

INTELLECTUAL PROPERTY RIGHTS AND THE INTERNATIONAL TRANSFER OF TECHNOLOGY: SETTING OUT AN AGENDA FOR EMPIRICAL RESEARCH IN DEVELOPING COUNTRIES

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1. INTRODUCTION

International technology transfer is a widely studied topic. The interest derives from the belief that technological progress is the engine of economic growth and high income countries tend to be technologically more advanced than developing countries. In turn, however, countries behind the technical frontier can accelerate their growth by acquiring technology from more advanced countries.

The possibility of this virtual “free lunch” has kindled interest in technology transfer. Inevitably, issues of IPR protection have come to the fore.¹ There is a large body of literature on the subject, too large to even attempt to review and classify here. My objective therefore is to suggest fruitful areas for empirical research in developing countries on the relationship between IPRs and technology transfer.

This paper is organized as follows. Section 2 briefly analyzes the concept of international technology transfer and raises some basic challenges. I summarize some quantitative estimates of the international flow of technology in section 3. Section 4 provides an analytical framework for how IPRs may condition the international flow of technology and provides a short discussion of the key conceptual and data-related challenges. This is followed by a very brief overview of empirical papers in economics on the relationship between IPRs and international technology transfer. In section 5, I outline potential areas for further research in developing countries on some of the topics outlined in section 4. Finally, section 6 concludes with suggestions on under-researched topics which could also be fruitful areas for future research.

2. INTERNATIONAL TECHNOLOGY TRANSFER

The standard model of economic growth predicts that while a country at the frontier can only grow (at a steady pace) at the rate of technical advance, countries behind the frontier (also called developing countries) should catch up – converge towards the high income countries in *per capita* income. Even more sophisticated models (e.g. Romer, 1990) in which technical progress requires investment in research and development, have a similar implication. Technology, once developed, can be applied broadly. The implicit assumption is that technology can be “transferred” with a lower expenditure of resources than were required to develop it in the first instance. Another is that the technologies developed elsewhere are indeed widely useful, which has given birth to the literature on “appropriate technology”. Undoubtedly, technologies have to be adapted and modified, but few believe that technologies developed and used in technically advanced countries cannot be usefully applied in countries behind the frontier.

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However, the difficulty experienced by developing countries, albeit with some spectacular exceptions, in catching up in the half century since the Solow model was unveiled, has many causes, including misguided policies followed by the countries themselves, corruption and weak institutions. Nevertheless, the difficulties of the large mass of developing countries to “catch up” points to the weakness of the assumption that technology transfer is easily accomplished. Instead, from the time that sustained application of new knowledge to economic ends was accepted as the basis of modern economic growth, scholars have investigated the difficulties in technology transfer.

It was recognized immediately that for understanding technology transfer, the conceptualization of technology as ideas was inadequate. More precisely, it was inadequate to think of technology as merely blueprints and formulas. Neither was it adequate to think of technology as merely new and advanced equipment. The latter, especially, are easy to move from place to place. Yet, by themselves, blueprints and even machinery have proved inadequate to replicate the miracle of sustained economic growth, driven by advances in knowledge and its application for economic ends.

A richer conceptualization of technology includes materials and knowledge codified in patents, blueprints and manuals. It also includes know-how, much of it not codified and held as tacit knowledge. Tacit knowledge is costly to transfer and contracting for tacit knowledge is potentially subject to even greater contractual difficulties than for codified technology, which, in any event, is also believed to be difficult to contract over.

Another significant challenge is what is called the absorptive capacity of the recipient – the ability of the receiving country to evaluate and effectively use the technology. An issue which has not received attention is the question of demand for technology. For the most part, this neglect is understandable. Insofar as new (to the recipient country) technology will reduce costs or make available new goods hitherto unavailable, it is inherently valuable. Nonetheless, a little introspection reveals that this is not enough. First, the technology will be transferred only if the benefits outweigh the costs. These costs include not only the costs of transfer, but also the opportunity cost. Simply put, the fruits of the technology may be made available to the recipient incorporated in goods and services exported to the recipient, rather than the technology itself.²

These issues have been extensively discussed in the literature and I raise them principally because they also impinge upon the topic of this paper, namely the role of IPRs in international technology transfer.

3. TRENDS IN INTERNATIONAL TECHNOLOGY FLOWS

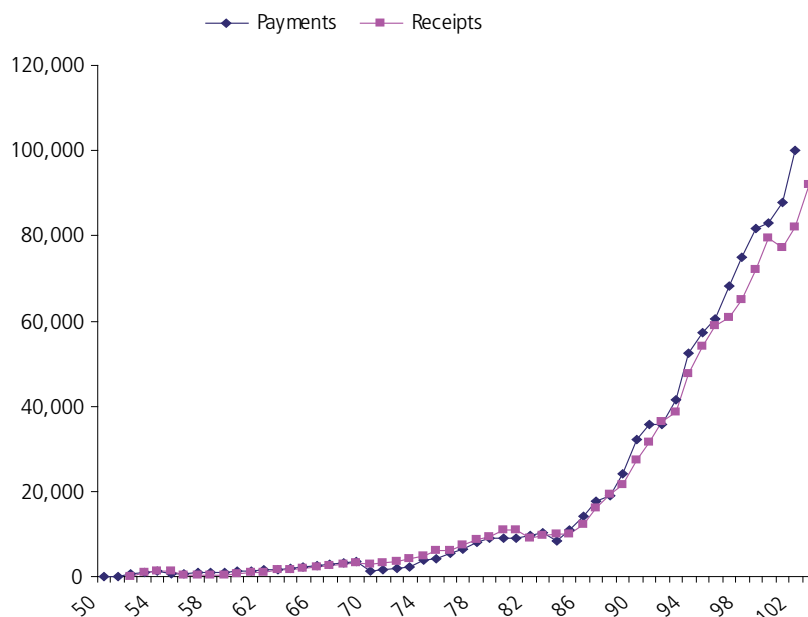
Technology markets have grown systematically over the past 20 years. There is evidence of growing international technology markets in the form of cross-border receipts and payments for disembodied technologies. Robbins (2006), using data from the International Investment Division of the US Bureau of Economic Analysis, estimated that US corporations purchased international industrial-process licensing and R&D and testing services totaling 12 billion US dollars in 2002, while they received 23 billion US dollars from foreigners for these items.³

Assuming that domestic US demand for technology licensing has a similar structure, Robbins estimated that US corporations received 67 billion US dollars in revenues from licensing industrial processes. Total R&D in the US in 2002 was about 280 billion US dollars and that performed by industry was 192 billion US dollars. Thus, transactions in technology account for a little less

than 25 per cent of total US R&D and about 33 per cent of the R&D performed by industry. Thus, markets for technology are large and substantial, and the evidence suggests that they have grown faster than total R&D over the last decade or so.

Interestingly, Robbins' (2006) estimates also indicated that more than half of the transactions involving US firms either as sellers or buyers of technology have an international counterpart. This fact points to the continued growth of international technology markets.⁴ Other evidence also points in the same direction. Figure 1 is based on Athreye and Cantwell (2007). Using data from the World Bank's World Development Indicators, they found that international patent licensing and royalty receipts have surged since the mid-1980s. From around 10 billion US dollars in 1984, international patent licensing and technology receipts grew to more than 80 billion US dollars in 2002 (on current prices). Over 120 countries reported receiving such royalties and more than 130 countries reported making such payments in 2002. Similarly, Mendi (2007a) analyzed data from the OECD's Technology Balance of Payment (TBP) database. The TBP database covers technology transfers in the form of licensed patents, know-how, trademarks, and the like, but excludes licenses of software or designs (along with advertising, insurance, and, more typically, commercial transfers). Mendi (2007a) found that between 1970 and 1994 the total volume of international receipts and payments for technology deals in 16 OECD countries (comprising the leading European countries, the US and Japan) have increased more than 10-fold. Receipts increased from about 3.6 billion US dollars to 46 billion US dollars, using purchasing-power-parity exchange rates, and payments increased from about 3.1 billion US dollars to 33.9 billion US dollars.

