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DISCUSSION PAPER

Intellectual Property Protection, Foreign Direct Investment, and Technology Transfer

Edwin Mansfield



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Washington, D.C.

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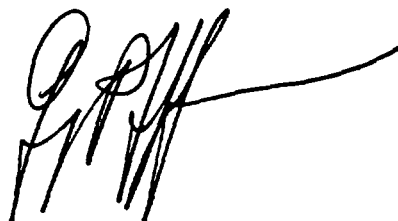
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Foreword

This Discussion Paper presents the first empirical evidence to my knowledge on the relationship between, on one hand, respect/disrespect for patents and other forms of intellectual property rights on the part of developing countries, and, on the other hand, foreign direct investment flows which are being attracted to these developing countries. The research project on which the findings are based was initiated by the IFC's Economics Department. Edwin Mansfield is director of the Center for Economics and Technology and Professor of Economics at the University of Pennsylvania.

A handwritten signature in black ink, appearing to read 'G.P.P.', with a long horizontal flourish extending to the right.

Guy P. Pfeffermann
Director, Economics Department
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Abstract

Policy makers and analysts require a better understanding of the effect, if any, that a developing country's system of intellectual property rights protection has on the transfer of technology to that country through foreign direct investment. It is frequently argued that relatively weak intellectual property rights protection in a developing country may lower the probability that multinational firms will invest there, and that, even if they do invest there, they may be willing (because of weak intellectual property protection) to invest only in wholly owned subsidiaries (not joint ventures with local partners) or to transfer only older technologies. But this and other hypotheses have been challenged, and there is very little evidence one way or the other.

This paper is an attempt to help fill this important gap. Based on a combination of survey data, interview studies, and statistical analysis, we find that the strength or weakness of a country's system of intellectual property protection seems to have a substantial effect, particularly in high-technology industries, on the kinds of technology transferred by many U.S. firms to that country. Also, this factor seems to influence the composition and extent of U.S. direct investment there, although the size of the effects seems to differ from industry to industry.

While we believe that this study sheds substantial new light on this topic, much more needs to be done. For one thing, the statistical analysis is only a beginning; further efforts should be made to refine and extend the results. Also, our findings pertain entirely to U.S. direct investment; it would be worthwhile to extend the coverage to Japanese and European investment. We are currently starting some work in these and other directions.

Acknowledgments

A preliminary description of some of the results derived in this paper was presented earlier in my 1993 article (cited below on page 43) published by the National Academy Press. I am indebted to Jacques Gorlin, Zvi Griliches, Robert Miller, Ashoka Mody, Mary Ellen Moguee, and Robert Sherwood who commented on this earlier paper. Also, thanks go to Gary Hufbauer, Leonard Lederman, Guy Pfeffermann, and others who took part in a seminar at the World Bank that I gave on this topic, and to Ashoka Mody and Brian Pinto for their comments on the present paper. Financial support was received from the Research Committee of the World Bank.

Foreign direct investment can be an important means of transferring technology to developing countries.¹ It is widely recognized that both policy makers and analysts require a better understanding of the effect, if any, that a developing country's system of intellectual property rights protection has on the transfer of technology to that country through foreign direct investment. Some observers² have argued that relatively weak intellectual property rights protection in a developing country may lower the probability that multinational firms will invest there, and that, even if they do invest there, they may be willing (because of weak intellectual property protection) to invest only in wholly owned subsidiaries (not joint ventures with local partners) or to transfer only older technologies. Other observers³ have challenged this hypothesis. Unfortunately, there is very little evidence to support or deny many of the hypotheses that have been put forth. The purpose of this paper is to help fill this important gap.

Based on a combination of survey data, interview studies, and statistical analysis, we find that the strength or weakness of a country's system of intellectual property protection seems to have a substantial effect, particularly in high-technology industries, on the kinds of technology transferred by many U.S. firms to that country. Also, this factor seems to influence the composition and extent of U.S. direct investment there, although the size of the effects seems to differ greatly from industry to industry. This paper begins with a description of our survey data, after which the interview studies are taken up, and some preliminary statistical analysis is discussed.

Effects of Intellectual Property Protection: A Survey of U.S. Firms

In 1991, I chose a random sample of 100 major U.S. firms in six manufacturing industries -- chemicals (including drugs), transportation equipment, electrical equipment, machinery, food and metals. The frame for this sample was the comprehensive list of major firms in *Business Week*, June 15, 1990. Each firm was asked to provide information regarding the importance of intellectual property protection in influencing whether or not the firm would make direct foreign investments of various types. Complete or partial information was obtained from 94 of the firms, a very high response rate. The respondents generally were patent attorneys, specialists in firms' international operations, and top executives. The limitations of survey data of this kind are well known, but interpreted with proper caution, they can be helpful.

The percentage of firms indicating that intellectual property protection has a major effect on their foreign direct investment decisions depends greatly on the type of investments in question (Table 1). For investment in sales and distribution outlets, only about 20 percent of the firms reported that intellectual property protection was of importance. For investment in rudimentary production and assembly facilities,⁴ about 30 percent said that such protection was important. For investment in facilities to manufacture components or complete products, about 50-60 percent said it was important, and for

¹For example, see Blomstrom and Wolff (1989).

²Sherwood (1988).

³United Nations (1993).

⁴Rudimentary production and assembly facilities are ones involving basic technologies that are reasonably well known to all firms in the relevant industry.

investment in R and D facilities, about 80 percent said it was important. Thus, to the extent that foreign direct investment by U.S. firms is focused heavily on sales and distribution outlets and on rudimentary production and assembly facilities, it appears that a country's intellectual property protection has a relatively small impact on the total amount invested by U.S. firms in that country. But it may have a much bigger impact on the amount invested in facilities to make components and complete products, as well as to do R and D.

For all types of investments other than in sales and distribution outlets, the chemical industry (which includes pharmaceuticals) has the largest percentage of firms regarding intellectual property protection as important in this regard. The food and transportation equipment industries tend to have the smallest percentage, and the electrical equipment, metals, and machinery industries tend to rank in the middle. As might be expected, there is a very high correlation between an industry's rank in this regard and its rank in previous studies with respect to rough measures of the importance of patents in the innovation process. (Intellectual property consists chiefly of patents, plant breeders' rights, copyrights, trademarks, and trade secrets.)

Perceived Intellectual Property Protection in Sixteen Countries

Each of the firms in our sample was asked to indicate whether, in its view, any of 16 countries—Argentina, Brazil, Chile, Hong Kong, India, Indonesia, Japan, Mexico, Nigeria, Philippines, Singapore, Republic of Korea, Spain, Thailand, Venezuela and Taiwan, China—had intellectual property protection that was too weak in 1991 to allow it to invest in joint ventures (where it contributed advanced technology) with local partners in that country. These countries were selected because of their size and importance, as well as the frequency with which they have been cited in connection with controversies over intellectual property protection. Except for Japan and Spain, these countries are major developing or newly industrialized countries in Asia, Latin America, or Africa. Japan and Spain were included so comparisons could be made to a developed country whose intellectual property protection has sometimes been a subject of controversy and to a relatively poor Western European country.

Over 30 percent of the U.S. firms felt that intellectual property protection in India, Nigeria, Brazil, and Thailand was too weak to permit them to invest in joint ventures there (Table 2), while 10 percent or less felt that this was true in Japan or Spain. The proportion of firms feeling that intellectual property rights protection in these countries is, on the average, too weak to permit such investments tends to be highest in the chemical industry, where patents are relatively important, and lowest in the metals industry.

Each of the firms was also asked whether, if it had a wholly owned subsidiary in one of the 16 countries listed, it would be willing to transfer its newest or most effective technology to such a subsidiary—or whether the weakness of the country's system of intellectual property protection would make such transfers very unlikely.² Thirty percent or more of the firms reported that they would be very unlikely to transfer such technology to India, Thailand, or Nigeria, but less than 5 percent felt this way about Japan or Spain (Table 3). Singapore seems to be regarded reasonably well, with only about

²Firms with subsidiaries (or joint ventures) in the country in question were asked this question. Firms without subsidiaries (or joint ventures) there were asked whether they would be willing to transfer such technology if they had such a subsidiary. The data in Table 3 pertain to all firms but are highly correlated with those pertaining only to firms having such subsidiaries (or joint ventures).

**Table 1 – Major U.S. Firms in Six Industries Where Strength or Weakness of Intellectual Property Rights Protection Has Strong Effect on Whether Direct Investments Will Be Made, 1991
(percent)**

Industry^a	Sales and Distribution Outlets	Rudimentary Production and Assembly Facilities	Facilities to Manufacture Components	Facilities to Manufacture Complete Products	Research and Development Facilities	Mean
Chemical^b	19	46	71	87	100	65
Transportation equipment	17	17	33	33	80	36
Electrical equipment	15	40	57	74	80	53
Food	29	29	25	43	60	37
Metals	20	40	50	50	80	48
Machinery	23	23	50	65	77	48
Mean	20	32	48	59	80	48

^a The number of firms in the sample in each industry is chemical, 16; transportation equipment, 6; electrical equipment, 35; food, 8; metals, 5; machinery, 24. However, not all firms in the sample responded to all questions.

^b The chemical industry includes pharmaceuticals.

