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1. The Effects of Intellectual Property Rights on Foreign Direct Investment and Imports into Developing Countries in the Post TRIPs Era

2. Technology Transfer for Humanitarian Use: Economic Issues and Market Segmentation Approaches

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Editorial Policy: The purpose of *IP Strategy Today* is to provide a forum to share creative, innovative and pragmatic analysis and ideas in intellectual property strategies and management issues, particularly as they affect the transfer of proprietary technologies to developing countries, developing countries access to proprietary technologies in agriculture, the environment and health, and the international exchange of genetic resources. Emphasis on the implications of biotechnology are specifically encouraged. Papers must have a problem solving orientation and demonstrate originality and innovation in thinking, analysis, methods or application. Issues related to research investments and management, bilateral and multilateral donor policies, extension, teaching, public-private partnerships are equally encouraged, as is interdisciplinary research with a significant IP and international development component. Manuscripts, review articles and working papers that offer a comprehensive and insightful survey of a relevant subject, consistent with the scope of *IP Strategy Today*, are welcome. All articles published, regardless of their nature, will be reviewed anonymously by members of the editorial board.

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Editors' Introduction

The present volume of *IP Strategy Today* contains two apparently disparate papers. The first, by William Lesser, entitled "The Effects of Intellectual Property Rights on Foreign Direct Investment and Imports into Developing Countries in the Post-TRIPS Era" (pages 1 - 16) presents a new "IP Strength Index" and demonstrates the importance of sound intellectual property (IP) protection in line with the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement and the link with direct foreign investment and consumption. Whereas there are a range of conclusions of Lesser's research, one that stands out is that some small changes in policy, such as joining the International Union for the Protection of New Varieties of Plants (best known through its French acronym UPOV) can boost trade and FDI. Also highly relevant is a change in enforcement matters.

The second paper by Travis J Lybbert, entitled "Technology Transfer for Humanitarian Use: Economic Issues and Market Segmentation Approaches" (pages 17 – 25), deals with technology transfer for humanitarian uses and outlines a research agenda to better implement market segmentation and optimize the benefits of technology transfer to meet humanitarian needs. Such research will be highly relevant to optimize philanthropic investments and should further encourage companies to donate technologies for humanitarian use.

Although the two papers are quite distinct, we are pleased to be able to publish them under one volume of *IP Strategy Today* because taken together, they underscore that appropriate IP protection does not run counter to meeting humanitarian needs. In fact, reading the papers together, it becomes apparent that appropriate IP protection can be a useful instrument for market segmentation: in that way, private investments can be directed at the commercial agricultural sector and concurrently benefit those who are traditionally excluded from market forces.

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The Effects of Intellectual Property Rights on Foreign Direct Investment and Imports into Developing Countries in the Post-TRIPS Era[1]

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Executive Summary

Under the TRIPS (Trade-Related Aspects of Intellectual Property Rights) agreements of the World Trade Organization (WTO), the 144 signatory countries have agreed to adopt certain minimal levels of Intellectual Property Rights (IPR) protection. Most developed countries were required to make major changes to comply, while developing countries focused on meeting the minimum standards that apply to them. As the compliance deadline has passed for all but the least developed countries, policy makers in developing countries have been confronting the issue of the affects of the mandated stronger IP protection.

The costs of enhanced IPR protection are easily observable in terms of greater royalty and license payments. Benefits include an incentive for investing in R&D, but many developing countries recognize that domestic capacity is not at the highly evolved levels typically required for thorough IPR protection. Indeed, it is frequently cited that indigenous inventors account for around only 15 percent of all patent applications in most countries. While this and other evidence can be interpreted differently, it is undeniable that the costs of stronger IPR are frequently more visible than the benefits, and this has created resistance to implementing TRIPS-mandated minimum standards across a range of countries.

This article examines aspects of the effects of stronger IPR protection in the areas of imports and Foreign Direct Investment (FDI) for a sample of developing countries. Existing literature, which generally shows a positive relationship between the strength in IPR and both imports and FDI, considers only the pre-TRIPS period. But this paper relies on post-TRIPS data, since it covers the year 1998, which is after many countries had strengthened IPR systems under TRIPS.

The analysis employs multiple regression and uses variables associated with FDI and imports, including per capita income, past FDI, exchange rates, tariffs, and the degree of industrialization. Data are from the World Bank. A key variable is the index 'strength' of IPR in a country. Past studies have use indexes based on either (a) an assessment of legislation or (b) expert judgment. Both have limitations. Systems relying solely on legislation exclude any consideration of enforcement, which is a key factor in the actual operation of IPR systems. Moreover, the significance (weights) of the components in the calculation of a

[1] Lesser, W. 2002. The Effects of Intellectual Property Rights on Foreign Direct Investment and Imports into Developing Countries in the Post TRIPS Era. *IP Strategy Today* No. 5-2002. pp. 1 to 16.

single score value appears arbitrary. Expert opinion does capture enforcement, but it is difficult to evaluate and varies from country to country (sample to sample).

For the purposes of this study, a new index was developed that uses membership in international treaties to measure the scope and efficiency of IPR. Membership in the Patent Cooperation Treaty (PCT), for example, reflects efficiency in application processes. Enforceability is captured by the inclusion of the Corruption Perception Index (CPI). The CPI measures the overall transparency of transactions, but is closely related with the functioning of the courts. A statistical method (factors) is then used to calculate the weighting of the components in the IPR index. The use of the CPI limited the sample to 44 developing countries. This index uses secondary data and can be readily updated annually to track progress within a country.

The results show that both imports and FDI are positively and significantly associated with the IPR strength index. A one point rise in the IPR score (about 10%) is associated with a $1.5 billion increase in FDI (50% of the median amount) and an $8.9 billion increase in imports (40% of the median). These are very large numbers and should not be interpreted literally as predictions for any individual country. Rather, the significant point is that some small changes in policy (such as joining the International Union for the Protection of New Varieties of Plants, best known through it French acronym UPOV) can boost trade and FDI. Most relevant is a change in the CPI, which makes sense given the sensitivity of IPR systems to enforcement matters. Enhancing the transparency of court systems is complex, but this study provides additional evidence supporting its importance for making progress towards a more value added economy. A similar analysis was used for exports and license fees, with similar if non-significant results, possibly due to the small sample size available.

This study's conclusions are limited by the difficulty of measuring the target of analysis. That is, does the IPR index measure IP per se, or does it reflect a general level of functionality of public institutions? The matter cannot be addressed directly, for the two aspects of government are related, although once the TRIPS mandates are fully satisfied there will be additional observations for resolving that matter empirically. For the present, related studies that examine IPR and FDI on a sector-by-sector basis show differing effects by sector. The more sophisticated ones are the most sensitive to IPR, giving credence to the role of IPR as opposed to general governmental functionality. Overall, the results indicate that governments interested in enhancing FDI as means of generating employment and advancing technology use are advised to strengthen IPR along the lines and schedule of TRIPS.

1. Introduction

In addition to being the last day of the twentieth century, December 31, 1999, was the deadline for all but the least-developed countries to comply with the Trade-Related Aspects of Intellectual Property Rights (TRIPS). These requirements under the World Trade Organization (WTO[2]) extend and harmonize Intellectual Property Rights (IPR). Many countries complied in full; others are still in process. Yet despite their participation virtually all developing countries are asking about the economic implications of compliance. Answering this question is an important and urgent task, for better insights into the benefits of enhanced IPR for developing countries will allow governments to plan economic policy more effectively and provide a counter to the voices, such as those heard in Seattle in 1999, that condemn the globalization taking place under the WTO process. In developing countries, strengthened IPR are a particular target of that rhetoric.