Royalty and Licensing fees, World (1950-2003)



Source: Athreye and Cantwell, 2007

These estimates are imperfect in a number of ways. For one, they do not adequately capture technology transfer that is not captured by royalty statistics. Many multinational corporations may account for the value of technology transfer in other ways. Even so, it is apparent that there has been a significant increase in international technology transfer. Further, this appears to coincide with an overall strengthening in IP regimes, first in the rich countries but later in developing countries as well, although one cannot be definitive about the strength and direction of the relationship.

As expected, and as Table 1 indicates, these flows are largely confined to the developed countries and to developing countries that have experienced rapid economic growth over the last few decades. Though regrettable, this points to the very important role of demand in technology transfer. For present purposes, the point of interest is investigating how IPR protection affects the demand for technology transfer, a point I discuss in greater detail below.

Table 1. Indicators of the Importance of Licensing in LDCs and ODCs, 1996–2005 (Royalty and License Payments, Period Averages)

	Value (‘000 US\$)		License payments/ GDP (%)		Licence payments/ per capita (US\$)	
	1996–99	2000–05	1996-99	2000-05	1996-99	2000-05
LDCs	29,044	33,250	0.02	0.02	0.07	0.07
Africa	20,231	23,308	0.03	0.03	0.07	0.07
Asia	8,605	9,779	0.02	0.02	0.06	0.07
Islands	207	163	0.03	0.01	0.34	0.24
Other developing countries (ODCs)	11,771,543	22,543,234	0.23	0.36	3.55	6.36
Africa	785,767	1,020,422	0.24	0.27	3.72	4.43
Latin America	2,698,636	3,253,528	0.15	0.17	5.82	6.53
Asia	8,287,140	18,269,284	0.28	0.47	3.14	6.49

Source: UNCTAD, 2007: Table 16

LDCs and regional aggregates are composed of the following countries: Angola, Bangladesh, Benin, Burundi, Cambodia, Cape Verde, Eritrea, Ethiopia, Guinea, Lesotho, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Samoa, Senegal, Sierra Leone, Sudan, Togo, Uganda, United Republic of Tanzania and Zambia.

4. ANALYTICAL FRAMEWORK FOR EMPIRICAL ANALYSIS

Intellectual property comes in many forms, trade secrets, copyrights, and patents being the most important in relation to technology transfer. The literature on trade secrecy and copyrights is sparse, especially for trade secrecy, and particularly as it relates to international technology transfer; much of the empirical evidence at hand deals with patents.⁵ The principal reasons are that patent databases are widely available, it is much easier to link patents to technology and industry groups, and there is great variation in the extent and nature of patent protection across countries. Details of patent protection and its role in technology transfer are also of great policy interest.

In thinking about technology transfer to emerging economies, it is very important to distinguish between technologies intended to serve the domestic market (of the recipient country) vs. technology intended to produce exports for developed countries. Most of the literature has failed to make this distinction, perhaps because of difficulty in measurement. The consequences of this failure are conceptual confusion and, potentially, conflicting empirical results. A corollary is that there is relatively little attention paid to why IP protection should matter for technology transfer. Although the answer may appear to be obvious, a little reflection reveals that the matter is more complex.

If the technology being transferred is for producing goods and services for the export market, what matters is the patent protection the technology holder enjoys in the export market. In other words, consider the case where a new chemical process is being introduced into a country, where it will be used to produce plastics for export. If the process were illegally copied, typ-

ically the technology holder would be able to block exports into the most important export countries, provided the technology holder enjoyed patent protection in those countries. This implies that transfer of technology should be relatively insensitive to patent protection in the developing country; for instance, there are substantial export markets where the technology is not patent protected. Of course, as a practical matter, the technology holder may greatly prefer to prevent competition by preventing its use in production in one country rather than protect its importation in a number of markets.

Technology transfer can filter through a number of channels. Table 2, reproduced from Maskus (2004), itself derived from a variety of data sources, shows that these channels have increased in importance over time, consistent with the broad patterns described earlier. The major modes of transfer are imports of goods and services, especially of capital goods, foreign direct investment (i.e. via multinational corporations (MNCs)), licensing and joint ventures, foreign trade, and movement of people. The latter is different enough for me not to devote attention to it here, though it should be remembered that the first patent grant recorded in history was for the purpose of technology transfer, albeit in the form of attracting the technology owner to relocate.⁶

Maskus (2004) also points out that technology can be involuntarily transferred, via imitation. The technology holder does not participate in this transfer, and in many cases, may actually seek to restrict it. This point is worth noting for, as also discussed later, although the presumption is that IP protection may retard such transfer, patents in particular also disclose. Thus, there is an intriguing possibility that patents may facilitate such transfer. A second source of transfer is exports by recipient country firms: it is plausible that exports are a means of learning not only about demand conditions but also technology. Many large firms control supply chains. Firms in developing countries that participate in such supply chains may receive a variety of training and technology from their customers. A third major source of transfer is the diffusion within the recipient country of the transferred technology. This diffusion can itself take place through purchase of goods or licensing, but is more likely to take the form of movement of people or direct imitation or both. Here, trade secrecy (and related employment rules such as non-compete clauses) play a more important role.⁷

Table 2. Exports of Capital-Intensive, Skilled Labor-Intensive and Technology-Intensive Goods, Royalty Income Earned and Net FDI Outflows from High-Income OECD Countries, 1970 and 2001 (billion US\$ and percentage)

Value (\$bn)	Capital-intensive		Skill-intensive exports		High-technology exports		Royalties exports		Net FDI outflows	
	1970	2001	1970	2001	1970	2001	1970	2001	1970	2001
High income	45.8	1,108.0	43.7	736.7	25.8	739.3	2.8	71.2	6.9	472.1
Low income	2.8	32.8	2.4	13.1	1.2	16.1	0.0	0.02	0.3	8.1
Lower middle income	8.4	183.4	5.7	60.0	3.5	104.3	0.0	0.7	0.9	105.6
Upper middle income	7.7	318.0	5.2	126.9	3.8	200.0	0.0	1.8	0.6	69.4
Sub-Saharan states	1.5	10.6	1.5	6.0	0.7	5.6	0.0	0.02	0.1	5.5
Shares (%)										
High income	70.8	67.5	76.6	78.7	75.4	69.8	99.7	96.7	79.9	72.0
Low income	4.4	2.0	4.2	1.4	3.5	1.5	0.0	0.0	3.2	1.2
Lower middle income	12.9	11.2	10.0	6.4	10.1	9.8	0.0	0.9	9.9	16.1
Upper middle income	11.9	19.4	9.1	13.5	11.0	18.9	0.0	2.4	7.1	10.6
Sub-Saharan states	2.3	0.6	2.8	0.6	2.0	0.5	0.0	0.0	1.2	0.8

Source Maskus (2004: Table 1)

Country groups are as defined by the World Bank; high income = OECD countries minus Mexico, Republic of Korea and Turkey; Sub-Saharan states exclude South Africa. Capital and skilled labor-intensive goods are defined on the basis of factor intensity using the SITC classification. High-technology goods are defined on the basis of R&D intensity.

