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DISCUSSION PAPER

Intellectual Property Protection, Direct Investment, and Technology Transfer

Germany, Japan, and the United States

Edwin Mansfield



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Foreword

In a field virtually bereft of quantitative evidence, this Discussion Paper follows up on the analyses of an earlier study (IFC Discussion Paper 19, *Intellectual Property Protection, Foreign Direct Investment and Technology Transfer*, by Edwin Mansfield, 1994). The present paper extends research from U.S. multinational firms to Japanese and German corporations; and an econometric model is constructed to estimate the effects of the strength or weakness of intellectual property protection in a developing country on the amount of U.S. foreign direct investment. Together, the two discussion papers suggest that improved intellectual property protection laws and their effective enforcement are likely to translate into significantly larger inflows of foreign direct investment.

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Abstract

In IFC Discussion Paper 19, I found 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 (Mansfield, 1994). Also, this factor seems to influence the composition and extent of U.S. direct investment there, although the size of the effects seem to differ from industry to industry. These findings, based on a combination of survey data, interview studies, and statistical analysis, have been used by a variety of policy makers and scholars, some of whom have complained for many years about the lack of empirical investigation of this topic.

The present paper extends these results in two ways. First, the survey findings are expanded to include Japanese and German firms, which, of course, are responsible for massive direct investments in developing countries. Second, an econometric model is constructed to estimate the effects of the strength or weakness of intellectual property protection in a developing country on the amount of U.S. direct investment there. The findings indicate that, in relatively high-technology industries like chemicals, pharmaceuticals, machinery, and electrical equipment, a country's system of intellectual property protection often has a significant effect on the amount and kinds of technology transfer and direct investment to that country by Japanese and German, as well as U.S. firms. Also, when a variety of relevant factors are held constant in an econometric model, the effects of such protection on U.S. foreign direct investment are substantial and statistically significant.

Acknowledgments

The research on which this paper was based was supported by the International Finance Corporation and by a grant from the Research Committee of the World Bank.

I. Introduction

In an earlier paper published by the International Finance Corporation, I found 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 (Mansfield, 1994). Also, this factor seems to influence the composition and extent of U.S. direct investment there, although the size of the effects seem to differ from industry to industry. These findings, based on a combination of survey data, interview studies, and statistical analysis, have been used by a variety of policy makers and scholars, some of whom have complained for many years about the lack of empirical investigation of this topic.¹

The present paper extends these results in two ways. First, the survey findings are expanded to include Japanese and German firms, which, of course, are responsible for massive direct investments in developing countries. Second, an econometric model is constructed to estimate the effects of the strength or weakness of intellectual property protection in a developing country on the amount of U.S. direct investment there. The findings indicate that, in relatively high-technology industries like chemicals, pharmaceuticals, machinery, and electrical equipment, a country's system of intellectual property protection often has a significant effect on the amount and kinds of technology transfer and direct investment to that country by Japanese and German, as well as U.S. firms. Also, when a variety of relevant factors are held constant in an econometric model, the effects of such protection on U.S. foreign direct investment are substantial and statistically significant.

1 For some recent discussions of intellectual property rights, see the references. Many of the relevant policy issues are taken up in Benko (1987), Evenson (1990), Frischtak (1990), Mansfield (1993), Mody (1990), Penrose (1970), Primo Braga (1991), Sherwood (1990), Siebeck et al (1990), and United Nations (1993). For empirical studies, see Ferrantino (1993), Mansfield (1994), Miskus and Konan (1994), and Rapp and Rozek (1990).

II. Effects of Intellectual Property Protection: A Survey of Japanese and German Firms

To begin with, a survey of major Japanese and German firms was conducted to obtain information concerning the importance of intellectual property protection in influencing whether or not a firm would make foreign direct investments of various kinds. Since my earlier study indicated that the industries particularly likely to be affected by intellectual property protection include chemicals, pharmaceuticals, electrical equipment, and machinery², we focus largely but not entirely, on these industries. A random sample of 45 major Japanese firms (40 from the above four industries and 5 from the transportation equipment, metals, and food industries) and 35 major German firms (30 from the above four industries and 5 from the transportation equipment, metals, and food industries) was chosen. The frame was the list of 30 largest firms in each of these industries in each country.³ As shown in Table 1, the response rate was relatively high (71 percent in Japan and 57 percent in Germany), but lower than the very high figure for the United States (94 percent). For a description of the U.S. sample, see Mansfield (1994). The respondents generally were patent attorneys, specialists in firms' international operations, and top executives. The limitations of survey data of this type are well known, but interpreted with proper caution, they can be useful.

In all three countries, 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. As would be expected, the percentage reporting that such protection is important tends to be lower for investments in sales and distribution outlets and in rudimentary production and assembly operations than for investments in facilities to manufacture components or complete products or to do research and development (Table 2). This is true in all three countries.

In accord with our earlier findings for U.S. firms, the percentage of Japanese and German firms regarding such protection as important is higher in the chemical, pharmaceutical, machinery, and electrical equipment industries than in the transportation equipment, metals, and food industries.⁴

2 Since these industries tend to regard patents as relatively important, it is not surprising that they were indicated to be particularly likely to be affected by intellectual property protection. See Mansfield (1986).

3 A list of the largest 30 firms in each of these industries in Germany and Japan was obtained from Dun and Bradstreet International and Worldscope Global (CD-ROM). The machinery and electrical equipment firms tended to produce items related to computers and electronics, among other things. Note that a substantial proportion of the respondents were among the top 200 R and D spenders outside the U.S. See Table 1.

4 Neither German firm and only one Japanese firm that were selected from the transportation equipment, metals, or food industries reported that intellectual property protection was of importance in this regard.

Table 1

| Composition of Sample of German, Japanese, and U.S. Firms | | | | |
|---|--------------------------------|---|--------------|--------------|
| | <i>Chemicals and Drugs</i> | <i>Machinery and Electrical (Number of Firms in Sample)</i> | <i>Other</i> | <i>Total</i> |
| Germany | 7 | 11 | 2 | 20 |
| Japan | 16 | 13 | 3 | 32 |
| United States | 16 | 59 | 19 | 94 |
| Number among top 200 R and D spenders outside the U.S. ^a | | | | |
| Germany | 2 | 3 | 1 | 6 |
| Japan | 10 | 8 | 0 | 18 |

^aBased on list of top 200 non-U.S. firms, based on expenditures on research and development, in Business Week, June 28, 1993.