Table 2 -- Major U.S. Firms Reporting That Intellectual Property Protection Is Too Weak to Permit Investment in Joint Ventures with Local Partners, by Industry and Country, 1991^a
(percent)

Country	Chemical [†]	Transportation Equipment	Electrical Equipment	Food	Metals	Machinery	Mean
Argentina	40	0	29	12	0	27	18
Brazil	47	40	31	12	0	65	32
Chile	31	20	29	12	0	23	19
Hong Kong	21	20	38	12	0	9	17
India	80	40	39	38	20	48	44
Indonesia	50	40	29	25	0	25	28
Japan	7	40	10	0	0	0	10
Mexico	47	20	30	25	0	17	22
Nigeria	64	20	39	29	20	24	33
Philippines	43	40	31	12	0	18	24
Singapore	20	40	24	12	20	0	19
Rep. of Korea	33	20	21	12	25	26	23
Spain	0	0	10	0	0	4	2
Taiwan, China	27	40	41	25	20	17	28
Thailand	43	80	32	12	0	20	31
Venezuela	40	20	19	12	0	20	18
Mean	37	30	28	16	7	21	23

^a See Table 1. Some firms reported they had too little information and experience regarding particular countries to provide this information. For these countries, firms of this sort are excluded. The number of firms that had to be excluded for this reason is generally very small.

^b See note b, Table 1.

14 percent of the firms being unwilling to transfer such technology there. The percentage of firms feeling that intellectual property protection in these countries is, on the average, too weak to permit such technology transfer is relatively high in the chemical industry and relatively low in the metals industry; the industry ranking is much the same as in Table 2.

In addition, each firm was asked to indicate whether the protection of intellectual property in each of 16 countries listed was too weak to permit it to license its newest or most effective technology to unrelated firms in that country. Over 30 percent of the firms said that this was the case for India, Brazil, Thailand, Nigeria, Indonesia and Taiwan, China (Table 4), while under 10 percent said this was the case for Spain and Japan. (More than two-thirds of the chemical firms reported that intellectual property protection in India, Indonesia, Nigeria, Thailand, and Brazil was too weak to permit licensing of their newest or most effective technology there.) The percentage of firms feeling that intellectual property protection in these countries was, on the average, too weak to permit licensing is relatively high in the chemical industry and relatively low in the metals industry, the industry ranking being similar to Tables 2 and 3.

Measures of Perceived Intellectual Property Protection

Tables 2-4 provided three crude measures of the perceived strength or weakness of intellectual property protection in 16 countries:

- (1) the percentage of firms believing that protection there is too weak to allow them to invest in joint ventures with local partners;
- (2) the percentage believing that protection is too weak to warrant the transfer of their newest or most effective technology to a wholly owned subsidiary in that country;
- (3) the percentage believing that protection is too weak to allow them to license their newest or most effective technology to unrelated firms in that country.

While the roughness of these measures should be stressed, they nonetheless should be of interest. A country's standing based on one of these measures tends to be highly correlated with its standing based on another of them. The coefficient of determination between the first two of the above measures averages about .73; the coefficient of determination between the first and third measures averages about .85; and the coefficient of determination between the second and third measures averages about .82. Because these three measures are so highly correlated, which one we employ makes relatively little difference for many purposes. In the analysis below, we often will use (in each industry) the mean of these three measures for a particular country as a rough index of the perceived strength or weakness of intellectual property rights protection in that country (for this industry).

There is little correlation between one industry's evaluation of the strength or weakness of intellectual property protection in a particular country and another industry's evaluation of the strength or weakness of intellectual property rights protection in the same country. To illustrate, consider our first measure of the strength or weakness of a country's protection system--the percentage of firms reporting that a country's protection is too weak to allow them to invest in joint ventures with local partners. While there generally is a moderate amount of correlation (r^2 greater than or equal to .40) among the evaluations by the chemical, food, machinery, and electrical equipment industries, there is little or no correlation between these four industries and the transportation equipment industry or between these four

industries and the metals industry. Reasons for this low level of correlation are discussed on pages 10-11 below.^{6/}

When we compare our findings in Tables 2-4 with the Pharmaceutical Manufacturers Association's (PMA) list of countries with very weak intellectual property protection,^{7/} we find both a reasonable degree of correlation and significant differences. Although Nigeria and Taiwan, China tend to have relatively weak protection based on our measures, they are not on the PMA list; and while Argentina, Chile, Mexico, the Philippines, and Venezuela are on the PMA list, they are not among the weakest based on our measures. However, this seems to be due in large part to our more extensive industrial coverage. If we focus solely on our results for the chemical industry (which includes pharmaceutical firms), our measures agree almost exactly with the PMA list, Nigeria being the only exception.^{8/}

If we compare our measures with those of Rapp and Rozek (1990), who used a procedure based on Gadbow and Richards (1988) to construct an index of patent protection measuring the extent of conformity of a country's patent laws to the minimum standards proposed in the *Guidelines for Standards for the Protection and Enforcement of Patents* of the U.S. Chamber of Commerce Intellectual Property Task Force, we find that there is considerable correlation between their index and ours. (Their index ranks the extent of patent protection on a scale from 0 to 5, where a country with no patent protection at all received a 0 and a nation whose laws are fully consistent with these minimum standards receives a 5.) Since their index is based solely on the laws on the books, not on the ways these laws are enforced, their results would be expected to differ somewhat from ours. Also, their results lump all industries together. For many purposes, interindustry differences are important, as we have seen, and it is necessary to formulate a separate index for each industry, as we have done in Tables 2-4.

The Estimates of the U.S. International Trade Commission

In 1988, the U.S. International Trade Commission (ITC) published a study which ranked

countries in the approximate order of negative marketplace impact ... that resulted from inadequate intellectual property protection. In assessing negative marketplace impact, the following factors were considered--market size, share of market lost, export market losses in third countries, reduction in margins through price competition and price controls set by reference to the price of infringing material, goods, or services; use of confidential test data by others, without the respondent's authorization, in securing government approvals; lost manufacturing efficiency because of reduced volume; loss of reputation and diminished

^{6/}Note that the percentage of firms in the metals and transportation equipment industries with foreign subsidiaries or joint ventures in at least one of these countries is as large as it is in the electrical equipment and machinery industries; so differences in this regard are not responsible for the lack of correlation.

^{7/}See Moge (1989) and Rozek (1990) for this list.

^{8/}Frame (1987) has constructed an index based on the PMA list and the International Trade Commission data discussed in the following section.

Table 3 -- Major U.S. Firms Reporting That Intellectual Property Protection Is Too Weak to Permit Transfer of Their Newest or Most Effective Technology to Wholly Owned Subsidiaries, by Industry and Country, 1991^a
(percent)

Country	Chemical ^b	Transportation Equipment	Electrical Equipment	Food	Metals	Machinery	Mean
Argentina	44	20	21	12	0	14	18
Brazil	50	40	24	12	0	39	28
Chile	47	20	21	12	0	27	21
Hong Kong	21	20	38	12	0	14	18
India	81	40	38	38	20	41	43
Indonesia	40	20	31	25	0	23	23
Japan	0	0	14	0	0	0	2
Mexico	31	20	21	25	0	22	20
Nigeria	67	20	25	25	20	23	30
Philippines	47	40	28	12	0	17	24
Singapore	12	40	21	12	0	0	14
Rep. of Korea	31	20	28	12	40	22	26
Spain	0	0	7	0	0	13	3
Taiwan, China	19	40	41	25	0	35	27
Thailand	60	80	31	12	0	14	33
Venezuela	50	20	18	12	0	18	20
Mean	38	28	25	15	5	20	22

^a See Table 2.

^b See Table 1.

Table 4 -- Major U.S. Firms Reporting That Intellectual Property Protection Is Too Weak to Permit Licensing of Their Newest or Most Effective Technology to Unrelated Firms, by Industry and Country, 1991^a
(percent)

Country	Chemical ^b	Transportation Equipment	Electrical Equipment	Food	Metals	Machinery	Mean
Argentina	62	0	26	12	0	29	22
Brazil	69	40	29	25	0	73	39
Chile	47	20	22	12	0	25	21
Hong Kong	33	20	38	12	0	14	20
India	81	40	38	38	20	50	44
Indonesia	73	20	33	25	0	37	31
Japan	12	20	17	0	0	0	8
Mexico	56	20	28	25	0	36	28
Nigeria	73	20	32	38	20	25	35
Philippines	47	40	34	12	0	24	26
Singapore	25	40	24	12	20	0	20
Rep. of Korea	38	20	34	12	40	29	29
Spain	6	0	14	0	0	14	6
Taiwan, China	44	40	55	25	20	36	37
Thailand	73	80	36	12	0	25	38
Venezuela	62	20	21	12	0	26	24
Mean	50	28	30	17	8	28	27

^a See Table 2.

^b See Table 1.

value for the company name because of counterfeiting or other infringing activity; and increased product liability costs; the added costs of intellectual property enforcement attempts; the difficulty of doing business in a straightforward, efficient manner; and opportunity losses where inadequate intellectual property protection acted as a deterrent to business activity.