For the foreseeable future, numerous countries will remain buyers rather than producers of key products and technologies, which limits the applicability of the incentive effects of IPR. For these nations, enhanced IPR could lead to increased imports and higher prices in some sectors; thus the domestic benefits of stronger IPR still remain to be established. Past justifications of stronger IPR as an important 'signal' of openness to economic activities have been useful, but national leaders seeking clearly documented evidence do not find this compelling. Theoretical contributions have also been of limited value, since there is no clear presumption that stronger rights will always be welfare-enhancing (Winter 1989). In general, determinate results are possible only on a country by country basis and then only when strong assumptions are made (see Braga 1995).

The best analyses of the effect of TRIPS are complex and place them in an international context, typically partitioned between developed (technology providing) and developing (technology receiving) countries. When the analysis includes multiple inventions, theoretical approaches show that welfare effects partly depend on population sizes in the supplying and recipient countries. Based on some strong assumptions, including products made freely available without patent protection and countries fixed as innovators or purchasers of innovations, Deardorff concludes that at least the poorest countries should be exempt from TRIPS requirements (1992, p. 50). Such countries can "free ride" with impunity on inventions developed externally. But to appreciate the effects of a change in assumptions, note Diwan and Rodrik's (1991) conclusion that as long as northern and southern countries have differences in preferences, both groups have incentives to provide patent protection.

Clearly, determining whether developing countries benefit from enhanced IPR protection should be as empirical as possible. One possible avenue for such an approach has been provided by Maskus, who suggests in a detailed literature review that foreign direct investment (FDI) is a mechanism through which stronger IPR can contribute to growth and welfare: "FDI typically carries efficiency advantages through superior technologies, management skills, and marketing." (2000, Chapter 5). This occurs through FDI learning-spillover effects such as improved management, association with state of the art technologies, and a need to counteract competition. Numerous studies have indeed shown that stronger IPRs are associated with greater FDI and imports (see Section 3.1). For example, Smith (2002, p. 506) has shown the statistical significance of IPR variables has increased in more recent years when IPR have become stronger.

That analysis, however, predates the implementation of TRIPS and their harmonizing effect on IPR systems. Is it possible that stronger IPR attracted investment only when very significant differences existed across countries? Will ongoing harmonization reduce the importance of IPR systems in allocating investments? This paper's general purpose is to provide a midstream update on empirical studies of the effects of IPR 'strength' on FDI and imports for developing countries. The results are indeed consistent

[2] Annex 1C of the Marrakesh Agreement, 15 April 1994.

with past studies in that there is a positive relationship between IPR and FDI and imports for a range of developing countries. This suggests that developing countries that have yet to comply with their TRIPS commitments have an economic justification as well as a political responsibility to implement the accords.

In order to conduct the analysis, it is necessary to have a measure of the 'strength' of national IPR systems. Typically, a scoring system has been used, but existing systems reflect the pre-TRIPS era. A new IPR score reflecting post-TRIPS changes is developed first, then used to examine effects on FDI and imports for developing countries.

2. Constructing an IPR "Score" for the Post-TRIPS Era

2.1 Current IPR Scoring Systems

Approaches to developing a scoring system typically use one of two methods. These are based either on the text of national intellectual property legislation or on a survey of practitioners' opinions. Ginarte and Park (1997) and Rapp and Rozek (1990) use the legislation-based approach. The former use a score based on the sum of five national components:

- extent of coverage (pharmaceuticals, food, etc)
- membership in international agreements
- loss of protection (compulsory license provisions, etc.)
- enforcement mechanisms (provisions for injunctions, pleadings, etc.), and
- duration of protection (standard = 20 years).

A sensitivity test was performed on the effects of a range of weights in the ranking of countries under the system. As the results are quite insensitive to the weights tested, an unweighted sum is used.

Rapp and Rozek (1990, footnote 11) based their five point ranking system on the minimum standards set by the Chamber of Commerce of the USA. Accordingly, most attention is given to laws "in force against infringement but not on their enforcement or implementation." Ginarte and Park (1997, p. 289) justify the lack of consideration of enforcement by noting that "the main concern about [developing countries] is the absence of laws [on infringement]". That may have been valid at the time the index was developed, but it seems to apply less today in the aftermath of the TRIPS minimum standards. Given the related base of the two indexes, it is surprising they are not very closely correlated (r =.235). Moreover, the Ginarte and Park index is closely related with the national GDP (r =.747) while Rapp and Rozek's is not (r =.124). This variability emphasizes the difficulty of using IPR scores.

A second set of indexes is based on the judgment of practitioners. Mansfield (1995) surveyed 180 executives and patent attorneys in the USA, Japan, and Germany. The study focused on the chemical/drugs, machinery, and electrical equipment industries that were believed to be particularly sensitive to intellectual property (IP) protection. In regards to 14 more technologically advanced developing countries, respondents were asked to indicate when IP protection was 'too weak' to permit transfer of sensitive technologies by means of (a) investing in joint ventures, (b) wholly owned subsidiaries, and (c) licensing key technologies. In general, protection levels were considered more adequate for machinery than chemicals/drugs.

Sherwood (1997) also utilized a judgment-based ranking, relying on his own assessment of the conditions in 18 developing countries, most in Latin America. Each country was ranked on a 103-point scale for nine components including enforceability (25 points), administration (10 points), and patents (17 points). The scales were thoroughly researched with interviews in each country. A verbal justification is given for deducting points in each component, but the overall allocation of points to each component is

not discussed. Thus, despite the care which went into its construction the system contains a major arbitrary component. The relationship between the Mansfield (1995) and Sherwood (1997) scales is fairly strong (r = .663), but it is weaker between Sherwood's and the two legislation-based systems (r = .144 and .060). Using a similar procedure, Sherwood (1997) scaled the TRIPS requirements. They received a score of 55, identical with the value given to South Korea, the highest granted of the 18 countries. In contrast, the IPR aspects of the North American Free Trade Agreement (NAFTA) are ranked at a 68.

Overall, the judgment-based ranking systems are more compelling as they include some consideration for enforcement, but they are now dated, have a significant arbitrary component, and lack the means for periodic systematic updates. We therefore turn now to a system designed to overcome these limitations, which begins with a practitioner survey for establishing system components.

2.2 Components of an IPR Score

The scores described above generally have the following components in common:

- protectable subject matter
- convention membership
- enforcement
- administration
- duration of protection.

The score developed here incorporates related components that are adjusted for recent changes. For example, TRIPS harmonizes the duration of patent protection at 20 years from first application (Article 33), so an indication whether a country is TRIPS compliant captures the duration factor as well as serving as a proxy for protectable subject matter. However, because countries have the option of protecting plants with patents, an "effective *sui generis* system", or both (Article 27.3[b]), it is important to identify their choice. Most developing countries are opting for Plant Breeders' Rights rather than patents for plants; membership in UPOV, the international convention, is a clear indicator.

Additional and more current information was needed on TRIPS-era protection issues, and so a practitioner survey was developed. The survey does not directly rank the adequacy of protection in countries since its primary intention is to attempt to measure how firms involved in the transfer of critical technologies viewed the aspects of protection offered. The survey was sent to patent attorneys and licensing executives of biotechnology firms in the USA and Europe after an extensive period of instrument development and in-person interviews. Public sector licensing officers were also contacted. In total, 17 surveys and interviews were distributed with a response rate of 59 percent. Biotechnology firms (pharmaceutical and agricultural) are an appropriate response group because the importance they attach to IPR protection indicates a high level of awareness of technology transfer issues.

Not surprisingly, the survey results reveal that a product's market potential is the principal issue for private firms when identifying developing country markets. Public sector entities have different objectives, including serving the public and product availability, but typically they do not market products directly in developing countries or elsewhere. That is the task of licensees. Within the IPR sphere, the ability to protect certain products and, particularly, the enforcement of those rights (adequacy and speed of the court systems), are ranked second. Third in significance is the cost of protection, for which the PCT is seen as a source of efficiency and cost savings.