Table 2

| Percent of Major German, Japanese, and U.S. Firms Reporting that Strength or Weakness of Intellectual Property Protection Has Strong Effects on Whether They Will Make Direct Investments of Various Kinds | | | | | | |
|---|---|---|---|--|--|-------------|
| | <i>Sales and distribution outlets</i> | <i>Rudimentary production and assembly facilities</i> | <i>Facilities to manufacture components</i> | <i>Facilities to manufacture complete products</i> | <i>Research and development facilities</i> | <i>Mean</i> |
| <i>Chemicals and Drugs</i> | | | | | | |
| Germany | 0 | 17 | 75 | 86 | 86 | 53 |
| Japan | 44 | 53 | 67 | 80 | 88 | 66 |
| United States | 19 | 46 | 71 | 87 | 100 | 65 |
| <i>Machinery and Electrical Equipment</i> | | | | | | |
| Germany | 20 | 27 | 55 | 60 | 60 | 44 |
| Japan | 42 | 45 | 80 | 80 | 70 | 63 |
| United States | 19 | 32 | 54 | 70 | 79 | 51 |
| <i>All Firms</i> | | | | | | |
| Germany | 11 | 21 | 55 | 63 | 63 | 43 |
| Japan | 39 | 45 | 64 | 71 | 76 | 59 |
| United States | 19 | 34 | 53 | 67 | 81 | 51 |

Also, for reasons discussed below, the chemical and pharmaceutical industries tend to have a larger percentage of firms regarding such protection as important than do the machinery and electrical equipment industries. This is true in all three countries. (Here and below, the chemical and pharmaceutical industries are lumped together because of their many similarities and because firms frequently are engaged in both; for much the same reasons, machinery and electrical equipment are lumped together.)

Perhaps the most interesting finding is that, regardless of whether one considers chemical and pharmaceutical firms, machinery and electrical equipment firms, or all firms in the sample, there is a remarkably small difference between Japan and Germany combined and the United States in the percentage of firms reporting that intellectual property protection was important in this regard.⁵ Of course, this does not mean that U.S. firms in some industries may not view such protection as more important than their Japanese or German counterparts, but it does indicate that, contrary to the feelings of some observers, the bulk of Japanese and German firms in high-technology industries do regard a country's system of intellectual property protection as important when deciding whether to make direct investments there.⁶ Moreover, according to the results presented in the next three sections, Japanese and German firms, like their U.S. counterparts, often look carefully at the nature of such protection when deciding whether to transfer advanced technology to a particular country, and if so, how.

5 In chemicals and pharmaceuticals, the mean percentage for Japanese and German firms is 62 in Table 2; for U.S. firms, it is 65. In machinery and electrical equipment, the mean percentage for Japanese and German firms is 54 in Table 2; for U.S. firms, it is 51. In the entire sample in Table 2, the mean percentage for Japanese and German firms is 53; for U.S. firms, it is 51. The German and Japanese firms are combined so that the sample size is reasonably large.

6 For example, at the National Research Council's Conference on the Global Dimensions of Intellectual Property Rights in Science and Technology in 1992, some people questioned whether the same factors motivate foreign direct investment by Japanese and European firms as motivate U.S. firms. According to some observers, intellectual property protection may be less important to the former than to the latter. See Mansfield (1993), p. 147.

III. Intellectual Property Protection and Investment in Joint Ventures

Each of the Japanese and German firms in our sample was asked whether, in its view, any of 14 countries -- Argentina, Brazil, Chile, Hong Kong, India, Indonesia, Mexico, Nigeria, Philippines, Singapore, Republic of Korea, Thailand, Venezuela, and Taiwan, China -- had intellectual property protection that was too weak in 1994 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. In Mansfield (1994), information of this sort was obtained from our sample of U.S. firms.

In the chemical and pharmaceutical industries, at least 25 percent of the firms in all three countries felt that intellectual property protection in India, Nigeria, Argentina, Brazil, Chile, and Thailand was too weak to allow them to invest in such joint ventures there (Table 3). In the machinery and electrical equipment industries, this was true in Brazil, Nigeria, India, Thailand, and Taiwan, China. In both sets of industries, the feeling, on the average, was that protection was strongest in Singapore and Hong Kong. American chemical and pharmaceutical firms seemed more likely than their German or Japanese counterparts (and the Germans seemed more likely than the Japanese) to regard protection in these 14 countries as too weak to permit such joint ventures; the mean percentage in Table 3 is 42 for the U.S., 31 for Germany, and 21 for Japan. In the machinery and electrical equipment industries, the Japanese seemed to be about as likely as the Americans (and both seemed more likely than the Germans) to regard protection in these 14 countries as too weak; the mean percentage is 27 for the U.S., 26 for Japan, and 19 for Germany.

As would be expected, there generally is a positive correlation between the percentage of one country's firms that regard protection in a particular country as too weak to permit such joint ventures there and the percentage of another country's firms that feel this same way. (The values of the coefficient of determination and the least-squares regression are shown in Table 4.) But this correlation seems stronger among the chemical and pharmaceutical firms than among the machinery and electrical equipment firms. Indeed, in the machinery and electrical equipment industries, there is little or no correlation in this regard between Germany and Japan.