The ITC's rankings were based on 1986 data received from 161 American firms in a variety of manufacturing and nonmanufacturing industries. For the 16 countries in Tables 2-4, the rankings (from largest to smallest losses to U.S. respondents) are (1) Taiwan, China (2) Mexico, (3) Republic of Korea, (4) Brazil, (5) India, (6) Japan, (7) Nigeria, (8) Hong Kong, (9) Indonesia, (10) Spain, (11) Singapore, (12) the Philippines, (13) Thailand, (14) Venezuela, (15) Argentina, and (16) Chile. The correlation between these rankings and our own is relatively low (about .33). Mexico, Republic of Korea, Japan, and Spain seem to rank higher on the ITC's list of countries (based on negative marketplace impact) than on our list, while India, Nigeria, Indonesia, and Thailand seem to rank lower on the ITC's list than on ours.

To a substantial extent, this low correlation seems to reflect the fact that the two rankings are measuring different things. The ITC is measuring the reduction in profits imposed by a country's firms on U.S. firms, whereas the present study focuses on the willingness of U.S. firms to engage in joint ventures or to license or utilize advanced technology in a country. Even if the profit reductions imposed on them by a particular country's firms are small (perhaps because this country's firms are not very adept), U.S. firms may not be willing to engage in such activities in that country. Yet U.S. firms may be willing to engage in these activities in another country even if the profit reductions are large, because they nonetheless find these activities profitable there. Also, the ITC's rankings are influenced heavily by counterfeiting, not taken up here, and by the entertainment industry, not included here.

The ITC's study shows the number of times that the firms in its sample reported inadequacies in a country's patent protection regime and inadequacies in remedies and enforcement in 1986. The correlation between this number and our results in Tables 2-4 is very low, which may reflect the fact that the ITC questionnaire asked firms to list countries "in approximate order of importance to you, which you would most like to see adopt fully adequate and effective intellectual property protection:" (U.S. International Trade Commission, 1988: D-22). The countries that are cited most often are those where U.S. firms felt that their reductions in profit due to weak intellectual property rights protection were biggest, not those in which U.S. firms would be least likely to license or utilize advanced technology. To repeat, these may not be the same thing.^{9/}

Why Protection Is Regarded as Inadequate and Why Perceptions Vary among Industries

Interviews with officials of many of the companies in our sample indicate that, in deciding whether a particular country's system of protection is too weak, they are especially interested in the answers to three broad questions. (1) Can the country's laws protect their technology? (As an illustration, some countries do not allow chemical or drug products to be patented.) (2) Is there an adequate legal infrastructure in the country? (Some countries contain few patent attorneys or other specialists in this area of expertise.) (3) Do the relevant government agencies in the country enforce the

^{9/}Also, countries like the Republic of Korea acted to strengthen their system of intellectual property protection after 1986. This too may help to explain the low correlation.

laws and provide prompt and equitable treatment to foreign firms? (In some countries, there are reports of corruption and of discrimination against foreign firms.)

In some of the 16 countries in Tables 2-4, a substantial number of U.S. firms seem to feel that the answer to at least some of these questions is no. In India, products patents are not issued for drugs, chemicals, alloys, optical glass, semiconductors, and intermetallic compounds. In Thailand, firms have objected to the lack of patent protection for chemicals, drugs, food and beverages, and agricultural machinery, as well as the weak protection of trademarks and copyrights.¹⁰ In Brazil, there is no patent protection for chemicals, drugs, and foodstuffs, and complaints have been made about weak trade secret protection.¹¹ In Taiwan, China, foreign firms have claimed that patent protection for chemicals and pharmaceuticals has been inadequate and that there has been no unfair competition law dealing with false advertising, imitative product packaging, and inaccurate marks of origin. In 1986, a revised patent law was passed that extends full patent protection to chemical and pharmaceutical products, but many problems are said to remain.¹²

If a country grants patent protection, this does not mean that the length of the patent is the same as in the U.S. (17 years). In India, those patents that are permitted in the food, medicine, and drug industries extend for seven years. In some countries, the patent holder must work the invention within one to three years after the patent is issued; if they do not do so, the patent is subject to compulsory licensing or may lapse. Firms argue that they cannot make their products in every country where they expect patent protection. When compulsory licenses are granted, the royalty rate is often set at 0.5 percent or less of sales, which firms regard as very low. In India and the Philippines, drug patents are subject to compulsory license on demand, even if the invention is worked there by the patent holder.¹³

Tables 2-4 have indicated that industries differ considerably in their evaluation of intellectual property rights protection in particular countries. Interviews with firms show that intellectual property protection does not play the same role for each industry. In some industries like metals and transportation equipment, competitors frequently cannot make effective use of a firm's technology without many expensive and complex complementary inputs. In other industries such as chemicals, local firms can imitate an innovator's new products relatively easily. Differences of this sort help to account for the lack of correlation between the chemical industry's evaluations of specific countries and the metals or transportation equipment industry's evaluations of these same countries. Since these industries do not face the same problems, they often evaluate a specific country quite differently.

¹⁰/See Sen (1990) on India and Schumann (1990) on Thailand. In the May 25, 1989 report of the U.S. Trade Representative on "Special 301," Thailand and India were leading on its "priority watch list," followed by the Republic of Korea, Taiwan, and the People's Republic of China.

¹¹/See Frischtak (1990) and Sherwood (1988). Also, metallic admixtures and alloys are not patentable unless they have "specific intrinsic qualities precisely characterized by the nature and proportions of their ingredients or by special treatment." Nonetheless, as shown in Tables 2 to 4, this seems to have had little or no effect in discouraging U.S. metals firms, illustrating once again the importance of an industry-by-industry analysis. According to some U.S. metals firms, they often can incorporate sensitive technologies in "black boxes" that can be protected.

¹²/See Schumann (1990) and references in note 13.

¹³/See Goans (1986), Hill (1985), Matthews (1988), and the President's Commission on International Competitiveness (1985).

A country's laws often affect different industries in quite different ways. Countries that do not extend patent protection to drugs and chemicals obviously are likely to receive low evaluations from the chemical industry, even though other industries--often ones in which patent protection is of less importance in any event--do not regard these countries very negatively. Thus, Argentina (which denies patent protection to drug products) and Venezuela (which has denied patent protection to drug products or chemical preparations, reactions, or compounds) get poor evaluations from chemical firms. (Almost two-thirds of U.S. chemical firms said protection in both of these countries was too weak to permit them to license their newest or most effective technology there.) But outside the chemical industry, U.S. firms give both of these countries relatively good evaluations. (Only about 15 percent of U.S. nonchemical firms said protection in these countries was so weak they could not license such technology there.)

Interindustry variation in the evaluation of protection in any specific country may also reflect the fact that local firms in one industry in this country may be more aggressive in exploiting weak laws and enforcement than local firms in another industry. While intellectual property protection may not vary between these two industries, U.S. firms may perceive it to be weaker in the former industry than in the latter. Some observers have suggested that this helps to explain our results regarding Argentina; in their view, Argentina's drug firms have been much more aggressive in this regard than other parts of Argentinean industry.

Responses and Views of Individual U.S. Firms Regarding the Effects of Intellectual Property Rights Protection

In previous parts of this report, data have been presented that summarize the responses of 94 U.S. firms to a number of central questions we asked them regarding the effects of intellectual property rights protection on their decisions concerning foreign direct investment and the transfer of technology. While summary data of this sort are of great value in delineating the overall contours of their responses, they cannot convey many of the nuances. Having spent over two years communicating with these firms, and probing their responses, I can testify that the viewpoints of U.S. top managers on this topic constitute a rich, variegated, and complex mosaic. To convey the spirit and range of their views, direct quotations of their responses to key questions are provided in Appendix I of this paper. These quotations come almost entirely from written statements to us, so there is no chance of misquotation. About two dozen major firms are included, so a reasonable diversity of viewpoints can be encompassed. The only editing of the responses was to delete names or phrases that would identify the firm or executive.¹⁴

Some firms, particularly research-intensive firms with products (or processes) that are relatively easy to imitate assert that they will not make substantial investments or transfer advanced technology to countries with weak intellectual property protection. But most such firms we contacted, particularly outside the chemical (including drugs) industry, regard such protection as an important factor, but only one of a number of factors, influencing their investment decisions. As would be expected, many firms with limited R and D investments consider intellectual property protection to be relatively unimportant in the investment decision.

The firms in our sample tend to regard strong intellectual property protection as being more important in decisions regarding the transfer of advanced technology than in investment decisions.

¹⁴/Not all of the firms included in this part of the report were members of the sample underlying Tables 1-4. To supplement this sample, 12 additional firms were drawn at random from these industries.

Although some high-technology firms avoid transferring advanced technology even to countries with strong protection, this is not true of most firms we studied. But research-intensive firms, particularly in the chemical (including drugs) industry, often will not transfer advanced technology to countries with weak protection. According to the statements of the executives, who were a mix of chief executive officers, vice presidents, patent attorneys, and others, the technologies withheld because of weak protection would have benefitted these countries considerably. For direct quotations from their responses, see Appendix I.

