Intellectual Property Protection and the International Marketing of Agricultural Biotechnology: Firm and Host Country Impacts

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Introduction

The protection of intellectual property rights (IPR) has been a contentious issue over the last 20 years. Industrialized nations have moved to knowledge-based economies and simultaneously trade barriers have fallen, making intellectual property (IP) vulnerable. Adding to this vulnerability are conflicting international institutional environments, belief systems, and economic realities. The debate over IPR protection has become a significant global trade issue pitting the net- technology producing North against the net-technology consuming South. The North has a distinct belief system towards IP (Steidlmeier, 1993; Mittlestaedt and Mittlestaedt, 1997), maintains a comprehensive IPR institutional environment, and actively employs enforcement mechanisms. The South on the other hand, is more conflicted. While in the last ten years many Southern countries have agreed to multilateral agreements on IPR protection, enforcement and real commitment has been lagging (Thurow, 1997; Levy, 2000).

With this in mind there has been much debate about the impact of alternative IPR regimes (tight or loose) on the welfare of Southern economies. Policy makers in both the South and the North search for arguments to convince recalcitrant Southern countries to follow the Northern model of strict IPR regimes. The South faced with a dilemma, searches for arguments to justify loose IPR regimes or alternatively to convince its populace that tighter IPR regimes are better for the nation.

While there has been much analytical work, mostly theoretical, conducted on the subject, the final results are inconclusive whether a strong IPR regime is better or worse for Southern countries (Vishwasrao, 1994; Sherwood and Braga, 1996; Globerman, 1998). The lack of clarity

as to the impact of IPR regime has been due to both the complexity of problem and the form of analysis. The theoretical models while being extremely valuable highlighting the drivers of firm and social welfare are by their nature abstractions.

The empirical models to date suffer from three effects that weaken the impact of their conclusions. The first is that often firms are not able to observe their losses from weak IPR (Fienberg and Rousslang, 1990). Many times the losses are due to investments not made and need to be estimated. (Host country impact analysis too suffers from this problem.) Second, firm impacts are generally estimates from surveys of a cross section of firms, representing opinions of impact not factual evidence (Evenson, 1990; Sherwood, 1990; Braga and Willmore, 1991; Fienberg and Rousslang, 1991). Finally, no work to our knowledge has attempted to directly measure firm and host country impacts from weak IPRs. Therefore while there has been some attempt to empiricize welfare impacts, evidence supporting or negating the theory is lagging. The end result for policy makers is there still remains much ambiguity and economic studies have yet to show where the balance should be struck (Alster, 1988; Dawson, 1987).

The objective of this research is to add some empirical clarity of the welfare impacts of weak IPR. To this end we employ a novel methodological design and a unique context. While previous studies have used cross-sectional survey or secondary data, our research employs the critical case study approach (see Yin, 1994). The research design is deductive, in that we use the empirical setting of Pioneer-Argentina, S.A., a seller of bioengineered agricultural seeds, to test the existing theory of weak IPR impacts in a North-South context.

Theoretical Background

The dilemma, both domestically and internationally, for IPR protection is the trade off between short-term costs and long-term benefits. The argument made by Northern countries is that while prices may rise in the short run, new technologies will be available over the long term and will, in turn, raise economic productivity (Stamm, 1993). As the result of protected property rights, the South will gain from new investment (Sherwood and Braga, 1996), the flow of technology (Sherwood and Braga, 1996), and technology spillovers (Zigic, 2000). The preferred mechanism of IPR protection by the net technology producing countries (North) is through public institutions, not product/process masking by private firms. For the net technology using countries (South) the significant short term costs may arise directly from an increase in the cost of the input due to the lack of complete substitutes and indirectly from the administrative and enforcement costs of a Northern style IPR protection system. Adding to the complexity is the fact that welfare impacts are best understood in a dynamic context, as the short-term losses of strengthening the South's IPR regime are believed to be trumped by the long-term gain from economic growth.

To address the complex question about the welfare impacts of an IPR regime, numerous theoretical models have been developed (Dollar, 1986; Chin and Grossman, 1988; Diwan, 1991; Deardorff, 1992; Helpman, 1993; Taylor, 1993; Maskus and Konan, 1994; Grossman and Helpman, 1995; Zigic, 1998). While it is generally agreed that technology is important for an economy to grow (Dollar, 1986), the theoretical models are not completely successful making the argument that IPR protection in the South improves Southern welfare (Zigic, 2000; Gould and Gruben, 1996; Helpman, 1993; Chin and Grossman, 1990). Additionally, the argument that strong IPRs lead to greater innovation too is questioned (Gould and Gruben, 1996; Braga and

Willmore, 1991). The lack of clear benefits from IPR production can be due to a fundamental difference in belief systems about private versus communal property (Steidlmeier, 1993; Mittlestaedt and Mittlestaedt, 1997; Thurow, 1997; May, 1998), the negative affects of a monopolist on future innovation (Chin and Grossman, 1990; Gould and Gruben, 1996; and Zigic, 2000), a "tit for tat" view in which the South is "owed" the technology based on a history of Northern resource extraction policies, or the South's assessment of the extreme hardship an enforced patent system would create. Whether it is an intrinsic skepticism about Northern property right regimes or a skepticism based on the realities of the moment, the end result is recalcitrance on the part of Southern countries to actively engage IPR protection.