Table 3

| Percent of Major German, Japanese, and U.S. Firms Reporting that Intellectual Property Protection is Too Weak to Permit Investment in Joint Ventures with Local Partners, by Industry and Host Country | | | | | | | | |
|--|--------------------------------|--------------|-------------|-------------|---|--------------|-------------|-------------|
| <i>Host Country</i> | <i>– Chemicals and Drugs –</i> | | | | <i>– Machinery and Electrical Equipment –</i> | | | |
| | <i>Germany</i> | <i>Japan</i> | <i>U.S.</i> | <i>Mean</i> | <i>Germany</i> | <i>Japan</i> | <i>U.S.</i> | <i>Mean</i> |
| Argentina | 57 | 33 | 40 | 43 | 11 | 25 | 28 | 21 |
| Brazil | 43 | 27 | 47 | 39 | 33 | 38 | 48 | 40 |
| Chile | 33 | 44 | 31 | 36 | 12 | 25 | 26 | 21 |
| Hong Kong | 14 | 0 | 21 | 12 | 0 | 0 | 23 | 8 |
| India | 71 | 71 | 80 | 74 | 33 | 33 | 43 | 36 |
| Indonesia | 50 | 20 | 50 | 40 | 38 | 11 | 27 | 25 |
| Mexico | 0 | 0 | 47 | 16 | 11 | 20 | 23 | 18 |
| Nigeria | 57 | 33 | 64 | 51 | 50 | 38 | 31 | 40 |
| Philippines | 29 | 15 | 43 | 29 | 0 | 50 | 24 | 25 |
| Singapore | 0 | 0 | 20 | 7 | 0 | 0 | 12 | 4 |
| Republic of Korea | 33 | 0 | 33 | 22 | 12 | 31 | 23 | 22 |
| Taiwan, China | 17 | 7 | 27 | 17 | 29 | 46 | 29 | 35 |
| Thailand | 29 | 29 | 43 | 34 | 25 | 25 | 26 | 25 |
| Venezuela | 0 | 20 | 40 | 20 | 12 | 29 | 20 | 20 |
| Mean | 31 | 21 | 42 | 31 | 19 | 26 | 27 | 24 |

IV. Intellectual Property Protection and Technology Transfer to Wholly-Owned Subsidiaries

Each of the Japanese and German firms in our sample was also asked whether, if it had a wholly-owned subsidiary in one of these 14 countries, 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.⁷ Information of this sort for our sample of U.S. firms was provided in Mansfield (1994). In the chemical and pharmaceutical industries, over 25 percent of the firms in all three countries felt that intellectual property protection in India, Chile, and Argentina was too weak to permit such transfers (Table 5). In the machinery and electrical equipment industries, over 20 percent felt that this was the case in Nigeria, Brazil, and the Philippines. In both sets of industries, on the average, Singapore and Hong Kong were regarded as having the strongest protection.

Table 4

| Least Squares Relationships between German, Japanese, and U.S. Measures of Perceived Intellectual Property Protection in Fourteen Countries: Joint Ventures | | | | |
|--|-----------------------------|------------------|--------------|-------------------------------|
| <i>Dependent Variable</i> | <i>Independent Variable</i> | <i>Intercept</i> | <i>Slope</i> | <i>Adjusted r²</i> |
| <i>Chemicals and Drugs</i> | | | | |
| Germany | U.S. | -10.4 | 0.99 | 0.44 |
| Japan | U.S. | -16.9 | 0.91 | 0.49 |
| Germany | Japan | 12.9 | 0.84 | 0.53 |
| <i>Machinery and Electrical</i> | | | | |
| Germany | U.S. | -11.8 | 1.13 | 0.37 |
| Japan | U.S. | 4.2 | 0.82 | 0.17 |
| Germany | Japan | 9.3 | 0.37 | 0.05 |

⁷ Firms 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.

Table 5

| Percent of Major German, Japanese, and U.S. Firms Reporting that Intellectual Property Protection is Too Weak to Permit Transfers of Their Newest or Most Effective Technology to Wholly Owned Subsidiaries, by Industry and Host Country | | | | | | | | |
|---|--------------------------------|--------------|-------------|-------------|---|--------------|-------------|-------------|
| <i>Host Country</i> | <i>– Chemicals and Drugs –</i> | | | | <i>– Machinery and Electrical Equipment –</i> | | | |
| | <i>Germany</i> | <i>Japan</i> | <i>U.S.</i> | <i>Mean</i> | <i>Germany</i> | <i>Japan</i> | <i>U.S.</i> | <i>Mean</i> |
| Argentina | 43 | 30 | 44 | 39 | 11 | 29 | 18 | 19 |
| Brazil | 43 | 18 | 50 | 37 | 22 | 33 | 32 | 29 |
| Chile | 33 | 44 | 47 | 41 | 0 | 29 | 24 | 18 |
| Hong Kong | 14 | 0 | 21 | 12 | 0 | 0 | 26 | 9 |
| India | 71 | 64 | 81 | 72 | 11 | 30 | 39 | 27 |
| Indonesia | 17 | 27 | 40 | 28 | 0 | 20 | 27 | 16 |
| Mexico | 0 | 0 | 31 | 10 | 11 | 20 | 22 | 18 |
| Nigeria | 14 | 50 | 67 | 44 | 44 | 38 | 24 | 35 |
| Philippines | 14 | 36 | 47 | 32 | 22 | 50 | 22 | 31 |
| Singapore | 0 | 0 | 12 | 4 | 0 | 0 | 10 | 3 |
| Republic of Korea | 17 | 7 | 31 | 18 | 11 | 25 | 25 | 20 |
| Taiwan, China | 17 | 20 | 19 | 19 | 11 | 46 | 38 | 32 |
| Thailand | 14 | 43 | 60 | 39 | 11 | 33 | 22 | 22 |
| Venezuela | 17 | 33 | 50 | 33 | 11 | 25 | 18 | 18 |
| Mean | 22 | 27 | 43 | 31 | 12 | 27 | 25 | 21 |

American chemical and pharmaceutical firms seemed more likely than their Japanese or German counterparts (and the Japanese seemed more likely than the Germans) to regard protection in these 14 countries as too weak to permit such transfers; the mean percentage in Table 5 is 43 for the U.S., 27 for Japan, and 22 for Germany. In the machinery and electrical equipment industries, the Japanese seemed about as likely as the Americans (and both seemed more likely than the Germans) to regard protection in these 14 countries as too weak to permit such transfers; the mean percentage is 27 for Japan, 25 for the U.S., and 12 for Germany.

A positive correlation generally exists between the percentage of one country's firms that regard protection in a particular country as too weak to permit such technology transfers there and the percentage of another country's firms that feel this same way. (See Table 6.) But this correlation seems stronger among the chemical and pharmaceutical firms than among the machinery and electrical equipment firms (where, for example, there is no correlation at all between Germany and the U.S.).