The key question is how IP protection affects the extent, form and channel of technology transfer. Within this broad area, there are several important sub-questions. First, how important is foreign direct investment as a source of international technology transfer as compared, on the one hand, with licensing, and on the other, with imports? A second theme is how IP protection affects these different modes of transfer. Here there are two related questions. First, how does patent protection affect technology transfer within a given mode? Second, how does patent protection affect the choice between these modes? *A priori* reasoning and some limited empirical evidence suggest both that the relative importance of the different sources may vary over time, and that IP protection may affect these sources differently. As noted earlier, there is relatively little evidence on the impact of non-patent IP protection on technology transfer. Virtually all empirical work has focused on patents instead.

There are several key challenges to empirical research. The first is to obtain a measure of patent protection. Many cross-country studies use some type of index, frequently the Ginarte-Park index, developed by Ginarte and Park (1997), or the earlier Rapp-Rozek index (1990). Their construction and properties are discussed in Maskus (2000). Despite being widespread, these measures, though acceptable if used mainly to control for the impact of patent protection, are problematic if used to study patent protection. For one, they are based on the available legal protection as it appears in the laws, rather than the actual level of protection. In regression-based studies, their use is additionally problematic if they are used, as is frequently the case, as cardinal variables, since the indices are ordinal.

Studies focusing on particular countries cannot use such indices because they are country-level measures. Industry-focused studies use variation in the effectiveness of patent protection across industries, sometimes using industry level effectiveness of patents reported in the Yale survey (Levin *et al* (1987)) or the Carnegie Mellon Survey (Cohen *et al* (2000)). Transaction-level studies use either industry-level effectiveness or simply whether a patent is present or not.

McCalman (2001) employed a more disaggregated set of measures using detailed information about patent institutions by summarizing the extent of coverage offered (e.g. are any sectors excluded from patent protection?), restrictions on the form of exploitation of patents (e.g. do imports satisfy working requirements?) and the availability of enforcement institutions (injunctions, burden of proof, etc.). This study is, however, an exception rather than the norm in not using a summary measure of the strength of IPR protection. However, unless one is fortunate, the use of multiple measures makes it difficult to empirically answer the impact of IPRs. Instead, one can only quantify the effect of this or that aspect of the IPR regime.

The second challenge is to measure technology transfer itself. Typically, the literature has used measures such as the total payments made for technology imports or technology licensing revenues. This poses a problem insofar as arguably stronger IPR protection may simply result in a higher price for technology rather than higher "quantity" or quality of technology. Some studies, that will be cited later, indirectly try to address this by investigating whether the recipient firm increases its own technology activities, indicating an increase in the extent of technology transfer, rather than merely a price increase. Other possibilities (which I have not seen implemented but are surely feasible with detailed data) include investigating whether the recipient firm increased profits or productivity or, better still, whether it introduced new products or lowered its costs.

Measurement is easier when the focus is on the mode of technology transfer (such as the choice between foreign direct investment and licensing) or the form of the technology contract. However, the key problem here is the counter-factual. Specifically, the empirical analysis is conditioned upon the transfer taking place, namely that given that it has been agreed to transfer

technology, is it transferred via FDI, arms-length licensing or some other form? Put this way, the problem is also obvious. It is possible that changes in IPRs may increase or decrease the total amount of technology transfer, in the process changing its share through FDI or licensing or imports. Few of the studies have adequately addressed this issue.

The final challenge, even more serious, is to find a source of variation in the measured patent protection that is exogenous – unrelated to the unobserved factors driving the variable being investigated, namely the extent or form of technology transfer or contractual provisions. Few studies have found a satisfactory solution to this, although there are exceptions.

A comprehensive survey of the literature is not undertaken here because several are available. Maskus (2004) provides a comprehensive overview of the literature on IPRs and technology transfer. Arora, Fosfuri and Gambardella (2007) explored international technology licensing. Maskus, Saggi and Puttitanum (2004) provided a survey of the theoretical and empirical literature on patents and technology transfer through direct foreign investment and licensing. The following brief review, therefore, simply illustrates these issues and also indicates the variety of data sources that have been used.

4.1 Patents and Technology Transfer

A number of empirical studies have looked at the relation between patents and technology transfer. Eaton and Kortum (1996), albeit studying productivity growth and technology diffusion in the OECD countries, found that the smaller and less-technologically advanced OECD countries derived most of their productivity growth from having foreign inventors patent in their economies. This finding may also apply to the more advanced developing nations. They control for the IPR regime using the Rapp-Rozek index. McCalman (2001) applied the Eaton and Kortum approach to a sample of developed and developing countries. He found that patent harmonization (which has *de facto* resulted in a strengthening of patent protection) leads to an increase in patent value (as reflected in the contribution to economic growth). Moreover, McCalman (2001) constructed an “enforcement” index, to capture the effect of patent harmonization.

Xu *et al* (2005) carried out a similar study of international technology diffusion through trade and patenting in a sample of 48 countries for the period 1980–2000. They used the Ginarte-Park index to measure strength of patent protection, together with actual patenting data from WIPO, and found that rich countries benefit from domestic technology and foreign technology embodied in imported capital goods; middle-income countries enjoy technology spillovers from foreign patents (patents filed in the country by foreigners) and imported capital goods; developing countries benefit mainly from foreign patents.

Bascavusoglu and Zúñiga (2002) used as their dependent variable the receipts in technology services flows exported by French firms to 19 countries over the period 1994–2000. These flows captured cross-border patent-licensing and trademark-licensing receipts, revenues from technical assistance and engineering services and income related to R&D services and R&D located overseas. The authors found a positive, although weak, effect of the degree of patent protection at the country level on the amount of such receipts. Patent protection seems to matter most for countries with strong imitative abilities and for industries with a medium level of R&D intensity.

Smith (2001) related US exports, sales of foreign affiliates and licensing fees to the Ginarte-Park patent index in several developed and developing countries. She found significant evidence that

stronger patent protection would increase affiliate sales and licensing payments, the result driven by the countries with strong imitative capacities (measured by a high percentage of engineers and scientists in the population).

McCalman (2005) investigated how Hollywood movie studios release motion pictures in 37 countries. The primary data source used in this analysis was the Internet movie database which contains information on the release dates of movies across countries. He found that moderate IPRs encourage the rapid diffusion of movies, whereas very weak or very strong rights are associated with delays. Interestingly enough, though copyrights rather than patents are the relevant rights for the movie industry, McCalman used the Ginarte-Park index as his measure of the strength of IP protection.

4.2 Patents, Trade and FDI Flows

Foreign direct investment is a major source of technology flows across countries. Seven hundred multinational corporations accounted for 46 per cent of the world's total R&D expenditure and 69 per cent of the world's business R&D in 2002 (UNCTAD (2005)). Indeed, the R&D budgets of the largest firms exceeded the entire R&D spending of virtually all developing countries.⁸ A recent comparison showed that in 2003, the R&D spending of firms such as Ford, Siemens, Pfizer and Chrysler was around 7 billion US dollars each, greater than the combined R&D expenditures of all CIS states, or the newly admitted EU member states (see Javorcik, this publication). Not only does FDI itself introduce new technologies to developing countries, but this knowledge also spills over to other domestic firms in a variety of ways as discussed later. The literature on knowledge spillovers from foreign direct investment is extensive, the results unclear and a review of that literature would be of limited relevance to this publication. However, as discussed later, it is possible that one reason for the mixed results may have to do with differences in patent protection across countries.