Chin and Grossman (1990) developed a duopoly competition model of one Northern and one Southern firm. The Northern firm's problem is setting the optimum level of R&D investment. The objective of the model is to analyze how each firm behaves as the IPR regime changes and how the firms' behavior affects the level of innovation available to society. One important conclusion of the model is there are certain conditions where the South is better off with weak IPR. That is if the Southern market is small, which it generally is, and the technology jump is moderate, welfare in the South is improved from the improved product distribution and lower price.

Diwan and Rodrik (1991) follow Chin and Grossman's lead in modeling the welfare balance between the North and the South but diverge in several important ways. They do not assume that holders of protected intellectual property have monopoly power. There is free entry and exit. The result of Chin and Grossman's market power assumption is that the loss to Southern consumers is estimated to be very high due to the high price and reduced product

distribution a monopoly connotes. But the direct mapping between a patent and a monopoly price is not axiomatic. There are numerous forces such as a dynamic environment of innovation, product substitutes, and market power distribution across the supply chain that drive prices away from the monopoly price towards the competitive price (Goldsmith, 2001). While it is correct to assume that developers of intellectual property gain market power, and the patent system formalizes this position in the marketplace, it is incorrect to assume that holders of patents operate as monopolists. While the monopoly/duopoly model may be appropriate in some cases, it is extreme in numerous situations where markets fall in between monopoly and pure competition. This market structure assumption of course has great impact on welfare impact calculations. In our case of agricultural biotechnology, barriers to entry are relatively low and the availability of substitutes relatively high, thus pure monopoly pricing practices should not be assumed. The setting is more competitive, driving down prices and increasing access. Therefore under such situations the direct welfare gains (losses) to the North (South) from strong IPR may be much less than anticipated.

Diwan and Rodrik also do not assume that preferences between the North and South are homogeneous. This is important because it negates the free riding benefits for the South and at the same time causing a welfare loss in the South from the region to develop its own preferred and needed IP-based products. This is not the case for our situation of marketing biotechnology seed in Argentina where North and South preferences map each other closely.

Deardorff's model (1992) is a monopoly model studying the regionalization of patents as a way of better allocating rents from innovation. He offers the "Solomonic" strategy of limiting the regional applicability of patents, allowing some monopoly rent extraction while also

allowing for greater distribution. The author unrealistically assumes regional patents can be operational as consumers and producers of innovation are not distinct groups, global information transmission is pervasive, and terms of trade will adjust.

Helpman (1993) develops a dynamic general equilibrium model and in doing so attempts to grapple with the real effects of interlinked economies, terms of trade, and dynamic effects. His model captures the interplay between the North's rate of innovation and the importance of imitation for providing northern consumers with a better mix of lower price products and the South with improved terms of trade. The degree of imitation though is critical to the net welfare balance. When the rate of imitation is low, both North and South benefit, as described above. When the rate of imitation is high, as is the case for many pharmaceutical and agricultural innovations such as biotechnology seed, the results do not hold and tighter IPR policy is preferred by the North.

Taylor (1993) developed a partial equilibrium static North-South duopoly model to explore the interaction between masking (North) and imitation (South) and their associated costs. The uniqueness of the model is in the endogeneity of the appropriability regime, where the firm has control, through masking and other private means to affect the rate of imitation. In this way the firm has some control over its ability to appropriate the rents from its intellectual property. Taylor concludes that the current state is pareto-inferior due to the extensive resources devoted to masking and unmasking significant technologies.

Vishwasrao's model (1994) concerns the optimal Northern firm strategy that maximizes profits given that a foreign licensee might pirate the technology and not pay the required royalties. Therefore, while the Northern firm acting as monopolist may prefer to license, it

cannot because contracts aren't enforceable and licensees pirate the technology. In order to protect the monopoly the Northern firm internalizes the transactions through a wholly owned subsidiary shifting the net benefits back north.

Zigic (2000) built a duopoly model whereby the South attained its market position through R&D spillovers, the leakage of important technical information, and the North achieved its market position through R&D. The model involves four stages whereby the South chooses its optimal IPR regime in light of the fact that the North, assumed to be a significant trade partner would respond with high import tariffs, if the South chooses a weak IPR regime. Like Vishwasrao, the model's focus is how the North addresses the rent appropriability problem given a world of weak IPR.

Theoretical Propositions

The theory of welfare and IPR protection hinges on its theoretical propositions about how weak IPR in the South effects the welfare of firms, consumers, and Southern countries as a whole. The following is an overview of nine propositions to be empirically analyzed using the Pioneer Case Study. They are organized into four topics; Southern Demand, Business Behavior, Financial Impacts, and Technology Flow.

Southern Demand

Proposition #1: Welfare in the South improves as preferences between the North and South are more homogeneous. Diwan and Rodrik (1991) and Deardorff (1992) argue that homogeneity allows for free riding and more readily transfers benefits to the South under a weak IPR regime. The South loses from a lack of access to the unique products it prefers. For many products, including our case of marketing agricultural biotechnology in Argentina, demand is somewhat homogeneous. The unique geographic and agronomic features of the Pioneer case provide excellent insight into

how willing the northern firm is to invest in adapting the product to the local market (Argentina) and how willing the Southern consumer is willing to accept the risk of using a product that is sub-optimally adapted to the local environment. Pioneer can choose to leverage the homogeneity and avoid all adaptation to the Argentinean market or could choose to enhance its products for local use.