V. Intellectual Property Protection and Licensing

Finally, each of the Japanese and German firms in our sample was asked whether the protection of intellectual property in each of these countries was too weak to allow it to license its newest or most effective technology to unrelated firms in that country. Mansfield (1994) provided information of this sort for the U.S. firms in our sample. In the chemical and pharmaceutical industries, over 40 percent of the firms in all three countries felt that protection in India, Indonesia, Nigeria, Thailand, and Argentina was too weak to permit such licensing (Table 7). In the machinery and electrical equipment industries, over 25 percent in all three countries felt this way about India, Brazil, and Nigeria. As usual, Singapore and Hong Kong received highest grades from both sets of industries, on the average.

Once again, U.S. firms in the chemical and pharmaceutical industries seemed more concerned about intellectual and property protection in these 14 countries than their Japanese and German rivals; but in the machinery and electrical equipment industries, Japanese firms appeared to be as concerned as the Americans. As shown in Table 7, the mean percentage in chemicals and pharmaceuticals is 56 for the U.S., 40 for Germany, and 35 for Japan; in machinery and electrical equipment, it is 31 for both the U.S. and Japan, and 24 for Germany. There generally is a positive correlation between the percentage of one country's firms that regard protection in a particular country as too weak to permit such licensing there and the percentage of another country's firms that feel that same way (Table 8). But as usual, this correlation seems higher among the chemical and pharmaceutical firms than among the machinery and electrical equipment firms (where the correlation between Germany and both Japan and the United States is close to zero).

Table 6

| Least Squares Relationships between German, Japanese, and U.S. Measures of Perceived Intellectual Property Protection in Fourteen Countries: Technology Transfer to Wholly-Owned Subsidiaries | | | | |
|--|-----------------------------|------------------|--------------|----------------------------------|
| <i>Dependent Variable</i> | <i>Independent Variable</i> | <i>Intercept</i> | <i>Slope</i> | <i>Adjusted r^2</i> |
| <i>Chemicals and Drugs</i> | | | | |
| Germany | U.S. | -4.6 | 0.63 | 0.35 |
| Japan | U.S. | -13.8 | 0.94 | 0.78 |
| Germany | Japan | 7.3 | 0.57 | 0.31 |
| <i>Machinery and Electrical</i> | | | | |
| Germany | U.S. | 6.8 | 0.20 | -0.06 |
| Japan | U.S. | 7.2 | 0.80 | 0.12 |
| Germany | Japan | -1.7 | 0.50 | 0.32 |

Table 7

| Percent of Major German, Japanese, and 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 Host Country | | | | | | | | |
|---|----------------------------------|--------------|-------------|-------------|---|--------------|-------------|-------------|
| <i>Host Country</i> | <i>-- Chemicals and Drugs --</i> | | | | <i>-- Machinery and Electrical Equipment --</i> | | | |
| | <i>Germany</i> | <i>Japan</i> | <i>U.S.</i> | <i>Mean</i> | <i>Germany</i> | <i>Japan</i> | <i>U.S.</i> | <i>Mean</i> |
| Argentina | 57 | 44 | 62 | 54 | 22 | 29 | 27 | 26 |
| Brazil | 43 | 36 | 69 | 49 | 33 | 38 | 51 | 41 |
| Chile | 33 | 55 | 47 | 45 | 25 | 29 | 24 | 26 |
| Hong Kong | 14 | 7 | 33 | 18 | 12 | 11 | 26 | 16 |
| India | 100 | 85 | 81 | 89 | 38 | 44 | 44 | 42 |
| Indonesia | 67 | 43 | 73 | 61 | 50 | 22 | 35 | 36 |
| Mexico | 0 | 7 | 56 | 21 | 22 | 20 | 32 | 25 |
| Nigeria | 57 | 50 | 73 | 60 | 50 | 38 | 28 | 39 |
| Philippines | 43 | 38 | 47 | 43 | 14 | 50 | 29 | 31 |
| Singapore | 0 | 0 | 25 | 8 | 11 | 0 | 12 | 8 |
| Republic of Korea | 33 | 7 | 38 | 26 | 12 | 38 | 32 | 27 |
| Taiwan, China | 33 | 21 | 44 | 33 | 14 | 54 | 46 | 38 |
| Thailand | 57 | 50 | 73 | 60 | 12 | 38 | 30 | 27 |
| Venezuela | 17 | 44 | 62 | 41 | 14 | 25 | 23 | 21 |
| Mean | 40 | 35 | 56 | 43 | 24 | 31 | 31 | 29 |

VI. Why Are Some Countries Perceived to Afford Stronger Protection Than Others?

The last three sections of this paper have presented three crude measures of the perceived strength or weakness of intellectual property protection: (1) the percentage of firms believing that protection there is too weak to allow them to invest in joint ventures (where they contribute advanced technology) 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; and (3) the percentage believing that protection is too weak to permit them to license their newest or most effective technology to unrelated firms in that country. A country's standing based on one of these measures tends to be highly correlated with its standing based on another of them. As shown in Table 9, the coefficient of determination between any pair of these measures is about 0.90 in Japan, 0.70 in the U.S., and 0.50 in Germany.

Table 8

| Least Squares Relationships between German, Japanese, and U.S. Measures of Perceived Intellectual Property Protection in Fourteen Countries: Licensing | | | | |
|---|-----------------------------|------------------|--------------|-------------------------------|
| <i>Dependent Variable</i> | <i>Independent Variable</i> | <i>Intercept</i> | <i>Slope</i> | <i>Adjusted r²</i> |
| <i>Chemicals and Drugs</i> | | | | |
| Germany | U.S. | -27.5 | 1.20 | 0.53 |
| Japan | U.S. | -26.3 | 1.09 | 0.59 |
| Germany | Japan | 6.1 | 0.96 | 0.67 |
| <i>Machinery and Electrical</i> | | | | |
| Germany | U.S. | 8.4 | 0.48 | 0.05 |
| Japan | U.S. | 0.6 | 0.98 | 0.40 |
| Germany | Japan | 19.9 | 0.12 | -0.07 |