Firms' Reactions to Recent Changes in Laws in Republic of Korea, Mexico and Taiwan, China

Each firm in our sample was asked to evaluate the significance of recent changes in intellectual property rights in countries like Republic of Korea, Mexico and Taiwan, China. Most felt that the changes were important. For example, a computer industry executive said:

We believe that the new trade secret and copyright laws in Republic of Korea, the [developments]... that should lead to a new copyright law in Taiwan, and the new patent, trademark, and copyright laws (as modified by the NAFTA draft agreement) in Mexico, are significant intellectual property law changes that will encourage investment.

According to the chairman of a chemical firm,

There is no question that intellectual property rights protection has improved in countries like Republic of Korea, Taiwan, and Mexico. This is particularly true of Mexico where the new proposals can serve as a role model for many other countries.

Many firms seemed to regard the changes in Mexico as particularly important to them. For example, a patent attorney at a food company said:

The changes in Mexico are probably the most significant to [us]. The changes in Republic of Korea and Taiwan appear to relate primarily to other aspects of intellectual property protection or other technologies, in particular pharmaceuticals in the case of Republic of Korea, and copyrights in the case of Taiwan. Even so, much of the change appears, from what we have read, to be window dressing rather than based on a real desire to implement a more favorable and effective intellectual property system.

A chemical R and D executive said:

The 1991 Mexican intellectual property law dramatically improved technology rights in that country. Of the three countries (Mexico, Republic of Korea, Taiwan), only Mexico made substantial changes in their laws. Since the law was not effective until August 1991, it is premature to make a judgment on enforcement.

Many of the respondents stressed that it would take a long time to determine whether the recent legal changes would be enforced. For example, the chairman of a chemical firm said:

[My firm] has been encouraged by the recent changes in the intellectual property laws in Mexico and Taiwan. These changes appear to add significant protection for our types of technology; however, it is still too early for us to determine whether the courts in these countries will be able to effectively translate the legal changes into real protection.

The managing counsel of a chemical firm commented as follows:

The awakening of Taiwan and Republic of Korea to the need to protect intellectual property rights has given comfort to plans to build plants there in conjunction with serving these markets. We are also freer to introduce new, even copiable products into these countries. The same is true of Mexico. This expanded business opportunity is only one side of the coin. The other side is that copying of our proprietary products, e.g., agrichemicals, does not exist. Prior to the new Taiwan patent law, Taiwan manufacturers copied and exported our proprietary agrichemicals which were not patent-protectable in Taiwan; this does not happen today. At the time of the new Korean patent law in 1987 and the accompanying protection provided by administrative guidance, we had information of at least one of our most important proprietary agrichemicals being developed for copying in Republic of Korea; this stopped. So, the law changes and the accompanying consciousness of the need to protect intellectual property, or trade pressure by the U.S. government, or all of the above has been helpful in sparing our agrichemical business from piracy on an international scale.

As to countries making substantial changes in laws and enforcement, I am more familiar with laws than enforcement, in the sense that enforcement questions are often not reached until after a period of operating under new laws. An exception is Mexico, which legislated criminal penalty, understood to include jail time, for infringement of intellectual property rights; that certainly gets people's attention. Mexico, Republic of Korea, and Taiwan have all legislated substantial improvements at least in their patent laws ... Indonesia has its first patent law.

The vice president of a pharmaceutical firm said:

The recently strengthened intellectual property rights of Republic of Korea and Mexico, as well as the newly reformed countries of Eastern Europe, are a welcome change. Republic of Korea, like Mexico, is now a country where serious investment by [us] in marketing and manufacturing is now possible. We must caution though, that the full significance of their improvements can't be judged until we see how vigorously those countries intend to enforce their laws. Finally, those

developing countries that comprise major pharmaceutical markets, such as Taiwan, India and Brazil, have not actually made any significant improvements in their intellectual property laws.

The following statement was made by a chemical executive:

The changes have indeed been significant for the chemical and pharmaceutical industry, because the products and sometimes even the processes of these industries were not protected under the former laws. Of particular importance are Korea, Taiwan, Mexico, the countries of Eastern Europe, and Spain. However, good laws mean nothing unless they can be enforced and enforcement is something that can only be judged by observing the system over a period of time. In our judgment it is too early to know whether the patents we are beginning to receive will indeed be enforceable. A new drug or agrochemical discovered today and patented in Taiwan will not be approved by health and environmental authorities for 5 to 10 years. Then they will have to be introduced to the market and the business built up to an interesting level. It is only at that point that a patent pirate will come into the market with an infringing product. So on chemical and pharmaceutical product patents we will not have a good idea of enforceability until late in this decade, if then. In the meantime we can draw some conclusions from enforcement in other areas such as copyright and trademark cases. In this connection, we understand that enforcement in Taiwan is still a serious problem, and that Korea is not much better.

While most firms seemed to welcome these legal changes, some stressed their limitations. For example, the chairman of an electronics firm stated: "I can certainly say that in the case of Republic of Korea there is absolutely no intellectual property rights protection. There has been no change ..." According to a chemical executive,

Many of the changes in the intellectual property laws in these countries will benefit industry segments other than the commodity chemicals business. Our concern still resides in being able to procure a quick injunction against a confidant who is in a position to disclose confidential information to third parties.

Changes During 1991-93 in the Evaluations of Mexico, Republic of Korea, India and Taiwan, China

Given the legal changes that have occurred in Mexico, Republic of Korea, and Taiwan, China, it is important to determine how many of the firms in Tables 2-4 that were unwilling in 1991 to transfer advanced technology to each of these countries would now (late 1993) be willing to do so. To obtain such information, a random sample of 50 percent of these firms was selected, and the relevant officials of each firm (or their successors) were re-interviewed. The results indicate that Mexico is the only one of these countries that has experienced a substantial increase in the proportion of firms willing to send it advanced technology. About 30 percent of the firms in Table 3 that said in 1991 that they were

unwilling to transfer their newest and most effective technology even to a wholly owned subsidiary in Mexico now say that they are willing to consider seriously such technology transfer.

On the other hand, despite the interest in the changes in Republic of Korea and Taiwan, China, there seems to be a wait-and-see attitude in many U.S. firms toward these countries. Only about 10 percent of the firms in Table 3 that said in 1991 that they were unwilling to transfer their newest and most effective technology even to a wholly-owned subsidiary in these countries now say that they are willing to consider seriously such technology transfer.

For the sake of comparison, we obtained the same sort of data for India as for Republic of Korea and Taiwan, China. The results suggest that attitudes toward Republic of Korea or Taiwan, China have not changed substantially more than toward India. About 10 percent of the firms in Table 3 that said in 1991 that they were unwilling to transfer their newest and most effective technology even to a wholly-owned subsidiary in India now say that they are willing to consider seriously such technology transfer. In considerable part, the limited change in attitudes toward Republic of Korea and Taiwan, China, is due to unresolved questions concerning enforcement of laws, discussed in the previous section. Also, some executives are frank in admitting that they have only a general knowledge of what changes have occurred in Republic of Korea and Taiwan, China.

Statistical Relationships between Protection and the Amount and Composition of Foreign Direct Investment

We turn now to some statistical tests to determine whether the perceived strength or weakness of intellectual property protection in a country is related to the size and composition of direct investment by U.S. firms in that country. These tests utilize the measures of the strength or weakness of such protection described earlier; these measures are based on the data we obtained from 94 firms. Our previous results have indicated that there has been no significant correlation between the extent of direct investment by U.S. firms in a country and the perceived strength or weakness of intellectual property protection in that country. (See Mansfield (1993).)

But whether or not such a correlation exists when other major determinants of U.S. direct investments are held constant is unknown. The purpose of the analysis described below is to see whether this is the case.

Size of Market and the Special Case of Mexico

Many economists have pointed out that direct investment in a particular country is likely to be influenced by the size of its market. For example, according to Anthony Scaperlanda and Laurence Mauer, "The size-of-market hypothesis, as generally stated, is based on the assumption that an inadequate market size has retarded the specialization of productive factors. The argument holds that the size of the market has been insufficient to absorb efficiently the technology which the direct investor desires to introduce. Based on this and related underlying assumptions, the size-of-market hypothesis is that foreign investment will take place as soon as the market is large enough to permit the capturing of economies of scale."^{15/} In their study of U.S. direct investment in the European Community, Scaperlanda and Mauer

^{15/}Scaperlanda and Mauer (1969), p. 560.

used gross national product as a measure of size of markets. So have many studies of investment in developing countries.

Robert Stobaugh has indicated some drawbacks in the use of gross national product for this purpose. "The problem in using gross national product (or gross domestic product) is its failure to show for some countries that a large number of people have very low incomes. Hence, a seemingly sizable GNP might nevertheless represent a small market for many U.S. goods. This measure suggests, for example, that India's market is about the same size as Canada's. But, for most U.S. manufacturers interested in foreign investment, India, of course, is not nearly as large a market as Canada."¹⁶ Nonetheless, Scaperlanda and Mauer found that size of market, as measured by gross national product, was directly related to U.S. direct investment in the European Community, whereas the other independent variables included in their analyses were not statistically significant.

Another factor that has been cited in this regard is the special case of Mexico. The United States has established many programs to encourage direct investment in Mexico, its neighbor to the south, long before the creation of the North American Free Trade Agreement. Thus, there seems to be good reason to expect that U.S. direct investment in Mexico will be relatively large. The fact that the United States and Mexico are neighbors also may play a role by itself. For example, Nankani, in his investigation of the foreign direct investments of the leading industrial nations in various developing countries, found that an industrial nation's investment in a developing country is generally greater if the two countries are located close to one another.¹⁷ One reason that is given is that communications and transactions costs go up with distance.