Respondents were keenly aware of the limitations of IPR. That is, while the extent of IP protection is very significant in selecting markets, firms know very well that products or technologies can be acquired in other ways than by direct sales. Hence, for larger markets, a firm may take a chance on direct sales rather than lose initial sales to pirates in countries where IP protection is considered inadequate. Pharmaceutical companies seem particularly willing to sell products in countries where patent protection is

judged inadequate or even where patents are not sought. That is, effective available patent protection is a desirable but not a necessary condition for pharmaceutical product sales. Agricultural firms, for their part, typically do not make the most current self-reproducible (i.e., non-F-1 hybrids) varieties available in the absence of plant breeders' rights (PBR) protection. This finding is supported by earlier studies which indicated access to current varieties was a major motivation for developing countries to adopt PBR and join UPOV (see Jaffé and van Wijk 1995; Lesser 2000).

Perhaps of greater significance to technology access is the issue of market size. All respondents indicated that some markets are not served simply because the risk-adjusted revenue potential is too small, presumably meaning that the costs of serving a market exceed the profit potential. Many of those costs are non-IP related, such as the access and cost factors encountered by many of the respondents for the Russian Federation. Yet the matter is partially IP-associated, since effective IPR can limit market costs by reducing some risks and standardizing other practices. For that reason, Maskus and Penunbarti (1995) conclude that small market countries require relatively stronger IP protection for the same level of access.

Perhaps most significantly, the survey results emphasized how important a factor the enforceability of IP statutes is in a country. Jaffé and van Wilk (1995) found *ex post* that PBR in Argentina was not effective and did not garner the expected investment in plant breeding until rights were enforceable. The slowness of a national court system, poor standing of a foreign plaintiff, lack of technical competence, or the inability to enforce a judgment once made were all reasons to downgrade the effectiveness of a national system.

Repeating the initial list, the duration of protection can be dropped as a component while cost of protection can be added:

- protectable subject matter
- convention membership
- enforcement
- administration
- cost of protection.

We will now explore ways to quantify each of these components using public sources.

Protectable Subject Matter

As noted, TRIPS mandates a minimum scope of subject matter for patent protection. Accordingly, satisfaction of the TRIPS requirements is an indication of the allowable subject matter. Countries must certify their compliance with WTO in the IP/N/1/[3 letter country code]/P publication series (www.wto.org). Those which have certified compliance are noted with a 1; a 0 is used otherwise.

The only subject area where compliance is not fully indicative is for plants, where countries under Article 27.3(b) have the option of using patents and/or PBRs. Membership in UPOV (see www.upov.org; a 1; non-members are 0) is taken as an indication of the selection of the PBR option. Using UPOV as an indicator does miss those countries that operate under a national law. At this stage, however, it is unclear whether a national system would be TRIPS compatible or indeed if national systems are often operationalized. Kenya, for example, had PBR legislation for years but never enacted it before the country began the process of joining UPOV in 1999 (see Juma and Ojwang 1989).

Convention Membership

In addition to membership in UPOV, signatories to the PCT are also noted (1 = member; 0 = not member). Participation in the PCT serves several functions for technology owners. Membership reduces direct and indirect costs (personnel) of application. The International Search also reduces the ambiguity

of a national search in technical areas where national examiners may not have full access to current documents (see Sherwood 1997, p. 273). Membership in the Paris Convention is no longer a meaningful distinction, as most countries are now members and compliance with 1967 Convention Articles 1-12 and 19 is mandated by TRIPS (Article 2).

Cost of Protection

While an important issue for firms, no data set of costs by developing countries presently exists, and only a few countries make even posted fees readily available through a web site or other system. Thus it is not possible to include a measure of costliness in the scoring system developed here.

Administration

Patent office administration incorporates a range of critical factors from efficiency and transparency to funding adequacy and the training of examiners. Perhaps the most significant of these is the technical competence of examiners. Such competency should be observable *directly* by examining the educational background and experience of employees, and *indirectly* by the number of granted patents that are subsequently overturned by the courts. For the former, few patent offices provide information on the backgrounds of their employees. And as regards court challenges, as one survey respondent noted, cases brought reflect not a random sample of issued patents but rather those cases which are both ambiguous and potentially involving significant sums. As a result, differences across countries can reflect a number of factors in addition to the actions of a patent office. There are also the issues of assessing the transparency of a national court system and the absence of a data base of cases and their resolutions. The approach, therefore, of quantifying the actions of a national court system is not viable. Ginarte and Park (1997, p. 290) identified related reasons for abandoning an attempt to use a measure of complaints against a patent system.

As an expedient, the decision was made to distinguish between those patent offices that maintained a detailed web page and those that do not[3] (1 = web page exists; 0 = does not exist). The presence of the web page is then taken to reflect an office which is better supported and more interconnected. It must be acknowledged, however, that this is an aspect of the scoring system that needs further development.

Enforcement

Enforcement has special relevance due to the emphasis placed on it by the survey respondents. But again, there is no generally available ranking of national legal systems, assessments of the competence of justices, and other criteria. The choice was made to use the Transparency International "Corruption Perceptions Index" (CPI) for 1998[4]. The annual Index presently ranks 99 countries on a 0 (highly corrupt) to 10 (highly clean) scale. Each country's score is an average of three to 14 individual surveys of the *perception*s of corruption "as seen by business people, risk analysts and the general public". All such indexes are limited in that they reflect only perceptions, but as Kaufman, Kraay and Zoido-Lobaton (1999a, p.2) note, the subject is "inherently subjective" and "perceptions of the quality of governance may often be as important as objective differences in institutions across countries."

There are other limitations, however, for as Kaufman, Kraay and Zoido-Lobaton (1999b) emphasize, there is substantial unexplained error in any estimates, to the point that an individual country's CPI rankings are not statistically differentiable. Furthermore, there is a difference between the competency and integrity of the IP court system, which is what is at stake for our analysis, and what is actually

[3] National patent office web pages are accessible through the 'links' menu selection on the WIPO web page, *www.wipo.org*

[4] Available at *www.gwdg.de/~uwvw/1999Data*

measured, namely, the aggregate perceptions of corruption in private-private and private-public interactions. This distinction can be seen in reference to the USA, which has a 1998 CPI value of 7.5 and is 18th on the list. Whatever the integrity of other kinds of interactions may be, the USA is widely regarded as having a highly effective IP court system, particularly after 1982 when patent cases were consolidated in a new Court of Appeals for the Federal Circuit (see Grubb 1999, Chapter 2). Nonetheless, the CPI does represent a systematic effort to quantify aspects of the application of law in a diverse group of countries.

2.3 Constructing an IPR Score

Of the 99 countries included in the 1998 CPI, 44 are developing countries, which constitute the sample used here. The sample is not a random one, but does represent a diverse geographical and economic range.

A key step is identifying a proper weighting scheme for aggregating the values into a single index figure. As noted (Section 2.1), prior studies generally rely on unweighted or arbitrarily weighted sums. For purposes here, a more systematic approach is sought, in particular the use of *factor analysis*. In this case, a three-factor model with a verimax rotation[5] provided results which could be described in terms of the expected underlying relationships as follows:

Factor 1 (33.0%): Scope, weighing most heavily on UPOV and TRIPS compliance

Factor 2 (24.0%): Efficiency, weighing on PCT which has an application efficiency component

Factor 3 (18.5%): Transparency, weighing on the CPI

The factor weights, which explain a total of 77.5 percent of the variance of the variables, are shown in Table 1.

The aggregate factor values are used to weigh the individual index components in generating the IP score. The weights have an intuitive appeal insofar as the greatest weight is placed on the CPI, a proxy for the enforceability of IPR, which the survey respondents indicated as the most significant aspect of the effectiveness of patents at the national level (Section 2.2). The score has a possible 12 point scale (technically, 12.36) but in practice the maximum and minimum are 7.2 and 1.6 (Table 2).

The purpose of this section is to utilize the IPR score developed above to measure the effect of the strength of IPR in the recipient country on foreign direct investment (FDI) flows and on imports. Prior to proceeding with the empirical analysis, the literature on prior IPR score studies and determinates of FDI is reviewed.

