that the period between 2003 and 2007 was characterized by a reduction in the number of lawsuits initiated by Monsanto along with an increase in revenue from the marketing

[19] In 2008 Monsanto's net revenues associated to GMO soybean seeds was USD 1,174 million according to its annual report (www.monsanto.com/investors/financial_reports/annual_report/2008). According to the same report, the company received on average 40% of their revenue in markets outside the U.S. The value 3.05% corresponds then to the ratio between USD 21.5 million and USD (0.6) (1,174) million.

[20] The design, the capture and the protection of economic property rights are based on expectations. In making a choice on the amount of resources allocated in the capture of property rights, individuals estimated the protection efforts made by other players.

of GMO soybean seeds in the U.S. (graph 3). This result suggests that the cumulative effect of protection efforts may enable higher levels of profitability with less effort. This result emphasizes the importance of expectations in the market equilibrium of GMO soybean seeds.

Graph 3 – Claims against farmers vs. profit from the commercialization of GMO soybean seeds – Monsanto, USA, 2003-2007



Source: Center for Food Safety (CFS 2005, 2007) and Monsanto Annual Report (2003 to 2007) – prepared by the authors.

4.2 Brazil

It was only in the second half of the 1990s that Brazil began to design a regulatory framework for granting property rights to plants and for regulating genetically modified organisms. The first regulation was passed in 1995; it is known as the "First Biosafety Law" (Law nº 8,974/95). This law in conjunction with Decree 1,752/95 created the National Technical Committee for Biosafety (CTNBio) which was in charge of passing sentence upon proceedings related to GMO activities.

One year after the creation of CTNBio, the patenting of GMO organisms was made possible by the Law of Industrial Protection (Law nº. 9.279/96) passed in 1996. The law classifies as a genetically modified organism (GMO) any organism that expresses through direct human intervention a characteristic not normally attainable by the species under natural conditions. According to the law, the whole or part of GMO organisms are patentable provided that it meets the principle of novelty, it results from an inventive

activity, it has some industrial application, and it does not represent a mere discovery. [21] In general, a biotechnology company in Brazil may gain a patent on a genetic trait and/or a biotechnological tool which points out that the Law of Industrial Property is similar to the concept of utility patent.

In 1997 Brazil became a member of the International Union for Protection of New Varieties of Plant (UPOV). [22] In the same year, the Law of Cultivar Protection (Law nº. 9,457/97) was passed. This law is similar to the Plant Variety Protection Act in that it benefits the breeder through the recognition of ownership rights related to new plant varieties. The law not only establishes the right of temporary monopoly on the commercial reproduction of the protected variety, but also ensures the small producers' right to save and exchange seeds (farmers' exception).

In view of the above regulatory framework, Monsanto obtained in 1998 the permission of CTNBio to market GMO soybean seeds resistant to glyphosate. This authorization, however, was suspended by the judiciary in 1999 in the face of a legal claim filed by the Brazilian Institute for Consumer Protection (IDEC). The legal claim was based on two allegations. Firstly, the authorization granted to Monsanto was groundless for the reason that CTNBio failed to require an environmental impact assessment (EIA) specific to the Brazilian conditions. [23] Secondly, and more importantly, the power originally conferred to CTNBio with the purpose of authorizing the marketing of GMO seeds was in opposition to the responsibilities of states and municipalities to regulate environmental issues. As a result, the marketing of GMO seeds was banned until the enactment of the "New Biosafety Law" (Law nº. 11.105/05) in 2005.

Despite the ban on planting GMO seeds, farmers (especially in the southern region of Brazil) have illegally adopted the technology through the smuggling of Argentinean soybean seeds from 2003 to 2005. [24] Farmers felt that the benefits of adopting illegal GMO seeds were greater than the potential penalties imposed by the Brazilian

[21] The introduction in a particular location of plants collected in other locations corresponds to a discovery.