For our purposes, the question is whether FDI flows and trade respond to patent protection. Maskus and Penubarti (1995) were the first to relate international trade flows to the cross-country strength of patent laws, using bilateral imports from OECD countries to other OECD countries and to a large group of developing countries in detailed manufacturing categories. The strength of patent rights was measured by the Rapp and Rozek (1990) index across importing nations. The authors found that import volumes were positively and significantly affected by increases in this patent index across most manufacturing categories, particularly in large and middle-income countries. Smith (1999) found that international firms would expand their exports to imitative (large and middle-income developing countries) nations significantly in response to an increase in the patent strength index. In supplementary regressions, Smith showed that patent rights strongly and positively affected the inflows of knowledge, measured as R&D expenditures undertaken on behalf of affiliates. Again, this finding applied only to recipient countries with strong imitative abilities; the impact was absent in countries with weak imitative abilities.

However, Primo Braga and Fink (1998) found no statistical relationship between patent rights, measured by the Ginarte-Park index, and international FDI flows or stocks. Blyde and Acea (2002) estimated the relationship between patent rights (measured with the Ginarte-Park index) and imports and FDI into Latin American countries. They found that imports were higher for higher values of the Ginarte-Park patent index for developed countries but were insensitive to patents in the developing countries. However, bilateral inflows of FDI from OECD countries were higher for higher values of the Ginarte-Park index, even after controlling for institutional variables, infrastructure, and human capital levels.

Ferrantino (1993) used data for 1982 on US exports and sales of overseas affiliates of US firms to identify the cross-country determinants of both exports and sales of multinational affiliates of these firms. Patent protection is measured by whether the country is a member of certain IP treaties. It found that membership in IP treaties increases the flows of payments and receipts for intellectual property as long as domestic patent protection is sufficiently strong. Parent companies in the US export more to subsidiaries in countries which do not adhere to such treaties, but their impact on arms-length exports and foreign investment is minimal. In other words, the author suggests that US firms export higher than expected volumes to their affiliates in countries that have weak IP regimes to limit technology leakage to their rivals abroad by confining production within the US.

A somewhat different approach is taken by Javorcik, who exploited differences in reliance upon patents across industries. She found that firms in industries relying heavily on IPR protection are (*ceteris paribus*) more likely to invest in transition countries with stronger IPR protection (Javorcik (2004)). This is an example of exploiting the differences across industries and countries.

4.3 Patents and Content of Technology Import Contracts

Nagaoka (2005) analyzed how the price of technology imported by Japanese firms depended on the strength of patent protection, using information over the period 1981-98 across 32 sectors. He found that high royalties are more likely to be observed when the licensing contract also includes patents. In short, stronger IPRs help increase the share of a technology's value the licensor can appropriate. The data was drawn from corporate reports filed by Japanese manufacturing corporations in 1999 under the Security Exchange Law, which requires public firms to disclose important contracts. In the case of licensing-out, 217 firms disclosed 1,458 contracts in total. Nagaoka (2002), using the same data, found that technology out-licensing contracts by Japanese firms were less likely to involve only a patent (rather than both patents and know-how) when the license country's IPR protection (Ginarte-Park index for patents, and the Business Software Alliance for software piracy) is weak.

Arora (1996) used a sample of 144 technology-licensing agreements signed by Indian firms to test the empirical relevance of patents. He employed the provision of three technical services – training, quality control, and help with setting up an R&D unit – as empirical proxies for the transfer of know-how. He found that the probability of technical services being provided was higher when the contract also included a patent license or a turnkey construction contract.

Mendi (2007b) used a sample of technology import contracts by Spanish firms in 1991. The dataset was taken from the records of the Spanish Ministry of Industry. All Spanish firms that imported technology were required, up to 1992, to report the terms of the technology purchase.⁹ The paper found that shorter scheduled contracts were less likely to include the transfer of know-how. It also found that technical assistance was bundled together with the transfer of know-how. In another paper based on a dataset derived from the same Spanish administrative records, covering 925 licensing agreements, mostly for the years 1964-68, Villar (2003) found that when the technology is patented, the parties are more likely to agree on fixed payments.

4.4 Patents and the Mode of Transfer (FDI vs. Licensing)

Smith (2001), in the study cited earlier, found that US firms are more likely to export or invest in direct manufacturing facilities rather than license technology in countries with weak patent

regimes. Similarly, Nicholson (2002) and Puttitanun (2003), both of whom used data on the number of various kinds of contracts (exports, FDI, licensing) found that increases in the patent index significantly raised both FDI and licensing, but also that the mode of transfer tended to shift towards licensing. Puttitanun (2003) analyzed decisions on entry mode by US firms in 135 industries and 62 countries in 1995. Using a multi-nomial logit regression model, she showed that while stronger patent rights increase total entries by multinational firms, they especially enhance the location advantage of FDI and licensing vis-à-vis exports. However, strong patent protection is associated more with increases in FDI than licensing. Javorcik (2004) used data on FDI projects to Eastern Europe and found that weak patent protection shifted the composition of FDI away from technology intensive industries, and away from production towards distribution.

On the other hand, Fosfuri (2004) used a comprehensive database on investments in chemical plants during the period 1981-96, distinguishing between wholly owned operations, joint ventures and technology licensing in 75 countries. After controlling for several country characteristics, he did not find that higher values of the Ginarte-Park index were associated with greater levels of licensing or FDI, nor its ratio. Similarly, Pfister and Deffains (2005) found that patent rights exert only a negligible influence on the location choices of French firms among 17 developing countries.

Eapen and Hennart (2002) analyzed whether technology was transferred through joint ventures or licensing for a sample of Indian firms. Data was collected by means of a survey sent to 1,258 managing directors of Indian firms, which had taken technology licenses from, or had entered into joint ventures with, foreign firms. The population was identified from a database of over 7,000 Indian firms and from the listings of foreign chambers of commerce in India. Their final sample consisted of 126 Indian firms of which 75 were local partners in joint ventures with foreign firms and 51 were licensees of foreign firms. They found that whether the technology is patented in India or not their measure of patent protection did not influence the choice between licensing and joint ventures.

Yang and Maskus (2001) found that license fees for industrial processes paid by unaffiliated foreign firms to US firms in 26 countries in the years 1985, 1990 and 1995 were higher for higher values of the Ginarte-Park index. On the other hand, Fink (1997), using German data, found a very weak relationship between the strength of patent protection and the level of technology licensing.

Using the same dataset as Mendi (2007), Mendi (2005) analyzed a sample of contracts that included technology transfers to Spanish subsidiaries of overseas firms in 1991. He found that know-how is more likely transmitted within multinationals than between unrelated firms, but there is no difference in the transfer of codified knowledge.

This mixed evidence reflects a variety of factors, not the least of which involve differences across the transferring firms and differences across technologies. Arora and Ceccagnoli (2005) showed that stronger patent protection increased patenting, but that it does not increase licensing by large firms. Small firms, and firms lacking commercialization capability, are more likely to license in response to stronger patent protection. In other words, stronger patents may favor FDI when the technology is owned by large firms that are able to invest globally. If the technology is owned by smaller firms, this will increase licensing. As discussed in the final section, investigating the source of technology and its response to patent protection is a promising avenue for additional research.