A Simple Statistical Analysis

To see whether the change in U.S. direct investment position in a particular country is related to the perceived strength or weakness of its intellectual property rights protection when the effects of market size and the special case of Mexico are taken into account, Jeong-Yeon Lee (1993) carried out a statistical analysis, described in Appendix II. Over the four years 1989-92, regardless of whether the change in U.S. investment position or capital outflow is the dependent variable, and regardless of whether both Spain and Japan or only Japan is excluded, his results indicate that the perceived weakness of protection is inversely related to U.S. direct investment in all manufacturing when these other variables are held constant. Taken at face value, the difference in protection between Indonesia or Republic of Korea and Hong Kong or Singapore seems to be associated with a difference in U.S. direct investment of about \$170 million per year. At the level of individual manufacturing industries, his results are often more blurred, which is not surprising due to data limitations.

Of course, market size and the special case of Mexico are not the only factors other than intellectual property rights protection that may influence foreign direct investment. For example, Schneider and Frey (1985) found that a nation's level of wage costs and secondary school enrollment ratio are relevant. Lee has added these variables, as well as the nation's economic growth rate, per capita electricity consumption, and per capita number of telephone lines, to his analysis, and has found thus far

¹⁶/Stobaugh (1969), p. 131.

¹⁷/Nankani (1979).

that the effect of intellectual property rights protection tends to remain significant when they are added. However, since his analysis is continuing, this finding must be regarded as tentative.^{18/}

It is almost impossible to separate a country's system of intellectual property protection from its attitudes (and procedures) toward protecting all forms of private property -- and the property of foreigners in particular. I suspect that Lee's results are due in part to a tendency for countries with very weak intellectual property protection to have a variety of other problems (from the point of view of U.S. firms) that discourage U.S. direct investment. As stressed in a previous section, the mere passage of a patent or copyright law is unlikely by itself to elicit substantial increases in direct foreign investment if the entire legal system and enforcement mechanisms are judged to be inadequate.

The Composition of Direct Foreign Investment

The governments of developing countries realize that the amount of technology transfer to their citizens and firms depends on the types of investments made by foreign firms, not just on the dollar volume of such investments. Specifically, investments in facilities to make components or complete products are likely to increase the country's technological competence to a greater extent than investments in sales and distribution outlets or in rudimentary production and assembly plants. Because firms tend to be much more likely to regard intellectual property protection as important for the former than for the latter types of investment, a country's system of intellectual property protection may influence the composition of direct foreign investment. While U.S. firms may be quite willing to invest considerable amounts in sales and distribution outlets and in rudimentary production and assembly facilities in countries with weak protection, their investments in R and D facilities or in facilities to manufacture components or complete products may be more likely to go to countries with stronger protection systems.^{19/}

To see whether a relationship of this sort exists, Jeong-Yeon Lee obtained detailed data from 14 major U.S. chemical firms regarding the composition of their investment position at the end of 1992 in each of the countries (excluding Japan and Spain) included in the previous section. For each firm, he determined the percent of its total investment in each of these countries (where it had substantial investments)^{20/} devoted to either sales and distribution outlets or to rudimentary production and assembly facilities. This figure was obtained for (1) all investments where the firm had over 10 percent ownership in the venture, (2) all investments where the firm had over 50 percent ownership in the venture, and (3) the firm's wholly owned subsidiaries.

Whether or not the perceived weakness of intellectual property protection seems to have an effect on the composition of a U.S. chemical firm's investment position in a particular developing country

^{18/}For details, see Appendix II.

^{19/}Of course, when the firm can defend the new technology through incorporation in "black boxes" or other means, such technology may be sent to countries with weak protection, but such defensive mechanisms are often unavailable or ineffective.

^{20/}Only countries where a firm had invested at least \$1 million were included in the analysis.

depends on how much ownership the U.S. firm has in the venture. Only for wholly owned subsidiaries is the estimated effect statistically significant.^{21/}

Based on the interviews, many chemical firms are reluctant to transfer relatively new or advanced technology to other than wholly owned subsidiaries; thus, for present purposes, only wholly owned subsidiaries may be relevant. The above evidence indicates that, in countries where intellectual property protection has been perceived to be weak, a larger proportion of these chemical firms' investment in wholly owned subsidiaries may be devoted to either sales and distribution outlets or to rudimentary production and assembly facilities than in countries where protection is perceived to be stronger.

Age of Transferred Technologies

According to a number of executives in our sample, some of whom are quoted in Appendix I, their firms transfer older technologies to countries with weak intellectual property protection than to those with strong protection. For a few chemical firms, it has been possible to estimate the age of a small sample of technologies transferred via foreign investment in these countries. (The age of a technology is defined here as the difference between the year the technology was transferred and the year the technology was first used by this firm.) According to the results, U.S. firms seem to transfer somewhat newer technology to countries with relatively strong intellectual property protection than to countries with weak protection, but the sample is so small that the results should be regarded only as suggestive. There is similar evidence in the machinery industry, but it, like the chemical data, is fragmentary.^{22/}

^{21/}The index in Table 3 (that is, the percent of major chemical firms reporting that protection is too weak to permit them to transfer their newest or most effective technologies to wholly owned subsidiaries in the country) is used here. It seems preferable to those in Tables 2 and 4 because the latter are concerned with whether or not to invest or with whether or not to license; what concerns us here is the sorts of technologies that will be transferred.

^{22/}These data are old and pertain to only a few firms. Unfortunately, data of this sort are extremely scarce, which explains why these fragments seem to be worth presenting at all.

Summary and Conclusions

1. The bulk of the 94 U.S. firms in our sample report that the strength or weakness of intellectual property protection has an important effect on some, but not all, types of foreign direct investment decisions. Whereas about 80 percent of the firms in our sample maintained that this factor was important with regard to investments in R and D facilities, only about 20 percent said that it was important with regard to sales and distribution outlets. Also, some industries--notably, the chemical (including drugs) industry--regard intellectual property as much more important than others, such as the food and transportation equipment industries.

2. Based on the evaluations by these firms of whether or not intellectual property protection in 16 major countries permits them to invest in joint ventures, transfer new technology to a subsidiary, or license new technology to each of these countries, it is possible to formulate a crude index of the perceived strength or weakness of intellectual property protection in each country. Averaged over all included industries, the countries perceived to have the weakest protection are India, Thailand, Brazil, and Nigeria; those perceived to have the strongest protection are Spain, Japan, Hong Kong, and Singapore. Our index seems to agree reasonably well with those of others, but there is little correlation between our results and those of the International Trade Commission. This seems to be because the commission is measuring the reduction in profits imposed by a country's firms on U.S. firms, whereas we are looking at the willingness of U.S. firms to invest in, or transfer advanced technology to, a country.

3. There is often little correlation between one industry's evaluation of the strength or weakness of intellectual property rights protection in a particular country and another industry's evaluation of the same country. For example, there is little agreement between the chemical industry and the transportation equipment industry. In part, this is because a country's laws may be different for one industry than for another. For example, in some countries, patents can be obtained for some products but not others (such as drugs). In addition, because industries face different problems, they tend to see a particular country in a different light. In some industries such as metals and transportation equipment, it is relatively difficult for competitors to make effective use of a firm's technology without many expensive and complex complementary inputs, while in other industries, such as chemicals, it is relatively easy for local firms to imitate an innovator's new products. Also, local firms in one industry in a particular country may be more aggressive in exploiting weak laws and enforcement than local firms in another industry.

4. Communications with executives in the chemical (including drugs), electrical equipment, transportation equipment, machinery, metals, and food industries provide further evidence of the diversity of viewpoints in this area. Some firms, particularly research-intensive firms with products (or processes) that are relatively easy to imitate, assert that they will not make substantial investments or transfer advanced technology to countries with weak intellectual property protection. But most such firms we contacted, particularly outside the chemical (including drugs) industry, regard such protection as an important factor, but only one of a number of factors, influencing their investment decisions. As would be expected, many firms with limited R and D investments consider intellectual property protection to be relatively unimportant in the investment decision.

5. The firms in our sample tend to regard strong intellectual property protection as being more important in decisions regarding the transfer of advanced technology than in investment decisions.

Although some high-technology firms avoid transferring advanced technology even to countries with strong protection, this is not true of most firms we studied. But research-intensive firms, particularly in the chemical (including drugs) industry, often will not transfer advanced technology to countries with weak protection. According to the statements of the executives, who were a mix of chief executive officers, vice presidents, patent attorneys, and others, the technologies withheld because of weak protection would have benefitted these countries considerably.

6. Most of the executives stated that the recent changes in intellectual property laws in Republic of Korea, Mexico, and Taiwan, China have been important, but the changes in Mexico were often regarded as much more significant than those in the other two countries. About 30 percent of the firms that said in 1991 that they were unwilling to transfer their newest and most effective technology even to a wholly owned subsidiary in Mexico now say they are willing to consider seriously such technology transfer. Practically all of them stressed that it would take a long time to determine whether these recent legal changes would be enforced. With regard to chemical and pharmaceutical patents, some believe that it will take until late in this decade, if then, for them to know how vigorously these countries intend to enforce their laws.