Proposition #2: The smaller the demand in the South relative to the North the more advantageous for the South to maintain weak IPR (Chin & Grossman, 1990; Diwan & Rodrik, 1991; Taylor, 1993.) This is due to the South's ability to free ride on the technology combined with the lack of incentive by the North to market to the South even in a world of strong IPR. Pioneer's investment behavior, which differs across products, not markets will be analyzed to assess how they respond to the smaller Argentinean market.

Business Behavior

Proposition #3 Firms will engage in either masking or enforcement to try and protect their IP. Vishwasrao (1994) and Chin and Grossman (19900 raise the issue of masking and its welfare effects. The South is believed to be harmed by masking. While the firm is believed to have a net benefit from masking, there are costs (Globerman, 1988; Braga and Willmore, 1991; Taylor, 1993). The Pioneer case will be used to study the masking, administrative, and enforcement (MAE) costs and strategies of the firm, its associated industry group, and the government.

Proposition #4 Weak IPR reduces investment in the South. Stamm (1993) refers directly to investment and its diversion away from the South to the North. Vishwasrao, 1994; Globerman, 1988; Mansfield, 1994; Sherwood, 1990; and Benko, 1987 refer to lowered R&D spending in the South, and Chin and Grossman (1990); Mansfield (1994); Helpman (1993); Benko (1987); Diwan & Rodrik (1991) hypothesize about how innovation is stifled in the South. Zigic (1998) raises the issue of welfare spillovers. The effects on investment are critical components of the indirect impacts from weak IPR and are necessary for conducting benefit-cost tests. For example, a loose IPR regime might cause a firm to avoid a country. The country not only loses by not having access to the latest technology, the firm would also be withholding investment in the country in support of the innovation. These are the "pebble in the pond" effects from introducing a new product into a market. They generally do not arrive in a limited fashion but can have broad indirect impacts on the economy. To empirically measure these ripple effects, our case study compares the relative levels of R&D, investment (human (Sherwood, 1990) and physical capital) between Pioneer units whose IP is affected against those whose IP is unaffected by

Argentina's weak IPR regime.

Proposition #5 Weak IPR causes a negative performance bias on the Southern operations of the technology firm. Sherwood believes that production processes will be outdated; Stamm states that service levels will be lowered and the distribution system will be less reliable. Agricultural seed production involves three distinct stages beyond R&D; Multiplication, Processing, and Distribution. Each one of these will be assessed in terms of the impact of weak IPR. If theory is correct there should be measurable operational differences between the units due to IP risk.

Financial Impacts

Proposition #6 Weak IPR reduces return on investment (Stamm, 1993). The financial data on Pioneer-Argentina will be analyzed estimating the differences in return on investment, as well as other financial metrics, between the two units. Chin and Grossman (1990) and Globerman (1988) expect lower profits. An important factor is the level of technological appropriability (Diwan and Rodrik, 1981; Teece, 1987). This is the degree to which the owner of the intellectual property is able to generate a return and is a function of technological feasibility as well as permissiveness of the IPR environment (Teece, 1987).

If severe financial harm is assumed to occur by these theorists, then there should be evidence in terms of the intensity of the firm's lobbying effort and degree of internalization (Vishwasrao, 1994; Globerman, 1988). The analysis of Pioneer's lobbying behavior and financial performance will shed light on how bad (good) the second best outcome is for the firm under weak IPR. This analysis will provide some insight into Chin and Grossman's claim that strong IPR always benefits the firm by answering the question of how "bad" is a second best strategy under weak IPR.

Technology Flow

Proposition #7 Weak IPR allows access to new technologies that improve the welfare of the South (Chin & Grossman, 1990; Vishwasrao, 1994; Gould and Gruben, 1996; MacLaughlin *et al,* 1988). The case will be used to demonstrate how Pioneer prices the product, how the distribution chain handles the product, and how farmers use the product. Results will provide insight into how farmers' welfare is impacted either directly from a change in prices or indirectly from the level of technology.

Proposition #8 Weak IPR lowers the speed on technology's entry into the South (Stamm, 1993 and Chin and Grossman, 1990). This has important welfare implications as quality available to the South is reduced (Globerman, 1988). The corn and soybean business units will be compared to look at

product offerings. The case is valuable because direct comparisons can be made with Pioneers product offerings in the North between the two businesses and the lag time before these products reach Argentina.

Proposition #9 — Weak IPR promotes diffusion of new technology (Chin and Grossman, 1990; Stamm, 1993). Under weak IPR prices should fall (Globerman, 1988; Diwan and Rodrik, 1991) allowing for greater distribution of the product. This proposition is juxtaposed against Proposition #8 that supports the idea of less technology rather than more. Thus the lag of the technology rollout (#8) is a force maintaining the technological disparities between the North and the South while lower prices from weak IPR promotes the rapid diffusion of (dated?) technology; a force for equalization of technology between the North and the South. The case will provide empirical insight into the welfare balance of these two effects.