Table 1: Factor Weightings of the Index Components

	Scope	Efficiency	Transparency	Communality
CPI 98	-.028	-.025	.971	.944
UPOV	.860	-.185	-.089	.782
TRIPS	.790	.423	-.064	.808
PO Eff.	.534	.354	.254	.474
PCT	.066	.922	-.033	.856
%	33.0	24.0	18.5	77.5

[5] Factors were computed using Minitab Version 12.1 for Windows.

Table 2: Computed Intellectual Property Score, selected countries (1998)

Country	IP Score	Country	IP Score
Argentina	4.8960	Malaysia	5.4772
Bolivia	3.4252	Mauritius	4.7200
Botswana	5.7584	Mexico	6.0352
Brazil	6.6960	Morocco	4.3488
Cameroon	2.1776	Namibia	5.0032
Chile	7.2012	Nicaragua	2.8320
China	5.4160	Nigeria	1.7936
Colombia	2.8588	Pakistan	2.5488
Costa Rica	6.1424	Paraguay	2.1980
Ecuador	3.7612	Peru	4.7220
Egypt	2.7376	Philippines	3.5892
El Salvador	3.3984	S. Africa	7.3548
Ghana	3.9712	S. Korea	6.1028
Guatemala	2.9264	Senegal	3.9712
Honduras	1.6048	Tanzania	1.7936
India	3.5936	Thailand	3.3060
Indonesia	4.2148	Tunisia	4.7200
Ivory Coast	3.7824	Uruguay	4.8412
Jamaica	3.5872	Venezuela	2.1712
Jordan	4.4368	Vietnam	2.3600
Kenya	4.8060	Zambia	3.3040
Malawi	4.7264	Zimbabwe	4.8208

Source: Computed by Author, see text.

3. Relationship between Intellectual Property Rights and Foreign Direct Investment and Trade

3.1 Literature Review

The literature on the determinants of FDI, of which investment location theory is a component, is voluminous, and no attempt is made here to go beyond the basis theories and findings of relevance to IPR.

General studies of determinates of FDI

McCorriston and Sheldon (1998) review the theory of determinates of FDI in an effort to explain the 'wavelike' level of inward US FDI. The classical theory explains FDI as a mechanism to accrue firm-specific assets such as brand image or research intensity. An empirical study would then include a number of industry-specific factors in a cross section analysis, but that approach cannot explain the observed wave pattern to FDI.

Alternative explanations can be characterized as 'relative wealth' and 'relative cost' theories, both associated with the exchange rate. The relative cost theory is concerned with the effective cost in the currency of the investing country since depreciation of the currency of the recipient country tends to reduce costs for the investor. However, the effect of the exchange rate is more ambiguous, for it depends on where the inputs are acquired and the finished goods sold. Assembly operations that import inputs

and export finished goods, for example, are relatively unaffected by exchange rate fluctuations. The relative wealth theory counters that ambiguity by evoking the imperfections of capital markets, which reduce the ability to evaluate the assets of a foreign operator. Currency depreciation increases the value of the would-be acquisition target in the eyes of an overseas investor, reducing the credit constraint to FDI. Studies have generally shown that FDI is inversely related with the real value of the dollar, which is consistent with the relative wealth theory.

In their analysis, McCorriston and Sheldon (1998, Table 2) attempt to explain cross-border acquisitions in manufacturing in the USA using both the real US dollar exchange rate and the relative stock price in a time series analysis. Both variables have the expected signs and are statistically significant, again providing consistency with the market imperfection hypothesis.

Gopinath, Pick and Vasavada (1998) extend the preceding analysis in two ways by considering (a) volatility in the real exchange rates as a measure of riskiness, and (b) effects on exports and foreign affiliate sales as well as outward FDI. In a pooled time series-cross section study of 10 high income countries, the independent variables were normalized by GNP to account for income effects and possibly differences in factor costs. An appreciation of the dollar increases outward FDI and resultant affiliate sales while reducing exports. Exports and FDI are then substitutes, but only partially, because FDI is more responsive to appreciation of the dollar than are exports. As expected, higher volatility of real exchange rates depress both outward FDI and affiliate sales. Despite those results, Erb, Harvey and Viskanta (1996) argue that exchange rate volatility is an *ex post* measure of risk, and that country risk ratings are better *ex ante* measures.

Wheeler and Mody (1992) extend the analysis by considering location theory, particularly the opposing forces on firms making choices about recipient countries. According to the traditional, or 'gravity' model of trade, firm choices are based on comparative advantage 'classical' variables of market size, openness of the economy, transportation, and relative costs. These variables come from the so-called ergodic location theories, long term patterns which can be affected, but only temporarily, by subsidies. In counter-distinction, the non-ergodic theory draws heavily on agglomeration economies. Disrupting this notion of 'winning' a location tournament is the desire for firms to reduce risk through geographic diversification.

Wheeler and Mody (1992) attempt to distinguish between these opposing theories by constructing an outward-FDI flow model for firms in the USA for the 1980s. Distinguishing among the competing theories is accomplished by three sets of data, (a) classical variables like costs, market size and taxation, (b) agglomeration benefits such as infrastructure and degree of industrialization, and (c) measures of riskiness. In general, risk was of little significance, while both the classical variables and agglomeration factors helped explain the location of investments. The *magnitude* (or, more properly, the elasticities) of the effects are heavily influenced by the degree of industrialization. When production is for the domestic market, openness of the economy actually *reduced* investment, which is attracted by high trade barriers.

FDI and IPR

Rapp and Rozek (1990) studied the *relationship* between the strength of IPR systems and 'modernization variables' including GDP, access to electricity, and health factors. The relationship was found to be a statistically strong positive one, but there is no indication of causality. As if to emphasize the *causality* issue, Ginarte and Park's 1997 work focused on identifying determinates of a country's level of patent protection. Using their own IPR score (Section 2.1), the authors find that a strong correlation between the 'strength' of IPR and GDP per capita lagged five years. However, once variables representing the determinants of economic development (R&D expenditures, market freedom, openness) are added, the explanatory power of GDP vanishes, suggesting it serves as a proxy. R&D is a better explanation of the strength of IPR for the richer nations, which, the authors conclude, have more to protect.

Seyoum (1996) examined the relationship of FDI and IPR from the perspective of government control. Can governments affect inward FDI more effectively through macroeconomic policy, or strength of IPR? Results are separated for the least developed, emerging, and developed economies in the sample. For the less developed, policy factors explain 21 percent of the variation in FDI flows, IPR factors, 13 percent. The relative importance is reversed for the emerging economies where economic policy variables account for only 28 percent of variation while IPR aspects capture 43 percent of the FDI flow variation. Among this second group, "enforcement is the most important concern".

In two high-profile studies, Mansfield (1994, 1995) examined FDI outward flows for USA, German, and Japanese firms. In addition to the IPR score, the independent variables include market size (GNP), stock of FDI, degree of industrialization, and 'openness'. The first three variables are significant with the results indicating that a 10 percent increase in the IPR score will, other factors held constant, increase annual FDI inflows to a country by about $ 200 million.

Braga (1995) reviews a number of other empirical studies and conducts his own. He notes that the effect of stronger IPR on trade flows is ambiguous. If the market-power (leading to higher prices) effect dominates the market-expansion (or availability) effect, trade will diminish, and vice versa, so the matter is an empirical one. Ferrantino (1993) found the latter dominates the former—stronger IPR are trade promoting. In his own analysis of the total foreign assets of firms in the USA, which uses the Rapp and Rozek (1990) IPR score (see Section 2.1), Braga (1995) includes as independent variables GDP, growth rates, and a measure of trade barriers. Results show that a higher IPR score has a positive impact on aggregate investment of the USA abroad, but the sectoral models are less robust. He cautions that a formal model of the equilibrium distribution of FDI is needed for more precise inferences, but at a minimum predicts the TRIPS standards will serve as a "threshold indicator".