7. According to Lee's findings, if one holds a country's gross domestic product constant and recognizes the special position of Mexico, there is a statistically significant relationship between U.S. direct investment in manufacturing in a country in 1989-92 and our index of the perceived weakness of intellectual property protection. Taken at face value, a 10-point increase in our index seems to be associated with a decrease in U.S. direct investment in manufacturing of about \$200 million per year. In interpreting this result, one should recognize that a country's system of intellectual property protection is inextricably bound up with its entire legal and social system and its attitudes toward private property; it involves much more than the passage of a patent or copyright law. Also, the tentativeness of these statistical findings should be emphasized; further efforts should be made to refine and extend the analysis.

8. Based on the results of our survey as well as the interviews and correspondence with major executives, the composition of U.S. direct investment in a country would be expected to be related to the strength or weakness of the country's intellectual property protection. Whereas U.S. high-tech firms may be quite willing to invest considerable amounts in sales and distribution outlets and in rudimentary production and assembly facilities in countries with weak protection, they may be much less inclined to invest in R and D facilities or in facilities to manufacture components or complete products. Detailed data obtained from 14 major U.S. chemical firms show no such correlation for their entire investment, but when only their investment in wholly-owned subsidiaries is considered, there is statistically significant evidence supporting this hypothesis.

9. According to a number of the interviews, technologies transferred to countries with weak intellectual property protection tend to be older than those transferred to countries with strong protection. Data obtained from a few chemical firms seem to bear this out. Fragmentary data in the machinery industry suggest the same thing, but they, like the chemical data, are too limited to be more than suggestive.

10. In conclusion, the strength or weakness of a country's system of intellectual property protection seems to have a substantial effect, particularly in high-technology industries, on the kinds of technology transferred by many U.S. firms to that country. Also, this factor seems to influence the composition and extent of U.S. direct investment there, although the size of the effects seems to differ greatly from industry to industry. We believe that this study sheds substantial new light on this topic,

which is both important and relatively unexplored from an empirical standpoint. But much more needs to be done. For example, our results pertain entirely to U.S. direct investment. It would be worthwhile to extend the coverage to Japanese and European investment. We are currently beginning some work along this line.

Appendix I

This appendix provides direct quotations from the responses of various executives to our questions. We begin with firms that say they rule out substantial investments in countries affording weak protection, then take up firms considering intellectual property protection to be one of a number of important factors in the investment decision, and next consider firms regarding intellectual property protection as relatively unimportant in the investment decision. Finally, we look at technology transfer, rather than investment decisions, and consider the types of technologies withheld because of weak protection.

Firms That Rule Out Substantial Investments in Countries Affording Weak Protection

Some firms, particularly research-intensive firms with products (or processes) that are relatively easy to imitate, maintain that they will not make substantial investments or transfer advanced technology to countries with weak intellectual property protection. According to a major executive of one such firm,

Intellectual property is absolutely essential to [our] willingness to make substantial research investments in a country or to transfer advanced technology there. It has played an important, and in some instances deciding, role in our decision to either reduce or limit our investments in such countries as the Republic of Korea, the People's Republic of China, and India. As you know, much of [our] advanced technology is wrapped up in a very simple package ... As a result, they can be reproduced and disseminated in a country even by persons who do not have additional know-how from us and do not have access to advanced facilities or equipment. Thus, we are basically at the mercy of three components in a recipient country:

First, a cultural ethic for fairness and integrity. We have limited resources to pursue infringers of our rights. Further, once such a violation has occurred, much of the damage has been done. Thus, it is important to us that the number of violators be few and the number of violations be occasional. An acceptance and recognition of the concept of private property is essential, too. Second, a legal or statutory framework which provides us with appropriate rights providing sufficient protection for our intellectual property ... Third, a legal infrastructure which is capable of supporting both the grant of rights in appropriate circumstances, and the enforcement of rights when violations occur. Thus, for example, the existence of a patent statute without a Patent Office is of no value to us. Likewise, the existence of a patent system without a developed court system which provides for redress of private wrongs such as patent infringement is of no value to us.

The chief executive officer of another firm stated flatly that "we are a high-technology company and would not consider setting up a subsidiary in a country without such protection." Perhaps for this reason, this firm has established only one foreign subsidiary, and it is not in a developing country.

The president of a large chemical firm said the following:

Our investment in building a chemical facility or entering into a joint venture is a long term strategic decision. When we make such a decision, we consider many factors including whether the laws of the host country can effectively protect the technology we are designing the plant to operate with today, as well as the improved technologies we will want to add to the plant in the future to maintain our competitive position. Intellectual property protection is especially important for those proprietary advanced technologies we have spent millions to develop and which we feel provide the basis of our global competitive advantage.

The strength or weakness of a particular country's intellectual property rights protection is, therefore, an important factor in [our] decisions to invest in a country. The weaker we perceive a country's system for protecting intellectual property to be, the more likely we are not to transfer any leading-edge technology whether through direct investment, joint venture or license. The risk that the laws will not be able to effectively deter or remedy a theft of our technology has led us to defer from investing in certain countries, to limit the technology we transfer, and has even factored into our decisions to withdraw from operating in other countries. For example, we closed a manufacturing facility in [a major developing country] because, among other things, [its] intellectual property protection laws did not adequately protect the technology needed to maintain our competitive position. We also are reluctant to provide certain state-of-the-art technology to a joint venture in [another major developing country] because of our uncertainty of the effectiveness of their intellectual property protection system.

The chief patent attorney of another big chemical firm stated as follows:

Inadequate or ineffective protection of intellectual property works against introduction of the product into such country, whereby the business can never grow sufficiently to even reach questions of direct investment or licensing to subsidiaries. Thus, inadequate or ineffective protection of intellectual property in a country weighs heavily against ... the natural progression of events which could lead to the question of foreign investment ...

Another manifestation of concern and reluctance is the assurance we need, when business needs indicate the desirability of foreign manufacturing investment, that the technology will remain proprietary. To some extent, this assurance arises from our subsidiary being the manufacturer.

We generally would not transfer leading-edge technology operated by [us] or a subsidiary, where such technology is likely to be pirated. Having said that, I am unaware of an investment decision being rejected on that basis. I believe the investment proposal comes with reasonable assurance of proprietary position.

Firms Considering Intellectual Property Protection as One of Several Important Factors in the Investment Decision

While some R and D-intensive firms rule out substantial investments in countries affording weak intellectual property protection, this does not seem to be true of most such firms we contacted (particularly outside the chemical industry). Instead, most R and D-intensive firms seem to regard intellectual property rights protection as an important factor, but only one of a number of important factors, influencing their investment decisions. For example, the vice president of a major medical products firm stated that:

Intellectual property rights protection in a particular country is important to [us] and is a consideration in deciding whether to invest or transfer technology to a joint venture or subsidiary. But it is only one factor and each case must be evaluated on its own merits. Other important factors to [us] are: (A) size of the market for our key products; (B) desire of the local customers to have products made locally versus imported; (C) health care reimbursement policies of the country in question; and (D) the need for a technical presence in the country to support sales effort and educate key opinion leaders/customers in the use of our products. All of these factors must be weighed and contrasted against the risk of loss of proprietary technical information in each case.

Similarly, the vice president of a major pharmaceutical firm said that:

[It] has always been difficult to ascertain precise measurements on the relation between intellectual property and investments, and it would certainly be disingenuous to suggest that pharmaceutical patents by themselves will determine our investment in a country. Pricing levels for pharmaceuticals, the ability to register products with local health authorities, and assessment of growth opportunities in a country related to demographic factors, serve along with pharmaceutical patents as chief determinants in our decision-making process.

The director of international marketing of a chemical firm stated that:

The strength or a particular country's protection of intellectual property rights is one of the considerations we would have in expanding or investing in the transfer of any of our technology to that country.

The vice president of an office equipment firm said:

While [my firm] has never refused to sell or service its products in any foreign country due to the lack of intellectual property protection, it is certainly a factor in our consideration for future investments in foreign countries.

Similarly, the vice president of a pharmaceutical firm stated that:

A given country's intellectual property laws do, however, influence the extent to which we will invest in an actual physical presence in that country, including marketing forces, branch structures and manufacturing and packaging facilities. For example, [my firm] divested all of its assets in [a major developing country] some years ago when [its] law gave us virtually no protection, although [our] products remained available to patients there. However, with the recent changes in [this country's] intellectual property laws, re-establishment of a presence there is once again feasible.

The director of international affairs of a chemical firm said the following:

Whether one invests in the usual developing country is a complex equation which involves issues like size of market, ability to serve by importing into the country, etc. To over-simplify, if the market is substantial and you are required (usually by the local government) to manufacture there in order to sell, you may very well invest. Lack of intellectual property protection is a factor, but it can be handled ...

If the investment question involves a country with very strong intellectual property protection and, in order to protect a patent the patent must be "worked" by local manufacture, the intellectual property considerations can be the primary reason for the investment. For example, in some countries in Europe, if you had a patent on a drug, or agrochemical, you had to manufacture them locally to insure that you could enforce the product patent. In those cases we built small local plants for last step manufacture (just enough to satisfy local "working" requirements). This of course has changed somewhat with the EEC.