Table 9

| Adjusted r^2 between Three Measures of Perceived Intellectual Property Protection, Germany, Japan, and the U.S. | | | | | | |
|---|-----------------------|------------------|-----------------------|------------------|-----------------------|------------------|
| | <i>Germany</i> | | <i>Japan</i> | | <i>United States</i> | |
| | <u>Joint Ventures</u> | <u>Licensing</u> | <u>Joint Ventures</u> | <u>Licensing</u> | <u>Joint Ventures</u> | <u>Licensing</u> |
| <i>Chemicals</i> | | | | | | |
| Subsidiaries | 0.51 | 0.51 | 0.79 | 0.92 | 0.73 | 0.70 |
| Licensing | 0.83 | | 0.91 | | 0.72 | |
| <i>Machinery and Electrical</i> | | | | | | |
| Subsidiaries | 0.21 | 0.08 | 0.91 | 0.86 | 0.54 | 0.78 |
| Licensing | 0.62 | | 0.86 | | 0.70 | |

In the chemical and pharmaceutical industries, as we have seen in Tables 4, 6, and 8, a country's standing based on the perception of U.S. firms is positively correlated with its standing based on Japanese perceptions, and both are positively correlated with its standing based on German perceptions. This is true regardless of which of the above three measures is used. To understand why, one must recognize that some countries like India, Argentina, and Brazil do not issue product patents for drugs or chemicals, and that other countries, while they may have laws protecting intellectual property on the books, do little to enforce them. Such countries receive very poor grades from chemical and drug firms, regardless of whether they are based in the U.S., Japan, or Germany, because of the importance of patents in these industries.⁸

In the machinery and electrical equipment industries, the correlation between a country's standing based on U.S. perceptions and its standing based on Japanese or German perceptions tends to be positive, but lower than in chemicals and pharmaceuticals. This may be related to the fact that intellectual property protection is generally regarded as less important in machinery and electrical equipment than in chemicals and pharmaceuticals (where local firms can imitate an innovator's new products relatively easily).⁹ Since the differences among developing countries seem to be regarded as less pronounced and less crucial than in chemicals and pharmaceuticals, there is more disagreement among Americans, Japanese, and Germans over the standing in this regard of particular countries.

⁸ See Mansfield (1986, 1994).

⁹ Ibid.

VII. Differences in Perceptions Among Industries

In all three countries, as we have seen, intellectual property protection seems to be less important in transportation equipment, metals, or food than in chemicals, pharmaceuticals, machinery, and electrical equipment. In part, this is because competitors in industries like metals and transportation equipment frequently cannot make use of a firm's technology without many complex and expensive inputs. Regardless of whether American, Japanese, or German firms are considered, there is only a relatively moderate amount of correlation between a country's standing in the eyes of the chemical and pharmaceutical industries and its standing in the eyes of the machinery and electrical equipment industries. This is true, no matter which of the above three measures of the perceived strength or weakness of intellectual property protection is used. As shown in Table 10, the value of the adjusted coefficient of determination averages about 0.2.

To a considerable extent, this is because a country's laws often affect different industries in quite different ways. Take the case of Argentina, which denies patent protection to pharmaceutical products. Regardless of whether American, Japanese, or German perceptions are considered, Argentina gets poor marks from the pharmaceutical producers, whereas the machinery and electrical equipment industries in all three countries seem to regard intellectual property protection in Argentina as stronger than the average among this group of 14 countries.¹⁰

In addition, the competence and aggressiveness of local firms may be different in the chemical and pharmaceutical industries than in the machinery and electrical equipment industries. Thus, even if the intellectual property laws (and their enforcement) are the same in both sets of industries, American, Japanese, or German firms in the industries facing local firms that are more aggressive in exploiting weak laws and enforcement may perceive protection to be weaker than the American, Japanese, or German firms in the industries with less aggressive local firms. For example, it has been suggested that Argentina's drug firms have been much more aggressive than other parts of Argentinean industry, which may help to account for the interindustry differences observed here in the perception of the strength or weakness of protection in Argentina.

¹⁰ In Table 3, the mean percentage of machinery and electrical equipment firms regarding protection in Argentina as inadequate is 21; in Table 5, it is 19; and in Table 7, it is 26. In every case, it is lower than the average for these 14 countries.

Table 10

| Adjusted r^2 between Chemical and Pharmaceutical Industries' and Machinery and Electrical Industries' Measures of Perceived Intellectual Property Protection in Fourteen Major Developing Countries | | | | |
|---|----------------|--------------|----------------------|-------------|
| | <i>Germany</i> | <i>Japan</i> | <i>United States</i> | <i>Mean</i> |
| Joint Ventures | 0.34 | 0.02 | 0.37 | 0.24 |
| Licensing | 0.32 | 0.16 | 0.17 | 0.22 |
| Subsidiaries | -0.08 | 0.29 | 0.02 | 0.08 |
| Mean | 0.19 | 0.16 | 0.19 | 0.18 |

VIII. Differences in Perceptions Among U.S., Japanese, and German Firms

In the chemical and pharmaceutical industries, U.S. firms seem substantially more likely than their Japanese counterparts to regard protection in these 14 countries as too weak to permit joint ventures which entail the contribution of advanced technology, transfer of such technology to wholly-owned subsidiaries there, or licensing of such technology to unrelated firms there. But in the machinery and electrical equipment industries, there is essentially no difference between U.S. and Japanese firms in this regard. In part, this may be because, while the major U.S. chemical and pharmaceutical firms are world technological leaders, their Japanese rivals are still not quite as strong technologically.¹¹ Thus, U.S. firms might be expected to require stronger protection before exposing or transferring their most advanced technology. On the other hand, in many types of machinery and electrical equipment, Japanese firms are often regarded as at least as strong technologically as their U.S. rivals, so it would not be surprising if their requirements, attitudes, and perceptions were similar.¹²

German chemical and drug firms, which have long been noted for their technological strength, generally seem to be midway between the U.S. and Japanese firms in this regard. In machinery and electrical equipment, on the other hand, German firms seem less likely than their U.S. and Japanese counterparts to regard protection in these 14 countries as too weak to permit joint ventures where they contribute advanced technology, transfers of such technology to wholly-owned subsidiaries there, or licensing of such technology to unrelated firms there. If the rate of innovation in machinery and electrical equipment has tended to be lower in Germany than in the U.S. and Japan, this might help to explain these findings.¹³

11 For example, see Grabowski (1989).

12 For example, see Business Week, November 18, 1994 (special issue).

13 According to some observers, whereas its technology is excellent in chemicals, pharmaceuticals, aerospace, and transportation, and it is strong in basic science, Western Europe must speed the transition to the digital electronic era. See ibid.