In summary, empirical studies generally support an expectation that stronger IPR protection does indeed enhance both FDI and imports. The relative wealth theory is better supported empirically than the relative cost model, but in fact both require the inclusion of an exchange rate variable in the analysis. Results across time and models do however vary according to:

- production for export or domestic consumption: openness of the economy favors the former over the latter,
- degree of industrialization: more industrialized nations show a more pronounced response to the strength of IPR,
- sector: more technologically advanced sectors (like electronics) are more IPR dependent than less technical ones (like food processing),
- exchange rate: due either to the cost or wealth effect, and
- stock of existing FDI: possibly as a result of the agglomeration effect, countries with significant prior FDI tend to attract more.

These factors are incorporated in the current analysis.

Unresolved in the preceding review is the underlying issue of just what an IPR index reflects in empirical analysis. The intent, of course, is to reflect the separate effect of the strength of IPR laws acting through incentives to innovate and through efficiency gains from reduced monitoring costs required for a well operating system. However, because effective IPR systems require well operating institutions, and because both the needs for stronger IPR and effective institutions typically rise with the level of development, the direction of causality is not always clear. That is, does stronger IPR measure IPR or does it proxy for a number of factors (like effective institutions) that are conducive to investments?

It is unlikely that this issue can be finally resolved, but more detailed studies than the aggregate type attempted here have lent credence to the separable role of stronger IPR (see review in Maskus 2000, Chapter 4). For example, high technology products, which are considered to be more IPR sensitive, are most affected by the strength of the system. Conversely, there is no reason to expect one sector would respond more than another to general institutional efficiency. Studies which divide the sample by national technical sophistication show a differing response to IPR system strength independent of GNP levels and other measures of institutional efficiency. For this study, the objective is only to measure the effects of IPR system strength in the post-TRIPS era; it is conditional on the prior body of knowledge which documents that the causal factor is IPR system strength, not general institutional attributes.

3.2 Selection of Variables for Analysis and Data Sources

Based on the preceding, independent variables can be grouped into three categories:

1. classical 'gravity'-type variables describing business justifications for selecting one country over another, such as market size, costs, openness, and taxation;
2. agglomeration benefits like infrastructure, FDI stock, and degree of industrialization; and
3. riskiness, such as the rule of law and exchange rate variability.

The dependent variables are FDI and imports for the full sample of countries. Additional dependent variables such as high tech exports and royalties earned or paid are also used, but for only the part of the data set for which data are available.

Model forms are quite variable, including trans-log, semi-log and linear, with no clear theoretical justification for one form over another. This will be left as an empirical, goodness-of-fit matter in the current analysis. Most studies do use a cross-section, time series (CSTS) approach which helps accommodate for unexplained inter-year variability. For the current application, the TRIPS provisions have been in place in a range of countries for a very short time period, meaning TS analysis is not feasible and leaving only simple cross section data. Specific variables and data sources are identified in the Tables provided in the Appendix below.

3.3 Results and Discussion

For this analysis, a linear model using a non-normalized dependent variable fits best in terms of expected signs and the multiple correlation coefficient[6]. Initially, all variables indicated by the literature review were included; subsequently, those being highly insignificant were excluded. Selection among alternative formulations of a variable, such as measures of 'openness' (Appendix), were done the same way. In the final analysis, variables were retained if there was a strong theoretical or empirical justification for their inclusion, even if the statistical significance was low. The preferred model results for both the FDI and export models are shown in Table 3. The FDI model is fit using the full 44-country data set, while the imports model due to data limitations used only 38 countries[7].

Several alternatives to these models were attempted and discarded. Both risk measure (credit index and variability of exchange rates) were highly insignificant, as were both measures of openness. GNP is strongly correlated with both FDI and exports, and so is not usable as an explanatory variable. It is included as a numeraire for lagged FDI. Two key gravity-model variables, manufacturing wages and road infrastructure, also were insignificant.

[6] Estimates were made using Minitab Version 12.1 for Windows.

[7] The six excluded countries are: Zimbabwe, Malawi, Zambia, Senegal, Vietnam and Cameroon.

Table 3: Statistical Results

Model	*FDI 1998*			*Imports 1998*		
Intercept	-15968	(-1.78)	**	-36129	(-.97)	
IPR score	1562.7	(1.88)	**	8886	(2.56)	*
Mfg. Tariff	228.1	(1.26)		400.2	(.55)	
FDI 1997/GNP 1997	39.33	(.88)		**********		
Degree Indus.	262.8	(1.95)	**	1295.2	(2.40)	*
Real Exchange Rate	3.35	(.07)		-53.6	(-.27)	
Real Internal prices	**********			-426.2	(-1.33)	
N	44			38		
R-sq (adj)	12.3%			24.0%		

* significant at the 5% level
** significant at the 10% level
NOTE: t-statistics in parentheses
Data sources in Table listed in Appendix.

Overall, the two models fit moderately well, at least considering the purely cross section nature of the analysis. In most cases, the variables have the expected signs. Imports, for example, are reduced when prices (external and internal) are higher, but the significance of the effect is minimal. That could be due to the dual use of imports for domestic consumption and as inputs into re-exports, which effects tend to counter themselves. FDI is enhanced by higher tariffs, in line with the benefit of domestic production to avoid the high tariffs and/or as protection from import competition. Again though, the statistical significance is not very strong, perhaps indicating a decline in the role of tariffs under the new WTO agreement. The significance of the industrialization variable indicates that the more industrialized countries are more international – whether this is due causally to agglomeration factors or is simply a control variable cannot be determined from these results.

Most pertinent here, the IPR index is positive and significant in both equations. That is, stronger IPR increases both FDI and imports. In the latter case, the availability effect of IPR overcomes the price factor in increasing consumption. On average, the results indicate that a one point increase in the IPR score (about 10 percent) will increase a countries FDI by $1.5 billion (50 percent of the mean amount) and imports by $ 8.9 billion (40 percent of the median amount). The FDI effect is substantially greater than the $200 million found by Mansfield (1995; see above), but he considered only sources from the USA and an earlier period when FDI was lower. Overall, the results do indicate that strengthening IPR is an effective policy tool for countries seeking to internationalize the economy or, conversely, increased internationalization is a benefit of TRIPS-compliance.

The analysis was rerun using high tech exports and license fees paid as dependent variables. Due to data limitations, these analyses were limited to 34 and 35 countries respectively. The results (not shown here) are generally consistent with those in Table 3. That is, the IPR score is positive if not strongly significant. Indeed, the only significant variable is the degree of industrialization in the high tech export model, a not surprising result.

4. Conclusions

This study attempts to add two components to the extensive existing literature on the effects of stronger IPRs on FDI and imports for developing countries:

- A new way of 'scoring' the strength of national IPR systems that incorporates aspects of the TRIPS mandates. One attribute is the use of secondary data, which means that scores are readily updateable and hence may also be used to compare a country's progression over time.
- An update of empirical studies for the post-TRIPS environment in which systems are more harmonized. Because of the reliance on empirical analysis to understand investment location decisions, it is also largely an empirical question how differences in IPR system strength are affected when the range of trans-country differences narrows under the harmonizing effects of TRIPS.

Significantly, the formulation of the new scoring system highlights the importance of national legal systems, something which is largely outside the TRIPS requirements[8]. A major challenge in subsequent WTO rounds for those who support ongoing harmonization of IPR systems will be how to stipulate the legal system reforms required. An even greater challenge will fall to countries which must implement any such requirements.

The issue remains of what an IPR score represents in investment and trade models. Is it the IPR system *per se*, or does it serve as a proxy for institutional improvements and structural change which have historically evolved concurrently with IPR systems? Past studies generally support the former role. Once the TRIPS requirements are fully implemented[9], additional observations will exist for countries at lower levels of economic development with relatively strong IPR systems and this will permit the causality issue to be answered more definitively. The present study is consistent with the significance of the role of stronger IPRs *per se*, but improved evidence should be available in the near future.