The vice president for research and development of a chemical firm said:

The strength or weakness of a particular country's intellectual property laws is only one factor in a decision on whether or not to invest in that country. We have no situation where we decided not to transfer advanced technology to a country having weak intellectual property laws solely because of such laws. However, to date we have transferred our advanced technology only to overseas affiliates or joint ventures where we have a substantial equity position, and therefore a strong voice in management.

The vice president of a major metals firm stated:

[The] major focus of our activity in recent times has either been in countries where such protection does exist or, where such protection has been questionable, in ventures where the factor of intellectual property protection has not been a major consideration. Since we seek out

potential investments on a continuing basis, this could, of course, change. I think it is fair to say that where a potential investment involved intellectual property rights as an important element and was targeted for a country with a reputation for minimum protection in that field, we would give serious consideration to these factors in arriving at an investment decision.

A computer executive said:

The strength or weakness of a particular country's intellectual property laws is of importance to us in determining whether we will invest in that country or transfer advanced technology to that country. For example, although we have made investments in [a large developing country], we have not implemented manufacturing operations there that use our highest level of technology due to uncertainty over adequacy of trade secret protection. Likewise, we limited the types of software being developed [there] due, in part, to the lack of adequate copyright protection.

Firms Regarding Intellectual Property Protection as Relatively Unimportant in the Investment Decision

The bulk of the firms in many low-technology industries--and some in high-technology industries like electrical equipment (and even chemicals)--regard intellectual property rights protection as being relatively unimportant in the investment decision. For example, an R and D executive at one of the nation's largest firms said that there was no correlation between how much money his firm was investing in particular countries and the strength of the country's intellectual property rights protection. In his view, the correlation, if any, was negative!

A patent attorney for a major machinery producer stated that:

Over the past nine years I can recall no case where intellectual property laws affected our investment or technology transfer decision for foreign countries. Further, I can recall no case where we felt victimized or disadvantaged by the intellectual property laws or lack thereof in any foreign country. We do business in over 130 countries, including Republic of Korea, Taiwan and Mexico.

It is not clear to me that investment or technology decisions have anything to do in most instances with problems of unauthorized copying. Nor is it clear that "stronger" laws will realistically resolve the problems that are most prevalent.

The current controversy mostly concerns products that are easily copied, e.g., audio or VCR tapes, application software for "personal" computers, pharmaceuticals or the like. The original products and related information in U.S. patents and other publications are readily available in the U.S. and elsewhere. The products at issue are thus freely able to

be copied in a foreign country even though no investment or technology transfer has occurred there.

In many cases, the copying and marketing are being done by fly-by-night operators. Even "strong" intellectual property laws may not stop this. For example, in New York City clone "Rolex" watches are now for sale on many street corners.

The president of a firm making machine tools stated that:

In our particular case, the strength or weakness of a particular country's intellectual property rights does not particularly influence us. We have a manufacturing facility in [a developed country] and one in [a developing country], and we are not hesitant about passing information back and forth. Of course, we have wholly owned subsidiaries and this might make a difference.

It is important to note in this regard that patents are of much less importance in many industries than in pharmaceuticals and chemicals. In some industries, it is relatively easy to invent around patents. In other industries, it is very difficult for rivals to imitate a new product or utilize a new technology without complementary inputs that are hard to obtain; thus, patents are of secondary importance. In industries like these, it is not surprising that intellectual property rights protection is not a major factor in investment decisions.

Intellectual Property Protection and Technology Transfer

Many firms regard strong intellectual property protection as being more important in decisions regarding technology transfer than in decisions regarding investment. Some companies have a policy of minimizing the transfer of technology to other countries. The director of technology of a biotechnology firm said:

It has been [my firm's] policy to keep to a minimum the transfer of its technology to other companies in both developed and developing nations. Therefore, the relative strength or weakness of a country's intellectual property laws generally has little or no impact on whether we will transfer advanced technology to another company.

Also, the vice president of a leading drug firm said:

[This firm] does not transfer leading-edge technology in its usual course of business. When such transactions have occurred, intellectual property laws have not been a critical factor in deciding whether we will transfer leading-edge technology to a foreign country. Thus, we cannot cite specific cases where [we] would not transfer these technologies to a country on the basis of weak intellectual property laws. However, it should be pointed out that the decision not to transfer a leading-edge technology to such countries is made simply because they generally do not have the technological infrastructure in place to put the technology

to work, and therefore could not benefit from it. Most [of our] products require an extraordinarily high degree of scientific talent and engineering resources to manufacture. We have found that such resources are generally insufficient in the type of developing countries that also happen to lack strong intellectual property laws.

And the international marketing director of a chemical firm said:

As a general rule, we are reluctant to do any straight transfer of technology deals unless the information is coded or the technology is older technology. If we do send technology to one of our foreign subsidiaries, it is coded with very limited access to the coded information by an expatriate manager or a well-known national.

Whereas some high-tech firms avoid transferring advanced technology even to countries with strong protection, this does not seem true of most firms we studied. However, research-intensive firms, particularly in the chemical (including drugs) industry, often will not transfer advanced technology to countries with weak protection. For example, the chairman of a major chemical company said:

There is no question that we will not put good product technology in a country where we cannot protect it. You ask for specific cases, and the most obvious ones are [a major Asian developing country] where there is no meaningful protection of intellectual property, and some of the Latin American countries like [a major developing country] where we and others have withheld some [products] because of the inability to protect them.

Another chemical executive stated the following:

[We] will not expose technology of any significant value in countries where it is not safe. Where there is a total lack of any protection and rampant piracy, such as in [a major Asian developing country] you provide no technology of value period. In [that country] you are assured that pirate competitors will steal anything you send in and use it to compete with you in [that country] and through exports. Combine this with the fact that government red tape makes it almost impossible to make any real money [there] and you will understand why that country operates on technology which is 15 to 30 years old. While the rest of Asia has taken off like a rocket, [it] remains in the post WW II era.

In countries where some protection exists, but it is very questionable, such as [a major Latin American country], you tend to use your older technology. For example, you may develop a chemical process to make a product. Over the years you will make process improvements and may even develop totally different, new processes which are much more efficient. If the technology is extremely valuable, you may decide to use one of your older processes in [that country]. Here again, the decision is not that simple. What is the value of the efficiencies of the newer

process? Are there likely local pirate competitors? Do they have the capital and technical capability to duplicate your technology if they get their hands on it?

According to managing counsel of still another chemical firm,

The technology embodied in new, but copiable products like highly successful agrichemicals, are withheld from countries where intellectual property is inadequately protected, and thus from subsidiaries and joint ventures.

And according to the chairman of a firm in the information processing industry, "We would transfer to Republic of Korea and Taiwan, China, only low tech processes."

But some firms are much less impressed by the potential problems in this area than other firms. Thus, the vice president of an instruments firms said:

So far, to my knowledge, [my firm] has not decided against transferring technology to a particular country where other factors were favorable, but the strength of the patent system there was suspect. We have not been confronted with that scenario to date.

Also, the chief patent counsel of a chemical firm stated:

The technology advantage that we enjoy over our competitors often results from catalyst compositions and process know-how. Knowledge of the composition and manufacture of catalysts and process know-how need not be transferred to licensees or subsidiaries outside the United States in order for the production of the commodity chemical to occur.

With our major commodity chemical licensing programs, the strength or weakness of a country's intellectual property rights have relatively little bearing on our decision to license technology. Other barriers to market entry exist which are often more foreboding. We typically minimize the risk to our intellectual property by not disclosing critical catalyst or process know-how information to the licensee. In short, the best protection of information is to avoid divulging the information.

Technologies Withheld Because of Weak Protection

We asked each firm in our sample to cite cases, if they existed, where advanced technologies were withheld from particular countries because of weak protection of intellectual property. Many firms which said such cases existed seemed reluctant to discuss them in detail, apparently because they did not want to provide details of instances where they were withholding technology from poor countries. However, they sometimes were willing to make general statements. For example, one firm's patent attorney stated as follows:

In many cases, potential recipient countries are among the poorest in the world. Much of their economy is dependent upon agriculture and its productivity. The products [my firm] has to offer, including our advanced technology, provide for significant increases in agricultural productivity and efficiency. Because [my firm] is unwilling to send its most elite materials to those countries, they lose out on the benefits of increased agricultural productivity and efficiency gains and the consequent enhancement of their standard of living and overall improvement of their agricultural-based economy which these materials would have provided.

Also, another firm's chief patent counsel said:

We have had several instances in which we decided not to transfer information to another country due to the weak intellectual property protection. In one instance, equipment embodying valuable technology to practice a process was not provided to Republic of Korea since there was no effective means to prevent a Korean employee who develops a knowledge of the equipment, from using that information in a subsequent employment. Although this is a problem faced in virtually every country of the world, the concerns in Korea were highlighted by the risk that the courts may view the confidentiality provisions as against public policy in Korea and therefore null and void ... the loss of gross income to Korea was a minimum of \$5 to \$10 million per year.