A similar remark applies to differences across technologies. It is plausible that mature technologies diffuse through informal channels (perhaps embodied in plant and equipment), whereas more advanced technologies require mechanisms such as licensing or FDI. An obvious, and understudied, research question is the impact of IP protection on the transfer of technologies with varying levels of sophistication and complexity.¹⁰

5. POTENTIAL AREAS OF ADDITIONAL RESEARCH IN DEVELOPING COUNTRIES

5.1 The Determinants of IPR Protection and the Measures of IPR Protection

An important lacuna in the empirical research is the measure of IPR protection. As noted, commonly used measures, such as the Ginarte-Park index or the Rapp-Rozek index suffer from multiple problems. The two most important problems are first, that they are based on laws as written and not as they are enforced, and second, that it is not clear why there are systematic differences across countries in the strength of IPR protection. In particular, if a country with a higher demand for technology also has, as a consequence, stronger IPR protection, then it is possible that the country may also import more technology than other countries with a lower demand for technology (and weaker IPR protection).

The problem of measuring the strength of IP protection can be partially ameliorated by also developing measures of the extent to which laws are generally enforced in the country. Assuming that IPR laws are then enforced to the same extent as other laws, one could obtain a better measure of the strength of IPR protection by interacting the Ginarte-Park index with an index of overall law enforcement, such as the one developed by Kauffman *et al* (2005). From 1996 the World Bank has provided a variety of measures for a large group of countries. These include “government effectiveness”, which measures the competence of the bureaucracy; measures of the “rule of law”, which includes measures of the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence; an index for the “control of corruption”, measuring the exercise of public power for private gain, including both petty and grand corruption and state capture.¹¹

Finally, one can use survey-based measures of the extent of patent protection. This approach has been used with success in measuring the effectiveness of IPR protection across industries in two landmark surveys, the Yale survey (Levin *et al* (1987)) and the Carnegie Mellon Survey (Cohen *et al* (2000)). In these surveys respondents (typically high-ranking executives in firms in the Yale survey, and R&D managers in the Carnegie Mellon survey) were asked questions about the effectiveness of patents (along with the effectiveness of other strategies such as secrecy or first-mover advantage). They were also asked about various indirect, and possibly more useful, measures such as the speed with which patented and unpatented innovations were imitated.

One might imagine implementing similar surveys in developing countries. Respondents might be asked to estimate the importance of patents for technology suppliers, as well as more indirect questions such as the importance of patents in contracts (or the fraction of technology transfer contracts that crucially involve patents) and incidence of imitation for patented and unpatented imported technology. One could also ask potential technology suppliers about the importance of patents. As with the other surveys, it is likely that the more effective measures would be indirect, such as whether the firm had transferred technology to one country but not to another, similar, country and to correlate that to independent measures of the strength of IPR protection. Similarly, respondents of potential technology suppliers could be asked about the form of technology transfer. They could also be asked to directly estimate the speed with which their technology, transferred to different types of developing countries, was imitated, and whether this speed varied with whether the technology had enjoyed patent protection.

The second problem, namely that it is not clear why there are systematic differences across countries in the strength of IPR protection, is harder to deal with. This requires identifying a source of variation in the strength of patent protection that is not correlated with the unmeasured influences that condition technology transfer, such as the demand for technology. In econometric terms, one needs a source of exogenous variation. This problem is most acute in empirically assessing the role of IPR protection on technology imports. It is likely to be less of a problem when investigating the impact on the mode of transfer or of the composition of technology-import contracts, although the problem is not entirely absent either.

Developing a systematic approach to solve the problem will require an entirely new line of research on what factors determine the strength of IPR protection in a country. The political economy of IPR protection involves not only the analysis of self-interested parties participating in the legislative and political process, the usual focus of economists. One also needs a historical perspective, which will take into account the peculiarities of each country's history. Rather than treat such country variation as an unwelcome diversion, empirical researchers can take advantage of it, because historical factors may in fact be a valuable source of exogenous variation.

Until such time as a deeper understanding of the determinants of the strength of IPR protection emerges, one will have to rely upon more *ad hoc* approaches. One such instance is the study by Branstetter *et al* measuring the impact of IPR on technology imports. There, changes in patent laws were the source of exogenous variation, so that estimation was "within" a country, less vulnerable than the purely cross-country variation implied by the use of patent indexes such as the Park-Ginarte index. One might still wonder whether these changes were in fact responses to unseen forces that increased the value of technology. However, the evidence indicates that while stronger patent protection increased technology transfer to the affiliates of the US multinationals, there was little effect on technology transfer to unaffiliated parties.

An alternative might be to exploit cross-industry and cross-country variation. Here, one also uses differences in the extent to which patents matter for different types of industries along with variation in overall patent protection across countries. The only example of which I am aware that has tried to exploit country-industry differences in patent protection is Javorcik (2004). Javorcik compared whether firms in patent intensive industries were more likely to invest in transition economies with stronger patent protection than transition countries with weaker patent protection, using as a baseline investments by firms in industries that are not patent intensive. This type of "difference-in-difference" approach is common in applied empirical work and, though not without problems, is a useful strategy given the lack of exogenous variation in patent protection across countries.

A related type of difference-in-difference approach can exploit institutional facts about industries. For instance, we know from a variety of sources that pharmaceuticals are patent intensive. However, countries vary in terms of policies such as price controls for pharmaceutical products, or in the ability of firms to extend *de facto* patent protection through "evergreening".¹² This variation, which is specific to industries and countries, can be used to see how differences in patent protection affect the variables of interest.

Another possibility is to use court decisions or administrative regulations in countries to create variation in patent protection. For instance, Hall and McGarvie (2000) used landmark court decisions that weakened copyright protection for software and others that enhanced patent protection for software as a source of variation. Clearly, this strategy will more likely work for single-country studies rather than cross-country studies. Investigators could use changes in regulations, changes in the cost of filing for patents or changes in the enforcement of patents as sources of variation.

For the most part, such large-scale studies, though very attractive because of their wider coverage, are likely to be handicapped by the significant problems of the availability of comparable and fine-grained data. In the immediate short run, more focused studies are easier to envisage. In the same vein, research that provides measures of the actual effectiveness of the enforcement of IPRs for instance, by measuring the number of patent-related cases and the disposition of those cases across countries, will be invaluable and highly influential. It is also likely to be extremely labor-intensive, particularly if it covers many countries.

5.2 IPR Protection and Transfer Mode

Here, country-focused (e.g. Eapen and Hennert (2002)) or industry-focused research is possible (Fosfuri (2004)), as also single-source country, but multiple-recipient country and industry focused studies are possible (e.g. Maskus and Penubarti (1995), Smith (2001)).

5.3 Content of Technology Import Contracts

Since many countries have reporting requirements for technology imports, data from administrative records can be used to address issues of the extent of technology transfer (e.g. whether know-how is provided or not) and correlate it to whether the imported technology is patented in the source country, and whether it is patented in the recipient country or not (e.g. Arora (1996), Mendi (2005), Nagaoka (2002)). More detailed data on the patents themselves (such as the number of claims, the citations received) may also be linked. Similar data sources can be used to investigate contractual details.

6. SUGGESTIONS FOR FUTURE RESEARCH ON UNDER-RESEARCHED TOPICS

Perhaps more interesting avenues of research will involve under-researched topics. A standard issue is the impact of imported technology on the recipient country. This has been extensively researched in the context of the productivity impact of MNCs. But the role of IPRs has been under-researched.