Empirical Studies

As noted above, the theoretical models help to provide a framework to analyze the welfare impacts but are lacking in their conclusiveness. This makes it difficult from theory alone to convince either side of the true welfare impacts. In an attempt to shed more light onto the question of welfare impacts, a few empirical studies have been conducted to try and measure impact. Empirical research in this area too is problematic. Writing in a 1993 survey of the empirical work to date, Helpman (1993) concludes that there exists very little evidence on the welfare effects of international infringements of IPRs. Similarly, writing in 1994 Maskus and Konan remark that there is a surprising paucity of empirical evidence concerning the most critical issues at hand. Subramanian (1995) echoes the sentiments of the lack of quantitative estimates of the Southern welfare impacts. Therefore, on the topic of understanding the phenomenon of North-South welfare impacts, the empirical attempts have not been much more successful than the theoretical models.

To date there have been five[1] key studies: the first is Braga and Willmore's use of 1981 survey data of 3,000 Brazilian industrial firms; the second is the United States International Trade Commission (USITC) survey conducted in 1986 of 736 US firms; the third is Gadbaw and Richards's 1998 statistical overview of four LDC counties using aggregated secondary data, the fourth is Mansfield's 1994 survey of 100 US firms; finally the most recent research on this topic is Pray et al's work in China (2001) that departs from the firm-level approach and surveys consumers (farmers) of technology in order to directly assess the benefits to them of exploiting weak property rights.

Braga and Willmore's study comprised a qualitative survey of 3,000 Brazilian industrial firms in 1981 linking the lack of a strong property rights to low levels of local technological innovation (Braga and Willmore, 1991). The qualitative survey queried industrial firms about the relationship between the IP environment and their willingness to invest or purchase technology from abroad (Gould and Gruben, 1996). It provided the first empirical evidence of the impact of weak IPR on Southern domestic firms' willingness to invest.

The United States International Trade Commission surveyed 736 U.S. firms in 1986 asking those firms to assess the impact of weak foreign property rights on their profits (USITC, 1988). The methodology used was a mailed structured survey asking "Fortune 500" firms about the impact on their business of weak foreign IPR. Losses were estimated at 2.7% of sales, with losses in one industry as high as 21% of sales. Infringement and enforcement costs were estimated at .03% of sales.

Feinberg and Rousslang (1990) using the USITC data set expanded its scope of analysis. They attempted to estimate the static welfare consequences of weak foreign property rights on

innovating firms, local infringers, and consumers. They found that while losses are significant to the legitimate firms, they might be less than the sum total of benefits to consumers and infringers. Consumers benefit from greater price competition and infringers (producing close substitutes) benefit from the inelastic demand for the product and the low marginal costs of infringing. As the authors point out, their study does not account for among other things the negative investment impacts arising from weak IPR in the South.

Gadbaw and Richards (1988) used USITC data as well to estimate the "right owner revenues" in the absence of piracy, thus the empirical focus is on the loss of sales not investment. The authors admit it is a daunting task as they are using estimates of demand and price elasticities garnered from interviews. Thus like the Braga and Willmore study, the estimate of investment or sales foregone due to piracy is difficult to address because the analysis reflects a partial equilibrium analysis and is subjective and static.

Mansfield (1994), using a similar methodology to Braga and Willmore and the USITC, surveyed 100 major U.S. firms in 1991. The response rate was 94% and respondents were generally patent attorneys, specialists in the firms' international operations or top executives (Mansfield, 1994). He found that the IPR environment had an important effect on some foreign direct investment. More of the effect was felt in R&D and less felt in sales and distribution. Similarly Mansfield found that much of the hesitancy involved the transfer of technology, not necessarily investment in general. This suggests that more of the impact of weak IPR concerns intellectual property questions not necessarily investment in general. Our case study will directly address this question to see if investment effects are limited to IP or are there spillovers to other investments as well.

Most recently, Pray et al. (2001) studied the adoption of Bt cotton in China using a survey of 283 farmers in Northern China. Their work documents quite clearly the incentives for local producers to adopt technology when property rights are weak. While their work is excellent at describing the motivation. Firm impacts and host country impacts net of producer impacts were not part of the study.

As Helpman has pointed out empirical work assessing welfare impacts has been lacking. While Sherwood and Braga (1996) note that the question is essentially empirical, they as well as Maskus and Konan (1994) also admit the difficulty in making welfare estimates. There is not only an inherent complexity to the problem, but the dynamic effects are difficult to capture and modeling in this area requires assumptions that are fundamental to the outcome. Feinberg and Rousslang (1990) find the empirical task difficult because much of the primary data that has been used is self-reported and involves so many estimates.

We offer an alternative empirical approach that recognizes the empirical challenges while at the same time integrating the rich theoretical literature. It is hoped by looking at this question from an alternative methodological perspective a greater understanding of this phenomena will occur.