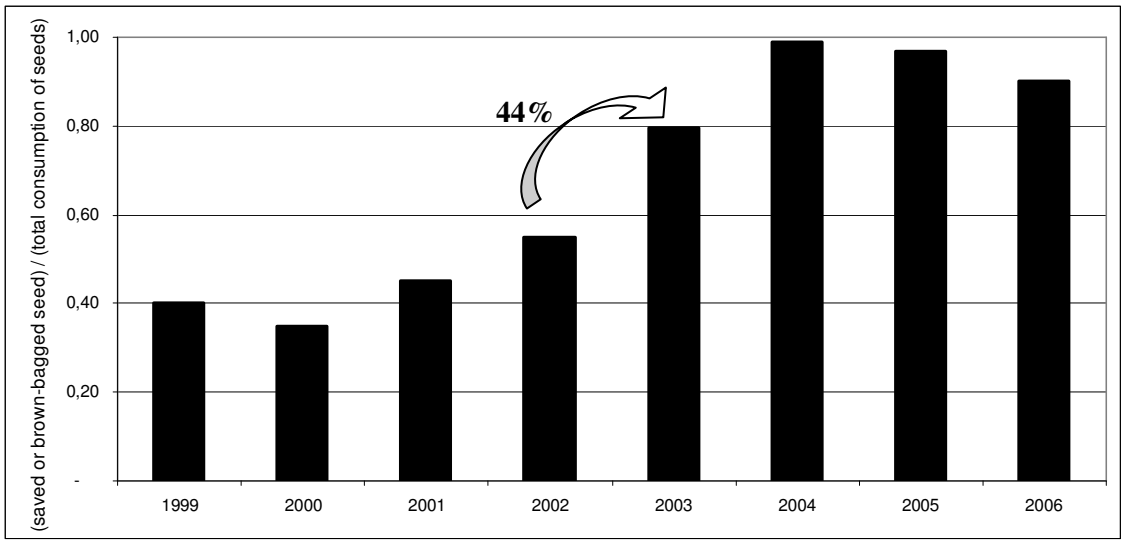
[22] The UPOV (www.upov.int) is an international convention that establishes a multilateral agreement setting common standards for the recognition and protection of new varieties of plants.

[23] At the time Monsanto submitted a Risk Analysis which included the examination of evidence for several countries, except Brazil.

[24] Monsanto began the marketing of GMO seeds in Argentina in 1996.

government. The graph below shows the consumption trend of saved and brown-bagged soybean seeds in the state of Rio Grande do Sul. As indicated, the year of 2003 marks an increase of 44% in the demand.

Graph 4 – Ratio between the consumption of saved or brown-bagged seed and the total consumption of seeds (soybeans), Rio Grande do Sul, 1999-2006



Source: Brazilian Association of Seeds and Seedlings (Abrasem) - prepared by the authors.

Along the lines of the analytical framework, the prohibition in domestic marketing of GMO seeds in conjunction with the illegal import of seeds from Argentina greatly reduced the set of protection strategies available to the biotechnology firm. There was no basis for the proposition of a legal action for recovery of royalties since the presence of GMO seeds in the domestic market was in theory prohibited.

The lack of foundation for protection efforts, however, did not last for long. In 2004 the Brazilian market was flooded with GMO grains whose existence in the national territory was not authorized. In the face of this contradiction, and considering the large volume produced, the Brazilian government had no choice but to implement a series of measures that allowed ex-post the planting of GMO seeds. [25] These measures, seeking to resolve a "given situation", enabled the access of biotechnology firms to an expanded set of protection strategies. If adoption of GMO seeds is legally permitted and farmers effectively adopted it, then firms may establish mechanisms for recovery of royalties (Zylbersztajn et al., 2007).

[25] Medidas Provisórias (provisional measures) nº. 113/2003, 131/2004, 223/2005.