Studies on the sources of spillovers from FDI flows or from multinationals themselves are many and results are mixed. For instance, Aitken and Harrison (1999) found that an increase in FDI presence reduces total factor productivity (TFP) of local plants in the same sector (relative to the baseline) in Venezuela. On the other hand, Haskel, Pereira and Slaughter (2007), using data from the UK found that an increase in FDI increased the TFP of local plants in the same sector, albeit by a small amount: a 10 point increase in the share of foreign plants leading to a 0.5 per cent increase in TFP. Javorcik (2004) found no effect of FDI on firms in the same industry in Lithuania. However, she found positive spillovers for firms in supply sectors: A one-standard deviation increase in FDI implies a 15 per cent increase in the TFP of firms in supply industries. This supports the idea that whereas passive or unintended spillovers of knowledge (such as through movement of workers and managers) from MNCs to local competitors may be small, MNCs can, in their own interests, transfer knowledge to their suppliers, from where knowledge may flow to others as well.

A related and important question is how these different channels of spillovers are conditioned by the IP regime in a country. Researchers could perform detailed case studies, tracing the movement of people from MNCs (or their domestic affiliates) to domestic firms, studying what steps

MNCs take to restrict the diffusion of technology and how, if at all, IP protection conditions this process. One could also undertake detailed case studies of technology being transferred inside global value chains, and relate it to the IP regime. For instance, is an MNC atop a global value chain more likely to locate suppliers in a country with stronger IP protection? Is it more likely to share technical information with the supplier in such cases?

A possible variant, in countries with extensive patenting, is to explore whether patents filed in those countries (or from those countries) cite patents filed overseas, and relate that to variables of interest. For instance, it is widely held that MNCs are less likely to cite technology-intensive activities in regions with weaker IP protection. Specifically, it has been suggested that MNCs are more reluctant to locate R&D operations in regions with weaker patent protection, because they fear that crucial proprietary technology could leak out. Though *prima facie* plausible, one could also provide alternatives that would imply the opposite. After all, insofar as the developing country is selected for R&D to support global production, not simply for sales in the developing country itself, what matters is patent protection in the target market, not patent protection in the country where R&D is conducted. As a case in point, Bayer, a pharmaceutical company, used patented research tools to conduct research overseas and to use the information generated to carry out follow-on research in the US. When challenged by the patent holder, Housey, Bayer successfully argued that this use was legal. The key is that in the country where the research was carried out, Housey had not filed for patents. Thus, certain types of research may be more attractive in countries with weaker patent protection.¹³

This suggests an obvious research opportunity. Even if it is the case that patent protection is important when deciding the location, the question is why. Is the concern that competing substitutes would be introduced (in the domestic market) with weak patent protection, or is it principally that somehow stronger patent protection in the recipient country will nonetheless protect against vital knowledge from leaking out, even when the patent protection is strong in the principal market? Indeed, Zhao (2006) studied the patenting behavior of MNCs, where she used USPTO data and found that patents filed by MNCs from inventors in countries with weak patents cite other patents of the MNC more heavily as compared to patents filed by the same MNC from inventors in countries with stronger patents. The inference is that MNCs locate only a selected part of their R&D activities in weak patent countries so as to minimize the chances of technology leaking out. This is a topic that calls for more extensive research, including more detailed case study research.

Another type of case study might be to focus on patenting by foreigners and to follow its impact. Are such patent filings accompanied by the introduction of new products or processes by the patent holder? How quickly do domestic firms follow suit? Are patent filings by an overseas firm followed by patents citing that patent, by implication, building on the initial patents?

In designing such studies, one faces a similar challenge of finding variations in the extent of IP protection, either across countries (if done for the same industry), or across industries (if done within a country). For instance, in studying the impact of patent protection on diffusion, one has to either compare across industries in a country or across countries in an industry. In the former, the problem is to control adequately for differences across industries in the nature of the technology itself which might condition diffusion. For instance, for technologies that are more codified, obtaining patent protection is easier but it may also be easier to diffuse. In the latter case, the problem is to control for unobserved differences across countries that might be correlated both with the strength of IP protection as well as diffusion. There are no silver bullets available.

6.1 IPRs and the Demand for Technology

Although it is widely recognized that IP protection would affect the value of the technology in the recipient country, this aspect has not been quantitatively studied in sufficient detail. Much of the discussion has been focused on the supply side, namely the willingness of technology holders to transfer technology, the form taken to accomplish the technology transfer and the contractual provisions and details. The literature has also devoted a great deal of attention to the absorptive capacity of the recipient country or firm. However, absorptive capacity is only one aspect, albeit an important one, of the demand for technology. For current purposes, I am proposing research on how IP protection affects the demand for technology. Another obvious research question is to explore what impact the IPR regime has on the nature of competition in the domestic market, and how market structure and the IPR regime together condition the value of technology.

Measuring the demand for technology separately from the supply of technology will pose additional data challenges. One interesting source of data is the stock market, the valuation it puts on R&D and how that valuation changes with changes in IP protection. For instance, Arora, Branstetter and Chatterji (2007) used data on publicly traded Indian pharmaceutical firms and found that the implied value of the capitalized R&D expenditures increased with the strengthening of the pharmaceutical patent regime. This study did not address technology transfer directly but one could imagine similar studies using the stock of expenditures on imported technology. Indeed, one could extend the analysis to separately analyze the value of R&D stocks and imported technology stocks, which would also enable one to estimate the relationship between indigenous R&D and technology imports.

Another useful method would be a case study of individual firms or industries, to understand in greater detail the role of IP protection in conditioning the demand for technology. One interpretation of the Arora *et al* study of the Indian pharmaceutical industry is that the change in the patent regime profoundly changed the strategies of the leading firms, moving them away from imitation towards innovation. In some industries, such a move might involve an increase in the demand for technology, where some or all of this increased demand may be satisfied by technology imports.

A virtue of the demand for the technology approach is that it will naturally lead researchers to look at the source of technology. Though we tend to think of technology, especially patented technology, as being unique, in reality there are many sources often offering close substitutes. For instance, in the oil-refining industry, technology may be obtained from pure technology suppliers such as UOP; from engineering contractors such as ABB/Lummus; licenses from oil companies themselves and from FDI. How does the strength of IPR condition the relative attractiveness of these different sources of technology? Extending this, one can examine, for a given industry, where the IPR regime varies across otherwise similar countries, the differences in the source of technology transfer and the consequences for productivity.

7. CONCLUSION

While the literature on international technology transfer has been growing over recent years, there remain a number of important gaps concerning the role of IPRs in international technology transfer, particularly in developing countries and countries with economies in transition. This paper has sought to identify ways in which those gaps might be partially filled by suggesting avenues for further research and exploring under-researched topics in order to obtain a better understanding of intellectual property and its impact on international technology transfer.