Methodology

Numerous propositions about the impact of IPR protection on firm and host country impacts emerge from the theoretical models. A review of the literature of empirical studies attempting to answer some of the fundamental welfare questions about IPR protection provides only weak evidence. Part of cause for weak evidence is the complexity of the IPR welfare

situation. As noted above there are numerous factors affecting hosts country and firm welfare and these factors can be contradictory. A second component causing the lack of factual clarity is that empirical measurement is difficult. While these empirical methodologies used to date have been effective contributing to the debate over IPR protection, they are unable to get at the central issue of measuring and documenting welfare impact. This is because they are at least one degree removed from actors, investments, and transactions that comprise the welfare assessment.

Additionally the empirical effort is complicated because much of the empirical assessment of IPR protection attempts to measure the investment or transaction that was never made. These are the negative effects host country and firms derive from investments purportedly not made. Measuring this is difficult. We think our methodology solves that problem. When researchers query northern firms about the impact of IPR protection they undoubtedly say that is harmful to their company because revenues are so low from the lack IPR protection that investments in the pirated product are untenable (i.e. Illinois Farm Bureau, 1998). But is this true? Can we measure it? Welfare analysis is about weighing benefits and costs, but without measurement how can we perform the analysis? Executives describe transactions not conducted and investments not made, how might they be measured? Once measured then a proper welfare analysis can take place, and the theoretical propositions above can be assessed.

We think we have come up with such a methodology and an empirical setting that will address the problem of measuring the investment not made. The subject of our study is the firm Pioneer- Argentina. Pioneer is a subsidiary of the multinational division Pioneer Hi-Bred International that is part of Dupont de Nemours. Pioneer-Argentina is in the business of producing and selling agricultural seed to farmers. Total sales for 2000 were $35 million and the

firm employs 105 people. The firm sells a variety of cultivars (Figure 1), but their dominant business is corn and soybean seeds. Herein lies the uniqueness of the empirical setting and its value for addressing the question of the welfare implications of IPR protection.

Corn and soybeans are complements. Agronomic convention holds that neither corn nor soybeans be grown in the same field in a continuous fashion. A producer may be able to get away with two years of continuous rotation but beyond that soil fertility suffers and weed and disease impacts increase. Therefore corn and soybeans are grown in rotation with 50% of a farm's acreage in corn and 50% in soybeans. In any given year though relative prices and input costs may provide an incentive to move away from a 50-50 split, but as mentioned above deviating far from a rotation over a long period of time is not possible. The impact for retail seed suppliers is that offering both corn and soybean seed is a successful strategy as there are very few pure corn farmers or pure soybean farmers. A farmer needs both products. A firm can effectively offer both types of seeds because brands are important and it affords one-stop shopping.

A second feature that makes the case unique and valuable for studying the IPR issue is that Argentinean crop production is very similar to that in the US. The center of the corn and soybean area, e.g. the province of Buenos Aires, is the 32nd parallel (south) comparable to the Mid-South region of the US. Thus US varieties and agronomic practices transfer readily to Argentinean producers. This makes the preferences between the North (US) and the South (Argentina) relatively homogeneous. In the year 2000, Argentina cultivated 3,326,000 hectares of corn and 10,300,000 hectares of soybeans (Secretaria de Agricultura, Ganaderia y Pesca (SAGyP), 2000). Argentina is the world's second largest corn exporter (USDA, 1997) and the

world's third leading soybean producer (Elliott, 2000).

To produce seed (for the North or South), a firm like Pioneer takes three general strategies. The first (I), involves extensive R&D to develop seed characteristics that can be introduced into adapted and successful existing germplasm. An example would be the development of transgenic events, i.e. Round Ready® tolerance, and then marketing that technology through the best varieties/germplasm. Therefore Monsanto, as an R&D company, would purchase a company like Asgrow, a producer and marketer of seed, in order to get its technology out into market (Goldsmith, 2001). This would be the high risk-high return strategy that has dominated the life sciences industry over the last decade (Goldsmith, 2001).

A second strategy (II) and more common in markets of developing countries is for firms to take already developed seed varieties and adapt them to the local environment. This still involves significant investment in seed research trials with extensive breeding programs and field plots in the local (Southern) environment. As long as the foreign region is relatively homogeneous to that of the central R&D area of the US, Strategy I is unnecessary and Strategy II suffices. An example of this is northern Brazil where Strategy II is not applicable because of the tropical climate and high aluminum soils (Mcvey *et al*, 2000). Local investment in R&D by EMBRAPA, Brazil's agricultural research system is necessary because direct technology transfers are agronomically inappropriate.

The third strategy (III), involves essentially no investment. A seed company simply exports the seed directly from the North to the South with no adaptation. The more comparable the northern environment is to the southern environment the less likely a crop failure would arise due to poor adaptation. It is important to note that a seed firm can never know with certainty that

a variety when taken out of its home region will perform exactly the same in a new region. Ex-ante the firm may be confident, but only after the seed has been purchased, planted and grown does the adaptiveness reveal itself. Thus older varieties are less risky, but represent older technology.

An anecdotal example of this situation was Pioneer's "Rio Cuarto" incident in 1994. According to current management, and confirmed by competitors, the firm's previous management took short cuts adapting US corn varieties to Argentina. A deadly fungus, named Rio Cuarto (the province where the greatest outbreak occurred) wiped out corn crops planted with Pioneer products, doing tremendous damage to its brand image. Even in the year 2000, the firm was still attempting to rebuild confidence in its products. This highlights the inherent risks transferring varieties directly from one region to another.