In the case of Monsanto, its protection efforts had to cope with two aspects. On the one hand, the collection of royalties had to be retroactive because producers had already harvested the GMO soybeans. On the other hand, the recovery of royalties would be based on seeds purchased on the black market. As described in figure 2, the protection strategy was based on three components: (i) the existence of an inexpensive field test for the detection of genetic traits in soybean seeds, (ii) the design of a contract involving three parties, and (iii) the establishment of a credible threat.

Since farmers in the southern region of Brazil are numerous and the adoption of the technology had already occurred, Monsanto would face a high monitoring cost if it decided to negotiate individually with each farmer. Yet, since the harvested grains had to be transported to cooperatives, processors, and trading companies, the monitoring cost in this stage of the production chain was comparatively lower. Hence, due to the existence of an inexpensive field test, Monsanto was able to identify the presence of the trait through genetic analysis of soybean shipments carried by trucks into the cooperatives, processors, and trading companies.

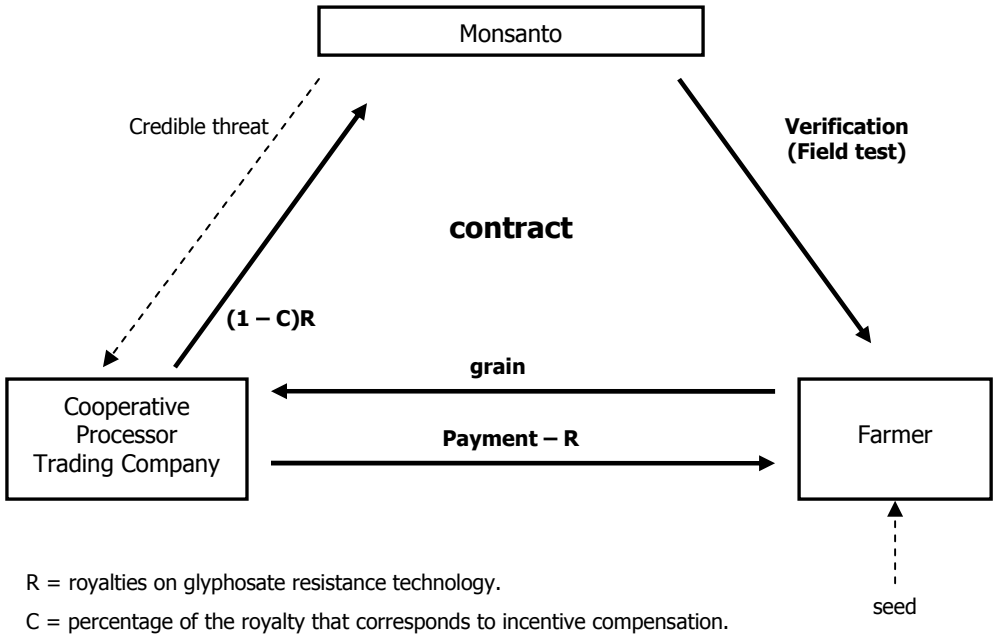
The biotechnology firm established a difficult negotiation with the four largest trading companies operating in the southern region of the country. Monsanto proposed that traders collect the royalties on the technology based on the ton of soybean grain and keep a percentage of the amount collected as incentive compensation. Initially, the traders have chosen not to cooperate. The resistance, however, was offset by a credible strategic move made by Monsanto. Supported by international laws for the protection of property rights [26], the company intercepted a ship in the port of Trieste, Italy, carrying a large shipment of Brazilian soybeans. For fear of exposure, the trading companies agreed to negotiate. For the same reason, cooperatives and processors also decided to collaborate with the biotechnology firm. As a result, Monsanto was able to structure a protection strategy based on a contractual arrangement.