Another case was cited by the chairman of a chemical firm, who said:

[My firm] is a world leader in [an important] technology. We have been constantly improving this technology over the past twenty-five years, and we are unwilling to transfer this advanced technology to developing countries with weak intellectual property protection systems. We believe that these countries would greatly benefit from manufacturing products using this technology in their country rather than having to import products from abroad.

According to another chemical executive, the situation is as follows:

It is usually a question of when a weak IP country gets the product. For example, agrochemicals require extensive and expensive registration work before they can be made and sold and farmers will try nothing new without a substantial marketing effort. You normally devote your money and effort to countries with significant markets and decent protection and leave the less attractive, weak IP countries to last. They lose the economic efficiencies of new technology. In agrochemicals, the farmers of the country will have lower yields at higher cost, resulting in higher than necessary food costs and less competitiveness on world markets. You can add this up for the 6 to 10 years a significant new product is not marketed. The FMC Corporation did a study of this some years ago in

Mexico and the results were dramatic. With respect to processes, if a new process can reduce the cost of producing a basic commodity chemical by 10% – for example sulfuric acid – you can easily calculate the costs to a country which does not have access to the new process.

The manager of intellectual property of a computer maker said:

We will not place high technology manufacturing plants or development operations, either via subsidiaries or joint ventures, in foreign countries that have weak intellectual property protection. I do not wish to identify particular technologies that we have restricted or the potential benefits that foreign countries would have derived therefrom. However, I will note that the level and availability of technology within a given country can have a direct effect on advancement of the country's infrastructure, including support companies, local suppliers, and its educational system.

Appendix II

To see whether U.S. direct investment in a particular country is related to the perceived strength or weakness of its intellectual property rights protection when the effects of market size and the special case of Mexico are taken into account, Jeong-Yeon Lee (1993) has carried out a statistical investigation using data obtained from the U.S. Department of Commerce for 1989-1992. While his study includes a variety of other independent variables, the basic features of his results can be illustrated by assuming that

$$I_j = A_0 + A_1G_j + A_2M_j + A_3P_j + Z_j^1, \quad (1)$$

where I_j is the change in U.S. investment position in (or capital outflow to ²³) the j^{th} country during 1992, G_j is the gross domestic product (in 1989) in the j^{th} country, M_j is a dummy variable that equals 1 for Mexico and zero otherwise, P_j is the mean value of the three measures (in the last column of Tables 2-4) of the weakness of intellectual property protection in the j^{th} country, and Z_j^1 is a random error term.²⁴ Of course, this model is highly simplified but it illustrates the sorts of results he has obtained.

Using least-squares, he estimated the A 's in equation (1), based on data for all manufacturing. Regardless of whether the change in U.S. investment position or capital outflow is the dependent variable, and regardless of whether Spain is excluded or included, the results, shown in Table 5, indicate that the effect of P_j always has the expected sign, and is statistically significant in every case.²⁵ Holding G_j and M_j constant, a 10-point increase in P_j seemed to be associated with about a \$200 million decrease in U.S. direct investment per year. To interpret this finding, it may help to recall that the difference between Indonesia's or Republic of Korea's value of P_j and that of Hong Kong or Singapore was about 8 or 9 points. Thus, taken at face value, the sort of difference in perceived protection between these countries seems to be associated with a difference in U.S. direct investment of about \$170 million per year. Also, the effect of P_j is about the same, and remain statistically significant, if data for 1990, 1991, and 1992 are pooled, and the number of degrees of freedom is about 40.

Data by industry concerning U.S. direct investment in each of these countries are not always available, but all available data (from the U.S. Department of Commerce) were used to estimate the regression coefficients of the model in equation (1), as well as more complex models, at the level of individual industries: (1) chemicals, (2) transportation equipment, (3) electrical equipment, (4) food, (5)

²³For obvious reasons, Lee is more interested in the total investment by the U.S. as a whole than that of our sample firms only. Since our sample is a random sample, it should be possible to use P_j for this purpose, although the results may be biased toward zero because of sampling errors. According to the U.S. Department of Commerce, the direct investment position is the book value of U.S. investors' equity in, and net outstanding loans to, their foreign affiliates. (A foreign affiliate is a foreign business enterprise in which a single U.S. investor owns at least 10 percent of the voting securities or the equivalent.) The change in direct investment position equals capital outflows plus the valuation adjustment. Capital outflows equal reinvested earnings plus intercompany debt outflows plus equity outflows. See Scholl (1990),

²⁴Note that the effect of M_j will include the effect of the re-evaluation of intellectual property protection in Mexico since 1991, as well as the other effects discussed in a previous section. Also, note that, because there is a delay between the decision to invest and the investment itself, GDP should be lagged. It is assumed here that GDP in 1989 is relevant, but the results in Table 5 vary only in detail if GDP in 1991 is used instead. Each estimate of A_3 remains negative and of about the same size as in Table 5.

²⁵One-tailed tests are appropriate here because the hypothesis stipulates the sign of the regression coefficient.

metals, (6) machinery. Because these data for individual industries seem to contain considerable noise and have often been revised substantially in the past, it is not surprising to find that the estimated effect of the mean (called P_{ij}) of the three measures (in Tables 2-4) of the perceived weakness of intellectual property protection in the i^{th} industry in the j^{th} country is frequently not statistically significant. However, if both Japan and Spain are excluded, there is substantial evidence that the coefficient of P_{ij} is negative in the machinery, food, chemical, and metals industries (Table 6).²⁶

Taken at face value, intellectual property rights protection seems to have a particularly strong effect on U.S. direct investment in the machinery industry. This is quite consistent with our interview and survey results, since many machinery firms emphasized the importance of such protection. The fact that P_{ij} seems to have a smaller effect in the chemical industry, where intellectual property protection has been such a major issue, may be due to the small number of observations and the large revisions often made in the chemical investment data. More surprising is the significant effect of P_{ij} in the food industry, which seemed in Tables 1-4 to regard such protection as less important than many other industries. Perhaps our results in Tables 1-4, based on a small sample, tend to underestimate the importance of such protection to food firms. But it is also important to recognize once more the obvious limitations of the model.

As indicated above, Lee has added other independent variables to his analysis, and has included investment data for the years 1989-91 as well as 1992. In particular, he has added many variables that Schneider and Frey (1985) found to be significant, such as a nation's level of wage costs and secondary school enrollment ratio. Also, he has included the nation's economic growth rate, per capita electricity consumption, and per capita number of telephone lines, among other variables. Thus far, the effect of P_{ij} tends to remain significant when each of these variables is added. But he is continuing the statistical analysis, and, for obvious reasons, his results must be regarded as tentative.

Table 5 – Estimated Regression Coefficients in Equation (1) and Their Standard Errors (in Parentheses). All Manufacturing, Japan and both Japan and Spain Excluded

Countries Excluded	Intercept	Weakness of Protection	Gross Domestic Product	Mexico Dummy	R ²
Change in U.S. Investment Position					
Japan	445 ** (153)	-11.1 ** (5.5)	.0001 (.0004)	290 * (200)	.62
Japan and Spain	694 *** (185)	-22.3 *** (7.5)	.0007 * (.0004)	180 (187)	.55
U.S. Capital Outflow					
Japan	458 (264)	-19.0 ** (9.4)	.0023 *** (.0004)	207 (344)	.79
Japan and Spain	757 * (349)	-32.5 ** (14.1)	.0030 *** (.0008)	74 (351)	.61

Source: Lee (1993).

- * Significant at .10 probability level (one-tailed test except for intercept).
- ** Significant at .05 probability level (one-tailed test except for intercept).
- *** Significant at .01 probability level (one-tailed test except for intercept).

²⁶The revisions of the Commerce data can have a substantial effect on the estimated effects of P_{ij} . For example, in the chemical industry, there is a rather low correlation ($r^2 = .43$) between the original estimates of changes in U.S. investment position and the revised estimates three years later.

Table 6 – Estimated Regression Coefficient of Weakness-of-Protection Variable in Equation (1), Six Manufacturing Industries, Japan and both Japan and Spain Excluded

Industry	Japan Excluded	Japan and Spain Excluded
Change in U.S. Investment Position, 1991-92		
Machinery	0.3 (4.5)	-12.6 ** (5.0)
Food	2.1 (3.5)	- 4.9 ** (1.6)
Chemicals	-0.2 (0.8)	- 1.4 ** (0.8)
Metals	-0.7 (0.5)	- 0.7 (0.6)
Transportation Equipment	-4.1 (3.3)	0.2 (1.6)
Electrical Equipment	2.8 (4.5)	2.8 (6.6)
U.S. Capital Outflow, 1992		
Machinery	-1.3 (3.2)	- 9.5 ** (4.1)
Food	0.0 (2.7)	- 4.9 ** (1.9)
Chemicals	0.1 (1.2)	- 1.8 (1.3)
Metals	-0.8 *	- 1.1 ** (0.4)
Transportation Equipment	(0.5)	0.7 (3.2)
Electrical Equipment	-5.4 (5.1)	0.2 (6.4)
	2.1 (4.4)	

Source: Lee (1993).

- * Significant at .10 probability level (one-tailed test except for intercept).
- ** Significant at .05 probability level (one-tailed test except for intercept).
- *** Significant at .01 probability level (one-tailed test except for intercept).

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