Strategy I (high R&D) is not pertinent to a company like Pioneer Argentina because the agronomic differences are small and market opportunities specific to Argentina are relatively minor for new technology development. New technologies available to Northern producers in North America and Europe can be successfully introduced in Argentina. Roundup Ready® technology for example is easily introduced into the many local varieties found in the US, Europe and South America.

Pioneer does have a choice between Strategy II (moderate investment) and Strategy III (no investment) and this option is the crux of our empirical approach. Pioneer is world leader in corn and soybean seed production and sale. Farmers in Argentina need both products and Pioneer wants to offer both products. The uniqueness of the situation whereby Argentina agronomically is directly comparable to the US affords a firm like Pioneer the opportunity to

choose a Type II or Type III strategy for either the corn or soybean products. They can both be Type II with significant R&D and Argentinean farmers would receive the most advanced technology adapted to their country's environment, or the firm can under-invest and choose a Type III strategy and completely free-ride off of investments made in the North. Corn and soybeans do not have to be treated the same. That is corn can be Type II while soybeans kept at Type III.

As revealed in our interviews with the company, their objective (not surprisingly) is profitability, which can be translated as return on investment (ROI). They are not wed to one strategy or another or matching a product, i.e. corn, with a certain strategy. They clearly expressed that their objective was profitability and the strategy (either II or III) would be used for the division that best achieved those objectives. Therefore as an endogenous choice problem, the corn or soybean divisions could either involve moderate or no investment. Ceteris paribus, according to Pioneer management, high investment is preferred to low investment. Thus if business conditions were ideal, the welfare of the firm is greatest under Strategy II, high investment.

The empirical question of this paper is not why Pioneer chooses one strategy or another, but to compare the welfare impacts of a Type II strategy versus a Type III strategy. In order to effectively perform the welfare analysis, a comparative case is valuable. In the Pioneer situation what are the benefits and costs for both the firm and the host country of the high investment decision and what are the benefits and costs of the low investment decision?

A final unique and valuable feature of this case is the cross-country differences in institutional environments are controlled. This is because even though Pioneer's strategic choice

is driven by IP concerns and Argentina has a weak IPR regime, corn is agronomically protected from IP piracy and soybeans are not. Therefore our methodology controls for the property rights environment, the market structure, and demand (farmers). The reason that the corn division can be operated differently from the soybean division is that corn is a hybrid and soybeans are not. A corn plant is pollinated only by means of another corn plant. If corn seed is saved from one year to next, the corn plant loses its hybrid (cross-pollination) vigor and performs very poorly. Therefore a farmer must return each year to the seller of seed to get a new version of the hybrid that has been properly crossed.

Soybeans on the other hand are self-pollinating and can keep reproducing in perpetuity. A farmer can take seed from the crop just harvested and replant them the following year. In this way a farmer who plants soybeans does not have to return to the seed supplier every year for new seed, dramatically lowering the cost of the seed input. In the US 25% (Hayenga, 1998) of the soybean seed is saved-seed. Most farmers still have an incentive to purchase new seed every year because new varieties perform better. Saved-seed will have a yield drag on average of 2.4% (Purdue University in Illinois Agrinews, 2001). Also purchased seed tends to be more consistent and reliable. In the last few years an added incentive, in the US and Canada, to purchase soybean seed on a yearly basis has been Monsanto's introduction and enforcement of a grower contract that stipulates that seed can not be saved as it infringes on Monsanto's patent rights (Goldsmith, 2001). Under the weak property rights conditions of Argentina, this last incentive does not exist. Our interviews with farmers and industry representatives in Argentina feel that the yield drag from saved-seed is closer to 1% - 2% per year for them and well worth absorbing, given that seed costs are so much lower. Because of this unique agronomic feature we are able to study Pioneer's

behavior where the only difference between the business of selling corn and the business of selling soybeans is that corn's IP is naturally protected while soybean's is not.

With the objective of this research being to measure the effects of weak property rights, the Pioneer Argentina case serves as a valuable empirical setting. Since the two goods are complements and operate side by side, they can be directly compared. Because both divisions operate in the same country any differences in institutional environment is corrected for. Because the divisions operate within the same company differences in business behavior across firms is corrected for. A study of Pioneer Argentina is a unique opportunity to compare the two divisions and assess how the divisions are operated, where investments are made, what costs are incurred, what revenues are generated, what seed prices are charged, and how seed is distributed. Based on theory of IPR protection, the impacts of the two strategies should be different. These differences then will provide evidence of welfare impacts derived from the set of theoretical propositions listed earlier.

To explore this unique empirical situation the case study method was selected. The lack of empirical evidence generated by previous methodologies in this area led us to believe that a more microeconomic approach was necessary. The case study method is valuable where depth of analysis is important. The ability to achieve depth is also the case study approach's weakness, in that only "one" observation is being used. In all of the studies mentioned above numerous observations were used and statistically significant results were estimated. As numerous authors have noted though, the application of those results to the phenomena has not been significantly illuminating. The case-study method used in this research greatly narrows the focus with the intent of improving the quality of the empirical evidence. The case study approach's narrow

focus and lack of statistical tests are seen as weaknesses as well. Neither broad-based statistical studies nor narrowly focused case studies are the perfect empirical methodology (Yin, 1994; Westgren and Zering, 1998; Gummesson, 2000). Both have their place and we suggest that case study method when applied to the situation of Pioneer Argentina adds important insights into the North-South debate over IPR protection.