A contract was designed so that each farmer had the freedom to state what type of technology had been used on his property. If the farmer revealed that GMO seeds had been used, a charge was laid and its value was reduced from the payment made to the producer by the cooperative, the processor, or the trading company. If the producer did not declare the adoption of the transgenic technology, the field test was conducted on

[26] Brazil joined UPOV in 1997.

each shipment delivered by the farmer. If the test was positive for the presence of GMO seeds, the farmer had to pay a fine and bear the cost of the test. Given the widespread adoption of GMO seeds and the risk of penalty, 98% of farmers in the southern region of Brazil acceded to the contract (Zylbersztajn et al., 2007). [27]

Figure 2 – Mechanism of collecting royalties, Monsanto, Brazil, the southern region.



Overall, the analysis of the mechanism of collecting royalties on GMO soybean seeds in Brazil reveals a more subtle aspect. The protection effort undertaken by the firm is based on the unbundling of the attribute (tolerance to glyphosate) from the asset (seed), outlining a particular way to negotiate the attribute regardless of how the acquisition of the asset is made. This is relevant since the collection of royalties is based on seeds purchased on the black market. The result contrasts with the U.S. case, where all the protection effort made by Monsanto focuses on combating the act of saving seed.

Although the above argument might suggest that the strategy implemented in the southern region of Brazil is more efficient than that established in the U.S. since the firm is able to collect royalties on the technology even in the case of saved seed, it is worth noting that the contractual arrangement structured in Brazil is more complex than the filing of legal claims. The arrangement entails the coordination of multiple agents

27 Currently, the royalty payment is set at 2% on the value of total production. The fine was set at R$150.00 per ton. (season 2004/2005) equivalent to approximately USD 53.40 per ton.

and different transactions. In truth, as soon as the problem of illegal seed acquisition becomes less intense, Monsanto alters its strategy of collecting royalties. This is the case of the central-western region of Brazil. [28]-[29]

Regarding the production of soybeans, the central-western region has two distinct characteristics when compared to the southern region of Brazil. Firstly, the average farm size in the central-western region is bigger than the average farm size in the south. A typical property in the state of Mato Grosso, for example, has approximately 8,483 acres compared to 2,698 acres in Rio Grande do Sul (Veiga and Antuniassi, 2008). Secondly, in the central-western region the adoption of GMO technology has been slower. In the south, smuggled GMO seeds showed rapid spreading out due to the correlation of climate and soil between the region and Argentina. In the central-western region, rapid adoption has not occurred due to the need for adaptation of seed varieties to the "cerrado" environment. This type of environment has specific climate and soil which make the planting of a seed originally intended for Argentina far from the most favorable choice. As noted in table 2, after a peak of 80% in 2003, the consumption of saved and brown-bagged seeds in the state of Mato Grosso do Sul (central-western region) has decreased faster than in the state of Rio Grande do Sul (southern region). Currently there are already GMO varieties adapted to the "cerrado" region. [30]

Table 2 – Percentage of saved and brown-bagged seed, Brazil (selected states), 1999-2006.

	Mato Grosso do Sul (central-western region)	**Rio Grande do Sul (southern region)**
1999	35,0	40,0
2000	35,0	35,0
2001	50,0	45,0
2002	50,0	55,0
2003	80,0	79,5
2004	50,0	99,0
2005	55,0	97,0
2006	58,0	90,0

Source: Brazilian Association of Seeds and Seedlings (Abrasem) - prepared by the authors.

[28] The discussion that follows is based on a study on the market for seeds held at the request of the Brazilian National Agricultural Confederation (CNA).

[29] The most important soybean-producing States of the central-western region of Brazil are Mato Grosso do Sul and Mato Grosso. According to research sources, GMO soybeans represent 80% and 40% of the total soybean production in Mato Grosso do Sul and Mato Grosso, respectively.

[30] Technical information regarding soybean production in the Brazilian central-western region can be found in the Brazilian Soybean Yearbook (2008), Santa Cruz do Sul: Editora Gazeta Santa Cruz do Sul, 136p.