Notes

- 1 The focus on IPRs has been intensified by efforts to have developing countries recognize and protect such IPRs as part of an overall effort to negotiate reductions in trade barriers.
- 2 Arguably, this too is a form of technology transfer, but is widely seen as a lesser form. The hankering for self-reliance, never buried too deep despite the intellectual appeal of the theorem of comparative advantage, doubtless plays a part here. The belief that technology itself feeds further technical advances is perhaps a more justifiable basis for seeking the transfer of advanced technology rather than merely the fruits thereof.
- 3 As a point of comparison, Arora, Fosfuri and Gambardella (2001) estimated that the global market for technology in 1995 was about 35 billion US dollars. Based on Robbins's estimate, the US alone now accounts for that volume.
- 4 Patent-based technology transactions are certainly not new. Lamoreaux and Sokoloff (1998) documented the extensive trade in patent rights in the US in the late 19th century. Also, while data availability limits the focus of the present chapter to technology licensing, the market for technology has other dimensions as well, including strategic alliance and mergers and acquisitions.
- 5 For an overview of the literature on the economics of copyright see Watt, this publication.
- 6 In 1416 the Grand Council of Venice awarded one, Franciscus Petri, from the island of Rhodes, a patent for a superior device for the fulling of fabrics – giving Petri and his heirs exclusive rights for 50 years to build, alter, and reconstruct the apparatus he would erect for that purpose. Venice, in the 14th century, had adopted patents as a means of encouraging an inward flow of technology. As early as 1332 its Grand Council established a privilege fund, providing loans and other rewards for a foreign constructor of windmills who offered to bring knowledge of this art to the city (see Prager 1944: p. 713).
- 7 Our focus in this paper is on how, if at all, IP protection affects spillovers and the different sources of the spillovers.
- 8 For instance, firms such as IBM and Microsoft each spent over 5 billion US dollars in research and development in 2000. By comparison, the latest figures available from the National Science Foundation indicate that R&D in all of Africa was only 5 billion US dollars in 2000 and only 18 billion US dollars in all of South America.
- 9 The importer of the technology had to file a TE-30 form with the Servicio de Información y Transferencia de Tecnología (Technology Transfer Office), a branch of the Spanish Ministry of Industry. In some cases, in addition to this form, the firm included the actual contract, although this was optional. This type of control is no longer allowed by the EU, and thus filing was terminated in 1992.
- 10 The author is grateful to Albert Hu for bringing this point to his attention.
- 11 The author is indebted to Beata Javorcik for this suggestion.
- 12 See Cockburn, this publication.
- 13 For more details, see <http://caselaw.lp.findlaw.com/scripts/getcase.pl?court=fedandnavby=caseandno=021598>.

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COMMENTS ON INTELLECTUAL PROPERTY RIGHTS AND THE INTERNATIONAL TRANSFER OF TECHNOLOGY: SETTING OUT AN AGENDA FOR EMPIRICAL RESEARCH IN DEVELOPING COUNTRIES

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Professor Arora's paper is a very useful summary of the current state of knowledge on the relationship between IPRs and international technology transfer. It points out shortcomings in the currently available measures of IPR protection, discusses methodological challenges facing researchers studying the link between IPRs and economic activity and suggests several areas for future research.

These comments will extend the discussion presented in his paper in three areas. First, they will suggest possible remedies for some of the shortcomings of the existing indices of IPR protection. Second, they will argue that the methodological challenges faced by studies of the relationship between IPRs and economic activity are unlikely to be resolved unless researchers put more effort into understanding the determinants of IPR protection. Finally, they will recommend studying spillovers associated with FDI as a fruitful subject of future research.

Starting with the first area, one of the main criticisms of the existing measures of patent protection, such as the indices compiled by Rapp and Rozek (1990) and Ginarte and Park (1997) is that they capture laws on the books but not their enforcement. Yet, as is widely known, not all countries enforce their IPR legislation to the same extent. However, if IPR laws were enforced to the same extent as other laws, one possible remedy would be to use the indices of patent protection in conjunction with indices of governance. For instance, the database by Kaufman, Kraay and Mastruzzi (2007) includes indicators covering 212 countries and territories and measures six dimensions of governance between 1996 and 2006. The indicators capture government effectiveness (the competence of the bureaucracy), rule of law (the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence) and control of corruption (the exercise of public power for private gain, including both petty and grand corruption and state capture). While employing these measures will not completely address the criticism, it will certainly give us more confidence in the results of empirical studies.

An alternative approach to relying on indices of patent protection is to focus on incidents of IPR reform, as done by Branstetter, Fisman and Foley (2006). The key advantage of this approach is the smaller data collection burden, but the disadvantages include inability to distinguish between various aspects of reforms and potential endogeneity with respect to outcomes of interest.

Yet another option is to initiate a new data collection effort. The World Bank's Doing Business Indicators may be a good model to follow. The basic idea is to create some hypothetical scenarios involving, for instance, patent or copyright infringement and ask law firms in countries around the world to provide information on the duration, available remedies and costs of resolving the case. The advantage of this approach is that it would capture the current state of laws and their enforcement and the information could be collected within a relatively short period of time. The main disadvantage would be the lack of time variation as it is difficult, if not impossible, to collect high quality historical data.

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Moving on to the second area, as Professor Arora discussed in his paper, a major shortcoming of most studies investigating IPR-related issues has been the failure to convincingly establish the direction of causality. To illustrate the difficulties involved with a simple example, let us assume a researcher is interested in asking whether sectors relying heavily on IPRs grow faster (or more slowly) in the presence of stronger IPR protection. Even if a researcher finds a positive relationship between growth in such sectors and IPR protection, this relationship will be difficult to interpret. It can be that IPR protection stimulates growth in these sectors, but it is also possible that fast development of sectors relying on IPRs encourages countries to adopt stronger protection. Disentangling the two scenarios is certainly not an easy task.

In my view, the first step towards establishing the direction of causality is to develop a deep understanding of the determinants of IPR protection. This will allow us to assess which IPR protection measures are appropriate in a given context and suggest ways of establishing the direction of causality. The list of potential determinants of IPR protection includes political economy factors, such as industrial composition in the country and, in particular, importance of domestic industries relying on IPR protection and existence of industries benefiting from weak protection. Another potentially important determinant is external pressure exercised through multilateral, regional or bilateral trade agreements, Section 301 of the US Trade Act or multinationals operating in the country.

Finally, as for suggestions for future research, focusing on spillovers from FDI seems to be a promising agenda for several reasons. First, almost all countries in the world are engaged in FDI promotion, and 59 out of 108 countries surveyed in the World Bank's census of investment promotion agencies offered FDI incentives in 2004 (Harding and Javorcik (2007)). The reason for this enthusiastic welcome is that FDI is viewed as one of the key channels of technology transfer across international borders. This is not surprising given that 700 multinational corporations accounted for 46 per cent of the world's total R&D expenditure and 69 per cent of the world's business R&D in 2002. Considering that there are about 70,000 multinational corporations in the world, this is a conservative estimate. In 2003, the gross domestic expenditure on R&D by the eight new members of the EU at 3.84 billion US dollars¹ was equal to about half of the R&D expenditure of the Ford Motor Company (6.84 billion), Pfizer (6.5 billion), DaimlerChrysler (6.4 billion) and Siemens (6.3 billion) during the same year. It was comparable to the R&D budget of Intel (3.98 billion), Sony (3.77 billion), Honda and Ericsson (3.72 billion each) (see UNCTAD (2005)).

Many host countries hope that the knowledge brought by foreign investors will not be limited to FDI projects but will also spill over to indigenous producers. This can happen when workers move from foreign companies to domestic enterprises taking with them knowledge and skills acquired while working for a multinational, when domestic companies observe actions of their foreign competitors and in this way learn about new technologies and marketing techniques or when domestic suppliers of multinational enterprises benefit from the knowledge acquired through such a relationship.

There already exists some evidence of FDI being responsive to IPR protection. For instance, Javorcik (2004) found that firms in industries relying heavily on IPR protection were *ceteris paribus* more likely to invest in transition countries with stronger IPR protection. Branstetter, Fisman and Foley (2006) demonstrated that strengthening of IPR protection in host countries leads to increased technology transfer to foreign affiliates located in these countries.