Approach

As in quantitative research, there are numerous case study methodologies. For the purposes of this inquiry, a deductive approach is employed. That is the case study is used to help provide empirical evidence about a phenomena that to date has been understood from theoretical, anecdotal, and limited empirical perspectives. Yin calls this the critical case study model and is built upon existing theory and guided by specific propositions. Its goal is to test theory instead of creating theory. Specific questions still remain as to how IPR protection actually affects farmers, firms, supply chains, and host countries. Theory, as noted above, abounds about how we think welfare is impacted and the theory yearns for some empirical evidence.

Evidence

The study used the following sources of evidence: key informant interviews, direct observation, and quantitative data (financial documents analysis and industry statistics). To conduct the interviews a semi-structured interview instrument was administered to over 30 key informants representing Pioneer and its various divisions, the Argentinean seed industry, supply chain members, and government (Figure1). Following Kumar (1989) guidelines for rapid appraisal, these interviews were qualitative and directed to carefully selected subjects.

The instrument comprised over 180 questions drawn and organized thematically from the theory. Depending on the informant's role or organization, some of the question might not have been asked. In general questions focused on business operations, investment, and intellectual property. The theme was always comparing the corn seed business with the soybean seed business. While an attempt was made to introduce the questions in the same order, it was not uncommon for respondents to shift off topic. The interviewers did keep track of those questions that remained unanswered and worked them back into the interview so that each informant addressed as many of the same questions as possible. This technique allowed for answer triangulation so that any significant answer from one respondent was validated by other informants. Following Kumar (1989), interviews were conducted with help of a previously designed interview guide taking special care to the way questions were worded in an attempt to maintain as neutral an attitude as possible.

Maintaining an easily retrievable case study database is critical to assure the validity of a case study (Yin, 1994). In this ways it is possible to re-inspect the data by the author or from other researchers. With this in mind all interviews were recorded in both audio and digital video formats. Almost all interviews were conducted in Spanish. Spanish language transcripts were produced and were analyzed using a qualitative data analysis software program called QSR NUD*IST- N5® (QSR International, 2000).

Direct Observation

Structured direct observation, according to Kumar (1989), can be an extremely useful in the data triangulation process. Armed with theoretical expectations about investment and expenditure

differences between the corn and soybean divisions, analysis was made of Pioneer infrastructure, technology, human resources, and advertising and marketing. Our use of the digital video equipment as well as photographs helped to document what investments were made and what equipment was being used for each business unit. To conduct the observations of physical assets visits were made to Pioneer R&D and production facilities and multiplier farms.

Quantitative Data

Firm Documents

Yin (1994) suggests that the best use for documents is to augment the evidence from other sources. Pioneer, Argentina provided us access to their financial records. Records are maintained separately between the two business units. Therefore an analysis of the balance sheet, income statements, and pricing data were made available to the authors. Due to the sensitivity of the material, ratios comparing the corn and soybean units will be used whenever possible. The financial data serves three purposes; first it is useful to corroborate the responses of Pioneer managers as to the state of each of the businesses; second the data can be used to analyze the propositions pertaining to the difference financial impacts weak IPR protection has on a firm; third the data helps to quantify the welfare impacts.

Methodological Validity

As numerous authors (Yin, 1994; Gummesson, 2000; Westgren and Zering, 1998) have noted, there is no hierarchy of research methodology. Of the many tools available to researchers each has an appropriate place. There is no perfect research methodology that serves all criteria

for proper empirical analysis.

Researchers offer several tests of validity with respect to the case study method. The validity test is: does the empirical evidence in fact correspond to the phenomena under study (Gummesson, 2000). Our study employs the single case approach. Therefore is the case of Pioneer Argentina and the research design valid for analyzing the phenomena of firm and host country welfare impact from weak IPR protection? In order to make the validity argument there are numerous design options many of which this research incorporated and some of which it did not.

First, theoretical grounding adds formality and discipline to the research process. Because of our extensive use of the theoretical literature, supported by the more limited empirical evidence, we would argue that Pioneer is a valid context by which to study the phenomena. Contributing to the methodological validity is our research design and implementation such that our research could be replicated within the same context or transferred to a new context.

The second important aspect of empirical validity with respect to the single case study approach is its context. Does the study of Pioneer effectively incorporate the phenomena of question (see Westgren and Zering, 1998)? The explicit discussion above, detailing the uniqueness of the Pioneer case to study the IPR question, constitutes our argument that this case provides an excellent context by which to analyze the phenomena.

Third is the depth of the research, what Yin calls embeddedness. Cross-sectional data (i.e. USITC, 1988 Mansfield, 1994 and Braga and Willmore, 1991) provides a form of breadth of analysis. The single case study approach, on the other hand, allows depth of analysis. In our case, embeddedness was captured through in-depth interviews, multiple interviews within the

firm, quantitative analysis of firm-level and industry level data.