In the central-western region the collection of royalties from GMO seeds occurs by means of payment slips which are delivered to producers by cooperatives or dealers at the time of purchase of the seed. Initially, Monsanto had stipulated that the value of the royalty should be R$ 0.88 per kilo of seed (approximately US$ 0.38). Subsequently, the value was set at R$ 0.50 per kilo (US$ 0.23). These values, however, were never charged. In the 2006/07 and 2007/08 seasons, the royalty paid by the producer was R$ 0.30 per kilo of seed (US$ 0.17) which is equivalent to 27% of the value of the soybean seed bag. In the 2008/09 season, the royalty was set at R$ 0.35.

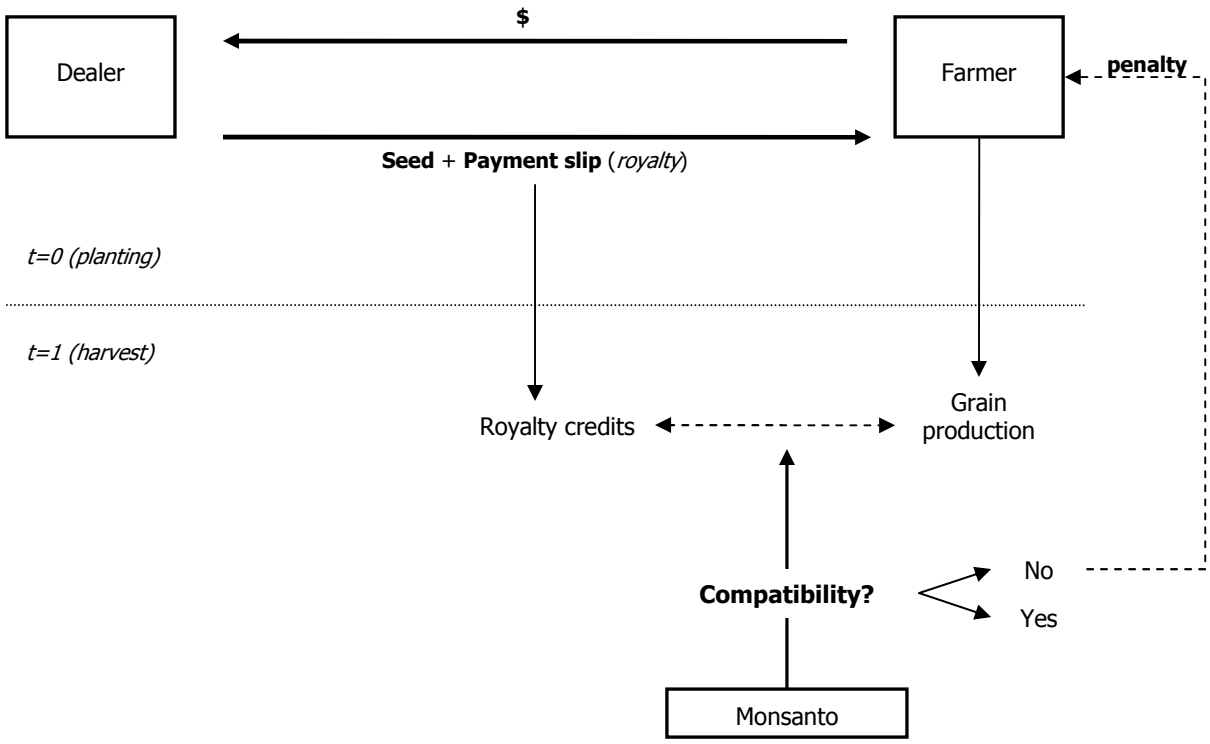
Monsanto aims to collect R$ 15.00 per hectare planted with GMO seed which is equivalent to 50 bags of GMO seeds per hectare. This is a benchmark that corresponds to the starting point of the entire strategy of collecting royalties. The implicit assumption is that soybean production is based on a fixed rate under which 50 bags of seed (per hectare) generate a given quantity of grain. In the case of non-payment of royalty, under the assumption that the producer is reported in the field test for detection of GMO traits, Monsanto can charge a default rate of 2% on production.