Economists and others have shown an interest in comparing East Asia, where growth has been so rapid, with other areas like Latin America. (For example, see Pfeffermann (1994).) In both the chemical and drug industries and the machinery and electrical equipment industries, the percentage of firms regarding intellectual property protection as too weak to warrant direct investment or technology transfer in the East Asian countries considered here tends to be lower than in the Latin American countries. This is true, regardless of whether the perceptions of the U.S., Japanese, or German firms are used.¹⁴

Turning to individual countries, it is worth noting that in both sets of industries, German and Japanese firms seem less concerned than U.S. firms about intellectual property protection in Mexico, Hong Kong, and Singapore. In the case of Mexico, this may be because the German and Japanese data pertain to 1994 whereas the U.S. data pertain to 1991; many observers feel that Mexico strengthened protection in the early 1990s. (See Mansfield (1994).)

14 If we compare the five Latin American countries (Argentina, Brazil, Chile, Mexico, and Venezuela) with the six East Asian countries (Hong Kong, Indonesia, Singapore, Republic of Korea, Thailand, and Taiwan, China), the mean percentages in Table 3 are:

| | Chemicals and pharmaceuticals | | | Machinery and electrical equipment | | |
|---------------|-------------------------------|--------------|-------------|------------------------------------|--------------|-------------|
| | <u>Germany</u> | <u>Japan</u> | <u>U.S.</u> | <u>Germany</u> | <u>Japan</u> | <u>U.S.</u> |
| East Asia | 24 | 9 | 32 | 17 | 19 | 23 |
| Latin America | 27 | 25 | 41 | 16 | 27 | 29 |

The mean percentages in Table 5 are:

| | Chemicals and pharmaceuticals | | | Machinery and electrical equipment | | |
|---------------|-------------------------------|--------------|-------------|------------------------------------|--------------|-------------|
| | <u>Germany</u> | <u>Japan</u> | <u>U.S.</u> | <u>Germany</u> | <u>Japan</u> | <u>U.S.</u> |
| East Asia | 13 | 16 | 30 | 6 | 21 | 25 |
| Latin America | 27 | 25 | 44 | 11 | 27 | 23 |

The mean percentages in Table 7 are:

| | Chemicals and pharmaceuticals | | | Machinery and electrical equipment | | |
|---------------|-------------------------------|--------------|-------------|------------------------------------|--------------|-------------|
| | <u>Germany</u> | <u>Japan</u> | <u>U.S.</u> | <u>Germany</u> | <u>Japan</u> | <u>U.S.</u> |
| East Asia | 34 | 21 | 48 | 18 | 27 | 30 |
| Latin America | 30 | 37 | 59 | 23 | 28 | 31 |

IX. Intellectual Property Protection and Foreign Direct Investment: A Simple Econometric Model

Having extended the coverage of the surveys to include Japanese and German firms, I turn now to the construction of a simple econometric model to test whether the perceived strength or weakness of intellectual property protection in a country influences the amount of foreign direct investment received by this country. Put simply, this section attempts to estimate the relationship between a variety of independent variables, on the one hand, and the amount of foreign direct investment, on the other hand. Then, holding other independent variables constant, we estimate the effect of the perceived strength or weakness of intellectual property protection in a country on how much foreign direct investment it receives.

Because data concerning Japanese and German foreign direct investment are not available for all these 14 countries, the tests are confined to U.S. experience. The dependent variable is I_{it} , defined as U.S. direct investment in all manufacturing (as measured by the Commerce Department's figures on U.S. capital outflow in millions of dollars) in the i^{th} country in year t . As a measure of the perceived weakness of intellectual property protection in the i^{th} country, I use G_i , the average of (1) the mean percentage of U.S. firms regarding protection in the i^{th} country as too weak to permit them to invest in joint ventures where they contribute advanced technology, and (2) the mean percentage of U.S. firms regarding protection in the i^{th} country as too weak to allow them to transfer advanced technology to wholly-owned subsidiaries there.¹⁵

The following model is proposed:

$$I_{it} = \theta_0 + \theta_1 G_i + \theta_2 K_i + \theta_3 M_i + \theta_4 F_i + \theta_5 S_i + \theta_6 O_i + \theta_7 d_{1t} + \theta_8 d_{2t} + \theta_9 d_{3t} + e_{it} \quad (1)$$

where K_i is a measure of the size of market in the i^{th} country,¹⁶ M_i is a dummy variable equaling 1 for Mexico and zero otherwise, F_i is the level (stock) of foreign direct investment prior to year t in the i^{th} country,¹⁷ S_i is a measure of the degree of industrialization in the i^{th} country,¹⁸ and O_i is a measure of

15 The percentage for each industry is weighted equally, as indicated in Mansfield (1994). The data on licensing are excluded because they seem less relevant to foreign direct investment than the components of G_i , but if they are included, the results change very little.

16 This measure, provided by Wheeler and Mody (1992), is based on the i^{th} country's GDP. Scaperlanda and Mauer (1969) used GNP in an early study of U.S. direct investment. For a discussion of the limitations of GNP (or GDP) as a measure of size of market, see Stobaugh (1969). For more recent studies, see Culem (1988). If the i^{th} country's GDP in year $t - 1$, rather than K_i , is used, the results are essentially the same.

17 For these data, see Wheeler and Mody (1992).

18 This measure, based on manufacturing and mining as a percent of gross domestic product, is described in *ibid.*

the openness (freedom from import restrictions, price controls, profit repatriation controls, and the like) of the i^{th} country's economy¹⁹, $t = 1990, 1991, 1992, \text{ or } 1993$, d_{1t} is a dummy variable which equals 1 if $t = 1993$ and zero otherwise, d_{2t} is a dummy variable which equals 1 if $t = 1992$ and zero otherwise, and d_{3t} is a dummy variable which equals 1 if $t=1991$ and zero otherwise.