Therefore, it is likely that differences in IPR protection affect the extent of FDI spillovers. Differences in IPR protection could be one reason why studies focusing on different countries produce very different findings with respect to intra-industry spillovers (for a review of the liter-

ature on FDI spillovers (see Görg and Greenaway (2004)). In countries with weak IPR laws, multinationals may put more effort into restricting knowledge flows or may choose not to transfer their latest technologies to begin with. While studies of spillovers to local suppliers are more consistent in finding a positive effect (see Javorcik (2004), Blalock and Gertler (2008)), relationships between multinationals and local suppliers are also likely to be affected by the extent of IPR protection. On the one hand, weak IPR protection may discourage knowledge transfer from multinationals to local suppliers and may discourage suppliers from undertaking innovation in order to supply foreign affiliates. On the other hand, if local suppliers can provide cheaper inputs thanks to their ability to infringe on technologies patented in other countries, lower IPR protection can increase the volume of inputs sourced and stimulate spillovers. It would be instructive to examine these issues using firm-level panel data for multiple countries and relate the extent of FDI spillovers to IPR protection in host countries. Alternatively, one could perform a meta-study of existing empirical work taking into account host country conditions.

To sum up, studying implications of IPR protection for economic activity is a promising research area with potentially important implications. Much work, however, remains to be done to produce convincing evidence on this link. The first step towards doing so is to devise better measures of IPR protection and deepen our understanding on the determinants of IPR protection.

Note

- 1 Countries included are the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. As the 2003 figures were not available for Lithuania and Slovenia, data for 2002 were used for these countries.

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COMMENTS ON INTELLECTUAL PROPERTY RIGHTS AND THE INTERNATIONAL TRANSFER OF TECHNOLOGY: SETTING OUT AN AGENDA FOR EMPIRICAL RESEARCH IN DEVELOPING COUNTRIES

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Professor Arora has conducted an informative review of the economics literature on the relationship between IPRs and the international transfer of technology in the context of developing countries. The thoughtful research agenda that he set out will no doubt be a useful guide for empirical researchers working in this area. My comments will largely involve elaborating on some of the themes touched upon in Professor Arora's paper and also highlighting some of the conceptual and measurement challenges researchers often find themselves wrestling with in this literature. I will also try to bring in some empirical observations of the experiences of the newly industrialized East Asian economies and China.

International Technology Transfer: Scope and Measurement

The literature available is often ambiguous about the scope of international technology transfer. It ranges from pure technology spillovers to arms-length technology licensing. This relates to Professor Arora's plea for a more broad-based approach to the conceptualization of technology. Strengthening IPR protection in developing countries is likely to have different impacts on the intensity of these different types of technology diffusion across national borders. For example, stronger IPR may raise the private return to technology licensing or FDI, but it may restrict the scope and magnitude of technology spillovers. Since these channels of technology diffusion generate different welfare implications for both sides of the technology transfer, it is important to understand empirically how IPR reform changes the relative intensity of technology diffusion through different channels.

Kim (2003) observed that in the Republic of Korea's early stage of economic development, Korean firms obtained simple, mature technology through "informal" channels, in part because such technology had become non-essential to the competitive strength of Western companies; on the other hand, more sophisticated, intermediate technology diffused to Korea largely through licensing, FDI and personnel flow. It is obviously a huge measurement challenge to properly account for these different kinds of technology diffusion. An imperfect solution is to employ a multitude of indicators of technology transfer in assessing the impact of IPR on international technology transfer: FDI spillover, technology licensing, patent citations, and personnel flow.

IPR Regime and Economic Development

One of the most interesting findings of the literature on IPR and economic development (Maskus (2000) and Chen and Puttitanun (2005)) showed that there was a U-shaped relationship between the strength of a country's IPR regime and the country's *per capita* GDP using a cross-section sample of countries. If one is willing to give the result a temporal interpretation, it suggests that a country's IPR regime is not independent of its level of economic development.

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As countries develop, their IPR regime will weaken before it is strengthened. Thus, cross-country differences in IPR regime, which many studies in the literature exploit as an exogenous source of variation to identify the impact of IPRs on international technology transfer, require more careful interpretation. Changes in IPR regime may also be driven by other extraneous forces. Since the Agreement on Trade-Related Aspects on Intellectual Property Rights (the TRIPS Agreement) placed IPR protection front and center in trade liberalization negotiations, reform of a developing country's IPR regime and its expanded engagement with the global economy are likely to be driven by the same pressures from developed countries to strengthen IPR protection.

IPR, Market Power, Competition and Technology Transfer

The theoretical literature on the impact of IPRs on international trade differentiated the market power generation effect from the market expansion effect of IPRs (Helpman and Krugman, 1985). While stronger IPRs in the host country may lead to a broader range and larger volume of exports from countries that benefit from the more effective protection of IPR, the greater market power that the exporting firms acquired from their IPR may dampen their incentive to increase sales. Thus, *a priori*, it is unclear whether stronger IPR will lead to a higher rate of technology transfer since the return to the latter is correlated with trade. So, instead of transferring more technology to the developing market, multinational corporations may just charge a higher price for the same technology.

In order to restrain the static welfare loss from IPR, it is therefore, at least conceptually, in the interest of developing countries to review and strengthen their competition policy in conjunction with adopting a more rigorous IPR regime. This is an area that has been under-investigated.

Proponents of stronger IPR protection in developing countries often invoke, implicitly or explicitly, the dynamic efficiency hypothesis. It suggests that stronger IPR would lead to more resources committed to building up the indigenous R&D capability of the developing country firms while inducing a higher rate of technology transfer from developed countries to developing countries. The competence of conducting R&D that developing country firms acquire not only helps them to innovate but also to absorb technology diffusion from developed countries. In the end, they will be able to climb the technology ladder. The scant attention paid to this hypothesis in the theoretical and empirical economics literature is overshadowed by the enormously successful experiences of Japan and the newly industrialized Asian economies, where some version of the dynamic efficiency hypothesis may well have been behind their success with technical progress. It seems that illuminating industry case studies such as that of Mathews and Cho (2001) on the Asian semiconductor industry would be extremely informative to find out if and how IPR has played a role in such technological catch-up or leapfrogging.

The Chinese Experience

In the last part of my comments, I would like to briefly describe the Chinese experience with international technology transfer, which shows the peril of generalization of policy lessons. Technology transfer from developed country firms to China has accelerated in recent years despite the general perception of weak IPR protection in China. The semiconductor and the automobile industries are two notable examples (Hu and Jefferson (2008)). Both industries are highly integrated with the global industry value chain and have hosted large FDI inflows. The technological sophistication of these FDI flows has noticeably accelerated in recent years. China's experience demonstrates that IPR is but one of the concerns of transferors of technology. Market size, openness and competition also play important roles in changing the dynamics of international technology diffusion.

Many developed country firms are drawn to China because of its huge market potential. China's commitment to economic openness has reduced the barriers to enter the Chinese market for these firms. As *per capita* income rises in China and foreign and domestic firms aggressively compete for the potential of the market, the technological sophistication of the products sold in China increases, which induces foreign firms to transfer more sophisticated technology to the Chinese market despite concerns about the appropriability of such newly transferred technology. In examining the surge of foreign interest in Chinese patents, Hu (2007) found that the number of Chinese patents from foreign countries is highly correlated with that of another foreign country when the two countries engage in product market competition in China.

How IPR affects international technology transfer has become an increasingly pressing issue for developing countries given the mounting pressure that they face in bringing their IPR protection to the level of that in developed countries. The literature has produced interesting insights and policy implications but much remains to be done. An eclectic approach, both in terms of measurement and methodology, is likely to produce findings that would be useful in providing guidance for public policy.

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