The default rate, however, is not necessarily applied to the whole production. The scheme works as follows: Each payment slip generates a certain amount of royalty credits. When performing the field test and verifying the farmers' total production, Monsanto compares the amount of credits accumulated by the producer and the actual level of production. If production exceeds the equivalent amount of credits, the farmer pays a fee of 2% on the excess. The logic of the scheme is simple. If the farmer has not only acquired a certain amount of GMO seeds, but also used saved seeds, there is an incompatibility in the period of harvest between the actual production and the ideal production – i.e., the production obtained by the exclusive use of seeds purchased legally. It is this inconsistency that is checked by Monsanto [31] and the rate of 2% levied on the difference between actual and ideal production.

The payment of the default rate may not occur if the farmer has purchased extra credits through the payment of additional royalties by means of specific payment slips (R$ 4.50 per ton of seed purchased). This type of charge, which emerged as a demand of the producers, aims to alleviate the financial costs associated with the fine of 2%. Figure 3 summarizes the layout of the scheme.

[31] Upon completion of field tests Monsanto identifies the producer and the amount paid in royalties.

Figure 3 – Mechanism of collecting royalties, Monsanto, Brazil, the central-west region



It is interesting to note that the stability of the mechanism of collecting royalties is still an open question since the relationship between Monsanto and the farmers in the central-western region of Brazil is not free of tension. In light of technological advances there are soybean varieties that consume a smaller quantity of seed per hectare which reduces the value that producers pay to Monsanto and enables the recovery of undue royalties. Currently discussions move towards the best time for collecting the royalties. The producers suggest that the royalty be charged close to the harvest period when it becomes possible to more precisely measure the effective yield of the crop.

5. Discussion and Conclusion

Economic property rights over technological attributes of soybean seeds are imperfectly defined because the biological characteristics of the seed place such attributes in the public domain creating the possibility of value capture. As a result, firms undertake protection efforts by means of developing organizational arrangements in order to minimize the capture of value. The previous section indicates that such organizational arrangements are dependent on the quality of the controls that outline the institutional environment in which the transaction occurs.

In the U.S., where the controls are strong, the firm transacts the attribute "resistance to glyphosate" as part of the asset (seed) and undertakes a protection effort based on the establishment of technology licensing contracts and the use of the legal system. As a general rule, the use of the legal system does not assume the form of an omnipresent threat that, by itself, automatically reduces the intensity of capture attempts. As shown, the protection of economic property rights requires an organizational structure.

In Brazil, the company holding the technology found a way to collect royalties even in a situation where the quality of institutional controls is low. [32] The solution involves two distinct structures, whose similarities are: (i) Monsanto ensures its economic rights by exercising a deliberate, active monitoring role; (ii) the attribute "resistance to glyphosate" is transacted in a separate from the asset (seed). [33]

The unbundling of the attribute from the asset indicates that the firm prefers to internalize the allocation function that is usually associated to the market. Accordingly, a firm's protection effort involves the building of governance structures that frame around the attribute. This is relevant in that the quality of the institutional control encourages the firm to directly handle the transaction of the attribute. The combination of these arguments suggest a more general proposition: *when the transaction of the attribute is disconnected from the transaction of the asset, the firm loses in economies of scale [34] but gains in efficiency of protection, given the possibility of capture and the quality of the institutional controls*.

With regard to the coexistence of two protection structures in Brazil, it is worth highlighting that the change from one structure for another is, above all, a profound change of the transaction itself, capable of changing supply and demand of many attributes (Barzel 1997). For that reason, two governance structures can not be marginally compared. Yet, the difference between the protection schemes can be explained roughly by the severity of the capture problem which is more intense in the

[32] Insofar as the legal orders in the U.S. and Brazil are similar, the differences can be credited to the quality of the judicial control (i.e., enforcement of laws) and to the state inability in monitoring the national border in such a way that it prevents the smuggling of seeds from Argentina.