In the short term though, developing country policy makers remain in a somewhat ambiguous position as far as the interpretation of the economic results. But the practical—as opposed to the conceptual—distinction was recognized almost 30 years ago: "it may be that cooperation in the [patent] system on the part of less developed countries will help them to obtain the cooperation of [multinational] firms" (Penrose 1973, p. 785). Countries wishing to attract that group of investors are advised to strengthen their IPR systems accordingly.

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[8] TRIPS (Article 41) requires "effective action" with "fair and equitable" procedures, plus "review by a judicial authority".

[9] That is, following 2005 when (barring any extensions) the least developed countries must have complied with TRIPS.

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Appendix: Tables with the Variable Identifications and Sources

Dependent Variables:

FDI inflows (UNCTAD, World Investment Report, 1999, Annex table B.1)

Total Imports (UNCTAD, World Investment Report, 1999, Annex table 4.6)

High-Technology Exports (WB, World Development Index, 2000, Table 5.12)

Royalty and License Fees (WB, World Development Index, 2000, Table 5.12)

Independent Variables:

IPR Score – computed, see Section 2.3.

FDI inward stock (UNCTAD, World Investment Report, 1999, Annex table B.3)

Risk: Country Credit Ranking (iiC.C.R.)[10] OR standard deviation of exchange rate (WB, World Development Index, various years, Table 5.6)

GNP (WB, World Development Index, 2000, Table 1.1)

Openness: notifications under Article 5.1 of TRIMs[11] OR exports/GNP

Exchange rate, 1999 (WB, World Development Index, 2000, Table 5.6)

Exchange rate, prior years (FAO Trade Yearbook, 1998, pp. xxx-xxxi)

Degree of industrialization/industry value added (WB, World Development Index, 2000, Table 6.6)

Real exchange rate: computed by dividing the exchange rate by measures of external purchasing parity index (WB, World Development Index, 2000, Tables 4.12 and 5.6)

Manufacturing wages (WB, World Development Index, 2000, Table 2.6)

Road quality index (100 = expected for country at development level) (WB, World Development Index, 2000, Table 5.9)

Manufacturing tariff (WB, World Development Index, 2000, Table 6.6)

Internal purchasing parity index (CIA)[12]

[10] Available online at *www.iimagazine.com*
[11] Available online at *www.wto.org*
[12] Available online at *www.cia.gov*

Technology Transfer for Humanitarian Use: Economic Issues and Market Segmentation Approaches[13]

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1. Introduction

Innovation is essential to economic growth. The efficient use of appropriate technology can drive economic development, thereby generating additional resources, ideas, and needs that fuel more innovation and technology creation. Such positive feedback loops generally characterize technological advancement, and these self-reinforcing cycles of innovation have created over time the extreme technological and economic inequalities that persist across the globe (Sachs 2000, UNDP 2001). The world's poor could benefit from access to technology, but incentives to develop and transfer technology are driven by expected profitability (Griliches 1957), which results in 'orphan' technologies and excludes the markets of developing countries (Kremer 2000a, 2000b; Sachs, Kremer and Hamoudi 2002).

Globalization, market integration, and harmonization of standards in recent decades have advanced the vision and virtues of an economically 'level' playing field, but in a world of persistent and severe economic inequality, big and small often compete together, making the notion of a 'level' playing field suspect. These tensions are especially evident in regards to technology, where 'harmonized' intellectual property standards seem to magnify technological disparities. What is to be done? Those loudly crying 'foul' deride the World Trade Organization (WTO)/ Trade-Related Aspects of Intellectual Property Rights (TRIPS) and demand that the harmonization process be reversed. In response, economic liberals relentlessly invoke models of comparative advantage to elucidate the virtues of free trade and harmonized standards. These are not the only options, however, and this paper outlines a more pragmatic approach, one that devises novel contractual strategies for segmenting markets and effectively creates a multi-tiered and fairer playing field.

2. Humanitarian Use Technology Transfer (HUTT)

The transfer of agricultural technology to developing countries is becoming more problematic for several reasons:

[13] Lybbert, TJ. 2002. Technology Transfer for Humanitarian Use: Economic Issues and Market Segmentation Approaches. *IP Strategy Today* No. 5-2002. Pp. 17-25.

a. research inputs and outputs are increasingly protected as intellectual property by both the private and public sectors;
b. the forces of globalization require institutions to consider the global market implications of their technology transfer strategies; and
c. trade liberalization and increased information flows make it difficult to treat markets independently.

Despite these trends and forces, however, there remains much promise for agricultural technology to improve the lives of the poor in developing countries (Conway 1997, Nuffield Council on Bioethics 1999; The Royal Society et al 2000, Serageldin and Persley 2000, Spillane 2000). But to realize this potential we must develop creative, novel technology transfer mechanisms that reconcile poor farmers' access to new technologies with proprietors' ability to maintain control over their technology and reap a return on their investment in more profitable markets.

Technology suppliers typically rely on contracts (e.g., licenses, material transfer agreements) to regulate the transfer and use of their technology. These suppliers, both private and public, typically segment their recipients into different 'use' categories (e.g., research only, commercial use, etc.). These use categories generally have clear and established definitions that are widely accepted and therefore easily interpreted. Humanitarian Use (HU), a phrase now common in press releases issued by agricultural multinational corporations announcing their intention to share proprietary technology with poor farmers, is presumably meant to ensure that the poor who are unable or unwilling to pay full price for a technology will benefit from it. Yet HU is typically defined very arbitrarily, if at all. Ambiguity about the meaning of HU makes organizations understandably hesitant to pursue HU licensing—even if they otherwise are interested in donating their technology. The successful HU segmentation of international markets is acutely needed, as is clearly illustrated in the pharmaceutical sector by recent demands for access to affordable AIDS drugs by South Africa and Brazil. Access to agricultural technologies generates similarly heated debate.

The most celebrated recent example of an HU clause used to segment access to an agricultural technology involves Golden Rice. Owners of key proprietary components of Golden Rice publicly committed to 'donating' their technology to the poor in August 2000, yet negotiations are ongoing over how exactly to define and operationalize such 'donations'. These negotiations focus on defining the HU market and, ultimately, on the precise wording of the HU clause. Importantly, this HU clause will determine ultimately who qualifies as a beneficiary of royalty-free access to Golden Rice and exactly how they benefit. Other cases in which an HU clause is intended to segment agricultural technology transfer include ringspot virus resistant papaya transferred from Cornell University to Thailand, as well as several projects brokered by the International Service for the Acquisition of Agri-biotech Applications (ISAAA). The latter include local varieties of potato transferred from Monsanto to Mexico as well as papaya ringspot virus resistance and delayed ripening papayas to Southeast Asia from Monsanto and Syngenta, respectively. Several similar HU negotiations are ongoing and more are likely in the near future. Finally, Byerlee and Fischer (2001) briefly discuss market segmentation and preferential licensing terms as a potentially promising means of making new agricultural technologies available to developing countries. They present a variety of other examples of different types of Humanitarian Use Technology Transfer.

3. HUTT Issues & Complexities

In negotiating an HU license, the stakes are often high for the technology supplier. It must reap a return on earlier R&D investments and is directly accountable to its shareholders or trustees for its performance. The interests of the technology supplier typically extend beyond short-run returns, however, and often include maintaining control of the technology and managing exposure to liability and public relations risks (Krattiger 2002). Of course, the stakes are also high on the recipients' end, since access

to the technology might mean better food security, better nutrition, and less poverty. Balancing these pressing needs and interests is no easy task, especially given real world complexities.