The rationale for including, besides G_i , each of the above independent variables in equation (1) seems straightforward. Since direct investment would be expected to be directly related to the size of a country's market, I include K_i . Because of Mexico's location next to the United States, the existence of many special programs (like the maquiladora program) to encourage U.S. direct investment in Mexico, and the process leading up to NAFTA,²⁰ I include M_i . Due to the agglomeration effects stressed by Markusen (1990), Arthur (1986), and others, I include F_i , which would be expected to have a positive effect on I_{it} . Because the percentage of manufacturing or mining in GDP has been shown in earlier studies to influence the amount of foreign direct investment in a country, I include S_i . Since the openness of an economy obviously can affect I_{it} , I include O_i . The data on K_i , F_i , S_i , and O_i come from Wheeler and Mody (1992), who found that each of these variables had a significant effect on U.S. foreign direct investment in 42 countries during 1982-88.²¹

Least squares estimates of the θ 's in equation (1) are contained in the first column of Table 11. The estimate of θ_1 is negative and statistically significant, which is in accord with the hypothesis that the volume of U.S. direct investment in manufacturing in a country tends to be inversely related to the weakness of protection there. The estimates of all of the regression coefficients have the expected sign.²² If we omit the time dummies (d_{1t} , d_{2t} , and d_{3t}), which are not statistically significant, the results, contained in the second column of Table 11, show that the estimate of θ_1 continues to be negative and statistically significant. Further, if O_i and S_i (neither of which has a statistically significant effect) are omitted, the results, contained in the third and fourth columns of Table 11,

19 This measure, devised by Wheeler and Mody (1992), is based on nine measures of government intervention -- import restrictions, export requirements, local content requirements, price controls, profit repatriation controls, exchange controls, foreign equity limitations for existing and new investment, and the risk of expropriation.

20 In the early 1990's, there were negotiations aimed at a free trade agreement including Mexico and the United States. Further, during 1990-93, the available evidence does not indicate much change over time in G_i , except perhaps for Mexico. The effect of M_i may partly reflect such a change (downward) for Mexico.

21 Wheeler and Mody (1992) included other independent variables besides these four in their study, but only these four plus a measure of the quality of infrastructure were significant. Because this measure of the quality of infrastructure is very highly correlated with S_i in our sample, we included only S_i , which in effect represents both variables.

22 According to Wheeler and Mody (1992), there is no reason to expect the effect of O_i to be either positive or negative because some types of openness may encourage foreign direct investment whereas other types may discourage it. Their measure of O_i is a first principal component of a wide variety of measures of government intervention. (Recall footnote 19.) In their study, its effect seemed to be negative, whereas in Table 11 it is positive but far from statistically significant.

show that the estimate of θ_1 is relatively unaffected. If the 1990 data are dropped and if only 1991-93 data are included, the estimate of θ_1 (shown in Table 12) is higher, which would be expected since the data regarding G_i pertain to 1991.²³

To sum up, a simple econometric model can explain about 50 percent of the variation among these 14 developing countries and over time (during 1990-93) in the amount of U.S. foreign direct investment. The key explanatory variables are the size of a country's market, the stock of prior foreign direct investment in this country, a dummy variable for Mexico, and a measure of the weakness of intellectual property protection in the country. Holding other factors constant, if the percentage of firms regarding protection in a particular country as inadequate falls by 10 points, U.S. foreign direct investment there seems to increase by about \$200 million per year. Regardless of which of a number of variants of this model is adopted, this estimate varies relatively little. However, any estimate of this sort should be treated with great caution because of data limitations and possible specification errors.

23 Given that the perceived levels of protection pertain to 1991, and that the effects on investment may occur with a lag, one might expect that G_i would have a more definite and pronounced effect on I_i in 1991-93 than in 1990-93. A comparison of Tables 11 and 12 indicates that this is true. Lee and I have also estimated this model using 1990-92 data (Lee and Mansfield (forthcoming)), and as might be expected, the estimated effect of G_i is smaller there than for 1991-93 or 1990-93, although it continues to be statistically significant.

Table 11

| Least-Squares Estimates of Coefficients in Equation (1), When All and Various Subsets of Variables are Included, 1990-93 | | | | |
|--|----------------------|--------------------|--------------------|--------------------|
| <u>Coefficient</u> | <u>All Variables</u> | <u>Subset 1</u> | <u>Subset 2</u> | <u>Subset 3</u> |
| θ_0 | -781 (-1.92) | -704 (-1.74) | -271 (-1.16) | -362 (-1.71) |
| θ_1 | -21.3** (-2.45) | -21.3** (-2.41) | -22.7** (-2.57) | -19.7** (-2.40) |
| θ_2 | 172*** (3.30) | 172** (3.25) | 113*** (3.93) | 105*** (3.84) |
| θ_3 | 595** (2.96) | 595** (2.92) | 568** (2.78) | 571** (2.80) |
| θ_4 | 108*** (4.90) | 108*** (4.82) | 111*** (4.93) | 101*** (5.17) |
| θ_5 | -66.7 (-1.60) | -66.7 (-1.57) | -28.8 (-0.92) | --- |
| θ_6 | 57.2 (1.33) | 57.2 (1.31) | --- | --- |
| θ_7 | 241 (1.87) | --- | --- | --- |
| θ_8 | 56.9 (0.44) | --- | --- | --- |
| θ_9 | 11.1 (0.09) | --- | --- | --- |
| \bar{R}^2 | 0.54 | 0.52 | 0.51 | 0.52 |

*** Significant at .001 level (one-tailed test except for θ_0 , θ_6 , θ_7 , θ_8 , and θ_9).

** Significant at .01 level (one-tailed test except for θ_0 , θ_6 , θ_7 , θ_8 , and θ_9).

Table 12

| Least-Squares Estimates of Coefficients in Equation (1), When All and Various Subsets of Variables are Included, 1991-93 | | | | |
|--|----------------------|-------------------|-------------------|-------------------|
| <u>Coefficient</u> | <u>All Variables</u> | <u>Subset 1</u> | <u>Subset 2</u> | <u>Subset 3</u> |
| θ_0 | -991 (-1.99) | -899 (-1.80) | -370 (-1.28) | -479 (-1.83) |
| θ_1 | -26.0* (-2.42) | -26.0* (-2.38) | -27.8* (-2.54) | -24.1* (-2.38) |
| θ_2 | 212*** (3.30) | 212*** (3.25) | 141*** (3.95) | 131*** (3.88) |
| θ_3 | 443* (1.79) | 443* (1.76) | 410 (1.62) | 413 (1.64) |
| θ_4 | 133*** (4.87) | 133*** (4.79) | 136*** (4.89) | 124*** (5.14) |
| θ_5 | -80.8 (-1.56) | -80.8 (-1.54) | -34.5 (-0.89) | --- |
| θ_6 | 69.8 (1.32) | 69.8 (1.30) | --- | --- |
| θ_7 | 230 (1.67) | --- | --- | --- |
| θ_8 | 45.9 (0.33) | --- | --- | --- |
| \bar{R}^2 | 0.55 | 0.54 | 0.53 | 0.53 |

*** Significant at .001 level (one-tailed test except for θ_0 , θ_6 , θ_7 , and θ_8).

** Significant at .01 level (one-tailed test except for θ_0 , θ_6 , θ_7 , and θ_8).

* Significant at .05 level (one-tailed test except for θ_0 , θ_6 , θ_7 , and θ_8).