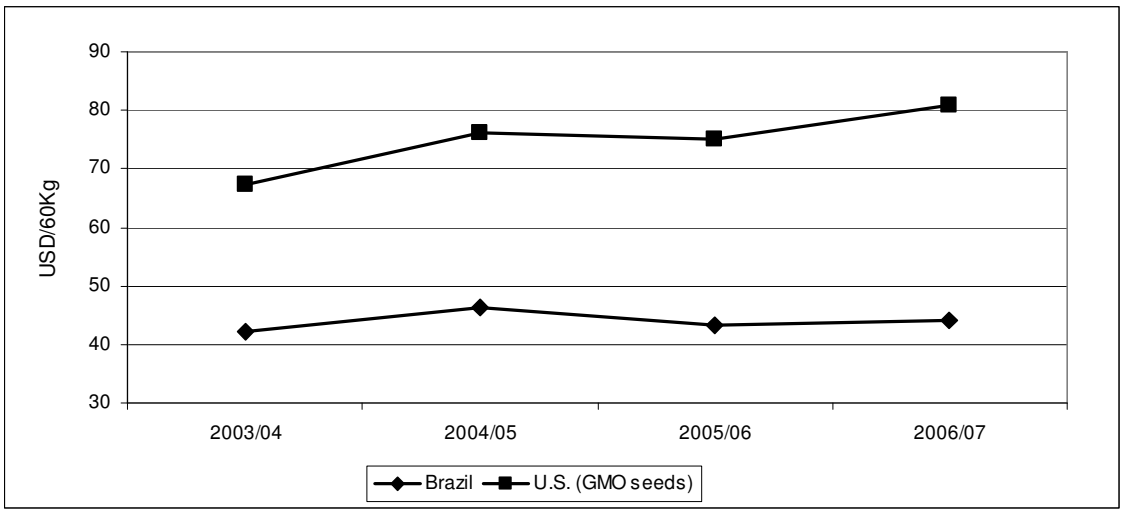
[33] In the central-western region of Brazil the value of the payment slip is not included in the price of the GMO seed.

[34] The greater the number of attributes commercialized inside a same asset (platform), the lower the unit cost of transacting each attribute.

south due to smuggling (influence of the technological environment). This finding indicates that the state's inability to monitor the national border and to prevent the smuggling of seeds from Argentina is a relevant factor that impacts the efficiency of different protection strategies.

Additionally, the analysis undertaken above also shows how the lack of knowledge can generate errors and biases. Suppose, for example, that an analyst examines the market for seeds, comparing prices of GMO soybeans seeds in the U.S. and in Brazil. The result is presented in graph 5.

Graph 5 – Soybean seeds (USD/60kg), USA vs. Brazil, 2003/04-2006/07



Source: Instituto de Economia Agrícola (Agricultural Economic Institute) and USDA - prepared by the authors. Values in Reais (R$) were converted according to the annual average exchange rate.

Since prices are consistently higher in the U.S., the analyst can speculate that the price difference stems from the weakness of institutional controls in Brazil which prevent the biotechnology company to collect royalties on the genetic traits in the seed. This reasoning can serve as a base to the claim that American farmers "subsidize" Brazilian producers, bearing all the costs associated with transgenic technology. Our analysis shows, however, that the above argument is fallacious.

While the price of GMO seeds in the U.S. incorporates the return on the GMO technology, the same does not occur in Brazil. The collection of royalties in Brazil occurs through discount on the payment made to the producer, or through payment slips. In this sense, the price of seeds in Brazil does not incorporate any information

about the return on the attribute "transgenic technology". Under some circumstances, all relevant information on all attributes of the asset can not be obtained through the sole examination of the price.

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