Fourth is the issue of triangulation, which asks multiple parties the same questions to see if their responses corroborate each other. While not all answers need not be "identical," they should be consistent. If they are not consistent, then a reason needs to be found. Triangulation was achieved by: conducting multiple interviews within the same firm; interviewing competitors, supply chain members, and third parties (i.e. government); analyzing quantitative data (firm and industry, and national); and conducting and documenting direct observations. In this way a consistent and reliable picture of the phenomena is created.

A fifth contributor to empirical validity is the use of multiple cases to analyze the same phenomena. Additional cases demonstrate reliability and in that way contribute to the robustness of the conclusions. In this way our methodology is lacking. With multiple cases there is always the question of cost and time. More significant in our situation would be replicating the level of intimacy with the company under study. We were very lucky to have had such a high level of access. This depth of access compensates for the lack of additional cases.

Finally, case study researchers recognize that longitudinal analysis adds power to the results by limiting the possibility of serendipity. Helpman (1993) notes the importance of dynamics when assessing the welfare impacts from weak IPR. This too is a valid critique of our methodology where more time spent is studying a phenomena is usually better. Because our analysis is static we are going to have to impute the dynamic implications of the firm's behavior.

Results and Discussion

At the time of the publication of this draft the results were not completed thus they were not included.

Table 1: Pioneer Product Mix

Crop	Category	Number of Products
Corn	Elite Hybrids	10
	Tropical Hybrids	4
	Imidazolinone Resistant Hybrids	2
	Insect Resistant (Bt) Hybrids	5
	Stacked Hybrids*	1
Total		**22**
Other Crops		
Soybeans	Roundup Ready Varieties®	7
Sunflower	Hybrids	4
Sorghum	Hybrids	4
Alfalfa	Varieties	5
Total Other Crops		**20**

Source: Pioneer Argentina 2000 Catalog
* Hybrids that combine insect and herbicide (imidazolinone) resistance

Figure 1: Overview of Key Informant Interviews

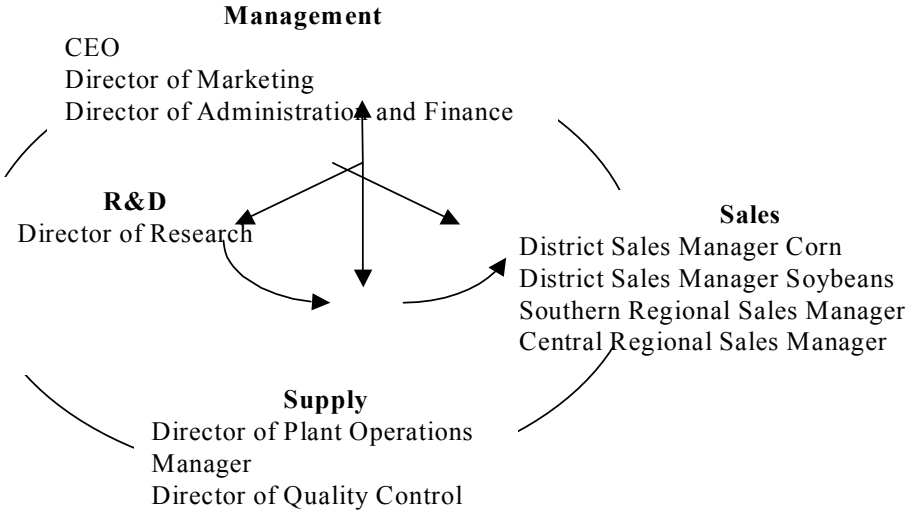
Government

INASE (Instituto National de Semillas (National Seed Institute) and Control
Director of Variety Registration
Director of Certification and Control
INTA (Instituto Nacional de Tecnologia Agropecuaria (National Institute of Agricultural Technology)
Former Director of Strategic Planning
US Embassy
Undersecretary for Commerce
Agricultural Attache

Industry Associations

ASA (Asociacion de Semilleros Argentinos (Seed Masnufacturers Association of Argentina)
ARPOV (Asociacion del Registro de Proteccion de Obtenciones Vegetales (Association of Registered Plant Variety Protection)
Association President
Corporate Attorney

Pioneer Argentina



Competitors

Novatis S.A.
Manager- Sales and Marketing
Manager Information Systems
Zeneca S.A.I.C.
Marketing Director
Product Manager

Farmers and Other Supply Chain Members

Estancia Don Adolfo
Antonio Carlos Calvo
Illinois Comercial
ACA (Associacion de Cooperativas Argentinas (Association of Argentinean Cooperatives)
Vice president
Special Projects Manager
Agrositio.com
Commercial Director

Multipliers and Distributors

ARECO Semillas
President
Agropecuaria Los Grobo
Chief Operating Officer

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Endnotes

1.Two other empirical studies were not mentioned. Subramanian (1995) studied prices of specific pharmaceuticals and used previous estimates of price elasticities to estimate welfare effects for the northern firm and the southern country. Maskus and Konan (1994) used the estimates of Gadbaw and Richards (1988) to study the welfare effects of licensing in a southern setting.