The intent of an HU license for the transfer of agricultural technologies is generally clear: to provide poor farmers free (or at least subsidized) access to beneficial technologies. Real world complexities, however, can make translating this clear intent into a workable and acceptable HU agreement very challenging. There are several complexities worth noting:

- Many technologies involve multiple stakeholders. Uncertainty about how to define HU and about the implications of various definitions is compounded because many technologies are creative configurations of existing (input) technologies, each with a potentially respective 'owner.' Reaching consensus among multiple stakeholders about how best to define HU can be problematic, especially when the calculation and payment of royalties to input technology suppliers hinges on this definition.

- Perfect HUTT would require information about farmers that is not generally available. For practical purposes, implementing HUTT typically requires the use of imperfect indicators (e.g., land holdings, agricultural earnings) to proxy for the targeted attribute (e.g., 'small-scale subsistence farmers'). The choice among proxies is generally very limited because there is little useful and reliable information about farmers in developing countries. Using an imperfect proxy to discretely impose an HU threshold on a continuum of farmers raises concerns about those who are excluded from the target by a narrow margin, as well as their incentives to deceive their way into the target.

- Leakage of the technology to unintended beneficiaries is possible and even probable. Decades of attempts to transfer food aid to the poor in developing countries painfully illustrate how difficult it is to ensure that the needy, instead of the local elites or the military, actually benefit from the transfer (Srinivasan 1989). Carefully defining the target and establishing a targeting mechanism so as to minimize leakage is essential to successful HUTT.

- Technology is rarely 'scale-neutral' and is often more easily adopted by large-scale farmers. New technologies come with new and unforeseeable risks. A farmer's ability to assume risk therefore largely determines his/her attitude and ability to incorporate new technology. It is thus conceivable that 'small-scale' farmers included in an HU might value the transferred technology less than larger excluded farmers. The benefits associated with accessing the technology may therefore be greater to unintended beneficiaries than to intended ones, introducing the possibility for post-transfer exchanges and strong incentives to deceive, making leakage yet more probable.

- Leakage of HUTT can erode the supplier's return on investment. Anytime a targeting mechanism fails to exclude unintended beneficiaries, the cost of the donation to the supplier can increase dramatically. In terms of lost markets, the cost of such a failure depends on how many farmers included in the target would have purchased the technology from the market had they not been granted preferential access via HUTT. This 'displacement' effect of HUTT, which results from imperfect targeting mechanisms, is a keen concern of suppliers (see Barrett (2002) for a discussion of displacement effects associated with international food aid). In contrast to imperfect food aid transfers, where the burden of displaced international grain trade may be spread among a set of exporters, the burden of displaced technology sales is generally born by the supplier whenever the technology is proprietary. As a key negotiating party in any HUTT negotiation, the technology supplier has considerable say over the HU targeting mechanism and might reasonably opt out of any proposed mechanism that it sees as potentially displacing too much of its prospective market.

- Developing countries are often considered growing markets. Byerlee and Fischer (2001) identify this as a major practical hurdle, stating that many developing countries have a growing potential private market for technologies and to be effective in larger countries, market segmentation must be *within*, as well as across countries—a much more difficult legal and administrative challenge. Furthermore, the technology supplier may plan to develop these growing markets as part of a long-

term market strategy, implying that the supplier expects these currently unprofitable markets to become profitable in the future. Depending on the nature of the supplier's technology and market strategy, HU donations could be more or less generous as a result of this consideration. If the supplier is confident it can create a loyal customer base in the future with a generous donation today, its donation will be less restrictive. If, however, the supplier is concerned about diluting the future profitability of these growing markets, its donation will be more restrictive.

- Displacement effects have dynamic implications. The technology supplier often must approach markets with long term strategies. Displaced sales from HUTT today therefore affect the size and shape of the market in the future, and hence can diminish the supplier's expected long run profitability. Because displacement affects future profits, it also affects the investment incentives that drive future innovation. Domestic suppliers might also see sales displaced by imperfect HU targeting, potentially setting off a series of domestic economy multiplier effects. These domestic economy effects are likely to be important considerations for government officials who often represent poor farmers at the negotiating table. Dynamic implications are therefore of critical importance to all negotiating parties.
- HUTT involves other dynamic considerations. The value of using a particular agricultural technology may increase with the number of users. If such network effects exist, the technology supplier may benefit indirectly from a relatively broad definition of HU, provided this increases its network of users (Takeyama 1994). There are several quasi-network effects in agricultural technologies. For example, biosafety procedures make the regulatory process tedious and time consuming. As the number of farmers using a particular seed ('approved' or not) increases, the regulatory process might be pressured to streamline. The recent case of *Bt* cotton being grown before being officially approved in India is one example of such quasi-network effects. Monsanto, who holds a patent on the technology in many countries, may well feel upset that its technology is used without it capturing a return, but such rapid technology adoption also placed pressure on the approval process in India.

4. HUTT Approaches & Criteria

HU clauses, which will undoubtedly become increasingly important as legal protection and ownership of agricultural technologies expands (Lele, Lesser and Horstkotte-Wesseler 2000), are relatively recent technology transfer tools. The last decade has seen several multinational agricultural companies issue press releases with a commitment to make proprietary technologies available 'royalty-free' for 'small-scale, subsistence' farmers in developing countries. How these commitments will materialize is largely subject to negotiation. The Golden Rice HU license cited earlier currently states that rice farmers earning less than $10,000 annually from rice cultivation qualify for royalty-free HU. How this figure was generated and its practical utility are unclear. Indeed, it can be argued that the $10,000 threshold seems to epitomize the ad hoc and arbitrary nature of the present HU negotiations.

This section outlines several alternative definitions of HU, briefly discusses their respective strengths and weaknesses, and comments on other possible HU licensing terms.[14] The criteria adopted to assess the merits of these approaches are:

- feasibility,
- efficiency, and
- optimality.

[14] Byerlee and Fischer (2001) offer a similar, though less extensive, set of possible definitions of HU, which provide a useful complement to the discussion in this section. In their presentation, they discuss these in terms of criteria for segmentation.

As a caveat, this brief discussion is meant only to present possible HUTT approaches and does not constitute a rigorous attempt to develop standards upon which HU negotiations might be based. The latter is the subject of more extensive research currently underway.

The intent of HUTT in agriculture is to provide poor farmers access to beneficial technologies. Generally, poor farmers in this context are defined as 'small-scale' or 'subsistence' farmers, suggesting that the most direct definition of HU should involve farm size and degree of subsistence.

- Maximum Farm Size: Defining HU according to a maximum farm size seems fairly straightforward, even if it requires information on farm size that is often not available or reliable in developing country contexts. Applying a blind farm size metric to rural populations could be hazardous, however, since many who have steady non-agricultural incomes (e.g., local government officials, merchants, etc.) maintain small farming operations on the side.
- Minimum Degree of 'Subsistence': A measure of 'subsistence' is more promising in theory, yet demands more information about farmers. A subsistence HU definition might state that farmers who "sell, exchange, or transfer less than X% of their agricultural production" qualify for HU. The obvious limitation with this approach is that it requires information that is often not reliably available, namely total market transactions and non-market exchanges of agricultural surplus. The possibility of deception is apparent.
- Maximum Income: A somewhat less direct measure of 'subsistence' is farm income, which presumably arises from sales of agricultural surplus. As mentioned, this is presently the approach chosen by the Golden Rice Humanitarian Board. This metric also requires information that is not readily available and that can be 'cooked' if incentives to do so are strong enough. Moreover, farm income is an imperfect proxy for degree of subsistence since farm income may be a small share of total household income.

There are a variety of indirect HUTT approaches that would require less information, making them potentially more feasible to implement and administer. The cost of this feasibility improvement comes in the form of a potential loss of precision and directness.

- Geographic Target: Subsistence farmers frequently eke out a living on marginal lands, which are often geographically concentrated. Thus, in many developing countries, regions within the country are consistently poor relative to the rest of the country. To the extent that 'small-scale' and 'subsistence' farmers are roughly concentrated in a geographical region, the HU target could be defined as all farmers within this region. Such a geographical target has the advantage of being relatively easy to administer and enforce, but it has the disadvantages of leakage to unintended beneficiaries and of excluding unfortunate farmers who are poor but have rich neighbors.
- Country Target: Extending the previous approach, the HU target could also be defined as all farmers within a specified country. This broad definition would likely require an additional restriction on exporting the resulting agricultural produce in the case of seed varieties or re-exporting the technology in the case of input technologies. The possibility of this approach depends on the concentration of poor farmers in a specific country. Countries such as Angola, Bangladesh, Afghanistan, and Somalia might fit this bid. Advantages and disadvantages are as above.
- Existing Program Participation: Many developing countries with relatively strong civil societies have established public extension-like programs to benefit small farmers. The existence of such programs allows for HU to be contingent on participation in a given program. Since these programs usually have already defined who qualifies for participation, this approach is relatively straightforward and may benefit from the local experience and knowledge of the program administrators. Of course,

such a target is only as good as the existing program. Further, many poor farmers in many poor countries simply do not have access to such a program.

A final set of approaches involves 'self-selection' mechanisms. These mechanisms have been discussed at length in the context of food aid transfers (see Barrett 2001 for a review). The idea is simply to devise a targeting mechanism that allows farmers to sort *themselves* according to their own perceived needs. These mechanisms are generally very promising in theory, but their applicability to technology is debatable. Nevertheless, a brief mention of a few 'self-selection' possibilities is warranted.

- Subsistence 'Bundles': While agricultural technologies have historically benefited large-scale farmers, there are crops (e.g., 'orphan crops') and technologies that are useful primarily to 'small-scale, subsistence' farmers. Farmers' technology preferences might be strong enough for them to 'self-select' into the HU target according to their own characteristics and needs if subsistence bundles of technology were freely distributed. This approach is open to leakage, however, and likely applies in only rare cases. Their rarity, in fact, points to a more fundamental, though tangential, problem: the lack of private incentives to develop subsistence technologies (Kremer 2000a, 2000b).
- Introducing Transactions Costs: Distributing technology in a cumbersome and tedious way could ensure that only farmers that truly need the technology participate. Common techniques for introducing transactions costs include requiring the farmer to wait in lines or jump through bureaucratic hoops. Only after proving that she truly values the technology is the farmer offered the technology. But there are obvious troubling aspects to such mechanisms, including wasted time and resources.
- Tiered Pricing: A supplier might establish a tiered pricing schedule that subsidizes small quantities of the technology, but increases the price as additional units of the technology are requested. Similar strategies are used commonly in many other settings. In order to be enforceable, this approach requires tracking repeated purchases by individuals so that total quantity purchased is known.

The above survey of approaches is not meant to be exhaustive. Certainly, other alternatives might emerge from creative discussions between the negotiating parties. Three criteria, however, should consistently determine the merits of any HUTT approach.

First, the approach should be feasible. It should be possible to determine who qualifies for the HU target given existing information of acceptable reliability. The administration of the actual transfer must also be feasible. The feasibility of a HUTT mechanism is also directly related to the enforceability of contractual market segmentation. Such feasibility, of course, matters to both the technology supplier and the party representing poor farmers.

Second, the approach should be assessed according to efficiency. Efficiency encompasses the technology supplier's concerns about including unintended beneficiaries in the target (i.e., leakage that could displace sales). This criterion also includes possible incentive effects, both incentives to deceive as well as incentives for future innovation and technology transfer. Efficiency is most directly a concern of the technology supplier, but because such concerns are likely to be sticking points in the negotiation and because domestic suppliers may also be affected by displacement, efficiency should be a key interest for the HU partner as well.

Third, the approach should be evaluated according to optimality. Optimality requires considering the total benefits to a society. In economics, this 'social welfare' is frequently measured as the sum of producer profits and consumer surplus. In HUTT, optimality should reflect the total social value of the transfer of a given technology according to a specified HU definition and mechanism. A primary concern here is for farmers who genuinely qualify for HU but are excluded in practice because of imperfect HU

definitions or transfer mechanisms. Optimality is difficult to measure in practice, but it is important to consider because it embodies the motivating intent of HUTT.

Table 1 summarizes the approaches mentioned above, each evaluated according to how it performs conceptually according to these three criteria. Performance is measured on a scale from poor (---) to excellent (+++). This table is purely hypothetical but serves to organize the possible advantages and disadvantages of various HUTT approaches.

Throughout this cursory overview of HUTT approaches it has been implied that farmers in the HU target were 'given' the technology 'royalty-free' and that the license required no upfront payment. While statements in press releases often seem consistent with free distribution of the technology, there are other potentially important variants. The technology could be subsidized for those in the HU target (i.e., distributed below-cost). In cases where training is required for the appropriate use of the technology, the terms of the license might stipulate the provision of training. In other cases, the provision of supporting infrastructure might be attractive. The negotiation of an HU license should recognize that while the definition of HU is critically important, there are other also other crucial variables. Creative brainstorming by the negotiating parties would surely reveal additional variables and options.

5. Conclusions

Economists have long considered questions about corporate strategy when facing markets composed of individuals with different preferences or income (Tirole 1988, Malueg and Schwartz 1994). From the perspective of the technology supplier, assuming this supplier is interested in maximizing its return on investment (increasingly a valid assumption for even some public institutes), HUTT is primarily a strategic price discrimination issue. HUTT, in this perspective, is simply a contractual means of segmenting markets and price discriminating. Using contracts to transfer technology for HU is valuable precisely because it offers a mechanism to segment markets that otherwise would be unavailable. When segmentation is not possible the poor are often priced out of the market (Malueg and Schwartz 1994).

Table 1: Approaches to HUTT and Criteria-based Evaluation

			Feasibility		**Efficiency**		**Optimality**	
			Information requirement	Administration/ enforcement	Leakage and displacement	incentive effects	Unmerited exclusion	Total social value
Indicator-Based	**Direct**	Max Farm Size	--	-	+	+	+++	?
		Min "Subsistence"	---	--	+	-	++	?
		Max Income	---	--	-	--	++	?
	Indirect	Geographic Target	++	+++	--	++	--	?
		Country Target	+++	++	---	++	--	?
		Program Participation	+++	+++	+	+	-	?
Self-Selection		Subsistence Bundles	+	+++	-	+	++	?
		Transaction Costs	+++	+++	--	+	++	?
		Tiered Pricing	+++	+	++	+++	-	?

HU clauses, as presently written, are often *ad hoc* and arbitrary because the implications of different mechanisms for HUTT are poorly understood. Submitting HUTT to rigorous analysis and developing a more systematic approach to defining HU could help strike the sensitive balance between the suppliers' interests and the recipients' needs. Practical, mutually beneficial mechanisms for HUTT will help ensure that crop varieties currently under development by both private and public sectors genuinely benefit poor farmers in the developing world.

Indeed, a key element of any negotiation is the standard used by the parties to determine what is fair (e.g., market value, salary offered for comparable positions; see Fisher, Ury and Patton 1991). Such a standard is only useful if it is considered by both parties to be somewhat objective. Indeed, the success of a negotiation often hinges on the degree to which the parties agree on the objectivity of a standard. Successfully formulating an approach to HUTT would be a step towards establishing an objective standard for segmenting markets. With such a standard available, technology proprietors would likely be more open to 'donating' their technology to the poor.

If an objective methodology for structuring efficient and workable HUTT can be obtained based on an analysis of the economic implications for both the technology supplier and the recipient, then companies in other sectors (e.g., pharmaceuticals, communications, electronics, etc.) might be interested in transferring technology to developing countries via HU clauses or variants thereof. In short, in a world of persistent economic inequality any technology with a public goods dimension and vested private interests might be distributed more fairly and, from the private proprietor's perspective, more efficiently as a result of a deeper, systematic understanding of HUTT.

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