X. Summary and Conclusions

1. The bulk of the Japanese and German 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 investment decisions. For example, in chemicals and pharmaceuticals, over 80 percent said that this factor was important with regard to investments in R and D facilities, but only about 20 percent said that it was important with regard to sales and distribution outlets.
2. Regardless of whether one considers chemicals and pharmaceuticals, machinery and electrical equipment, or all firms in the sample, there is a remarkably small difference between Japan and Germany combined and the United States in the percentage of firms reporting that intellectual property protection was important in their foreign direct investment decisions.
3. In chemicals and pharmaceuticals, at least 25 percent of the firms in all three countries (Japan, Germany, and the U.S.) felt that protection in India, Nigeria, Argentina, Brazil, Chile, and Thailand was too weak to allow them to invest there in joint ventures where they contributed advanced technology. In machinery and electrical equipment, this was true in Brazil, Nigeria, India, Thailand, and Taiwan, China.
4. In chemicals and pharmaceuticals, over 25 percent of the firms in all three countries felt that protection in India, Chile, and Argentina was too weak to permit them to transfer their newest or most effective technology to a wholly-owned subsidiary there. In machinery and electrical equipment, over 20 percent in all three countries felt that this was the case in Nigeria, Brazil, and the Philippines.
5. In chemicals and pharmaceuticals, over 40 percent of the firms in all three countries felt that protection in India, Indonesia, Nigeria, Thailand, and Argentina was too weak to allow them to license their newest or most effective technology to unrelated firms in these countries. In machinery and electrical equipment, over 25 percent in all three countries felt that way about India, Brazil, and Nigeria.
6. Both the chemical and pharmaceutical firms and the machinery and electrical equipment firms in all three countries tended to regard Singapore and Hong Kong as having the highest level of protection, among the 14 major countries considered here. Japanese and German firms seemed to give them higher marks in this respect than did U.S. firms.
7. In chemicals and pharmaceuticals, the perceptions of U.S., Japanese, and German firms are more highly correlated with one another than in machinery and electrical equipment because differences among developing countries in protection often seem more pronounced and more crucial in chemicals and pharmaceuticals than in machinery and electrical equipment.

8. No matter whether Japanese, German, or U.S. firms are considered, there is only a modest amount of correlation between the perceived strength or weakness of protection in a country, according to chemical and pharmaceutical firms, and the perceived strength or weakness of protection in the same country, according to machinery and electrical equipment firms. This is due in part to the fact that a country's laws often affect different industries in quite different ways and that the competence and aggressiveness of a country's firms may differ from industry to industry.

9. In chemicals and pharmaceuticals, U.S. firms seem substantially more likely than their Japanese counterparts to regard protection in these 14 countries as too weak to permit direct investment and the transfer of their most advanced technology, whereas in machinery and electrical equipment, there is essentially no difference between U.S. and Japanese firms in this regard. In part, this may reflect Japan's being a technological leader in many areas of machinery and electrical equipment, but not quite as strong in chemicals and pharmaceuticals.

10. A simple econometric model can explain about 50 percent of the variation among these 14 developing countries and over time (during 1990-93) in the amount of U.S. foreign direct investment. The key explanatory variables are the size of a country's market, the stock of prior foreign direct investment in this country, a dummy variable for Mexico, and a measure of the weakness of intellectual property protection in the country.

11. Holding other factors constant, if the percentage of firms regarding protection in a particular country as inadequate falls by 10 points, U.S. foreign direct investment there seems to increase by about \$200 million per year. Regardless of which of a number of variants of this model is adopted, this estimate varies relatively little. However, any estimate of this sort should be treated with great caution because of data limitations and possible specification errors.

12. In conclusion, this study indicates that the strength or weakness of a country's system of intellectual property protection seems to have a substantial effect in relatively high-technology industries like chemicals, pharmaceuticals, machinery, and electrical equipment on the kinds of technology transferred to that country and the amount of direct investment in that country by Japanese and German firms. This finding is entirely consistent with my earlier study regarding U.S. firms, part of which has been refined and extended in the econometric analysis presented here. I believe that this study sheds substantial new light on this important, but relatively unexplored, topic, but more needs to be done. Further investigations, both empirical and theoretical, would be welcome.

Appendix

This appendix provides direct quotations from the responses of a sample of executives to our questions. We begin with Japanese and German firms that say that intellectual property protection is one of the important factors influencing technology transfer and investment decisions. Then we take up the views of Japanese and German firms that say that intellectual property protection is not important for such decisions. Finally, we summarize the views of a sample of U.S. firms regarding the differences, if any, between Japanese and German firms, on the one hand, and U.S. firms, on the other hand, in their concern over intellectual property protection.

Firms Considering Intellectual Property Protection as an Important Factor in Technology Transfer and Investment Decisions

Most of the firms we contacted seemed to regard intellectual property rights protection to be an important factor, but only one of a number of important factors, influencing technology transfer and investment decisions. For example, the chief patent attorney at a major Japanese chemicals firm stated the following:

While the system necessary for the protection of intellectual property (IP) rights in developing countries is undergoing gradual improvement, I must admit that their system, in comparison with that existent in some other countries such as Japan, the United States and in Europe is still quite inadequate in terms of protection enforcement, and we are very desirous that their protection be improved and further fortified, and that if and when such improvement is accomplished, technology transfer and direct investment would become definitely easier to implement.

Our practice has been to effect such technology transfer and direct investment normally after determining how good the IP protection in the country in question is. In case the IP protection available is not sufficient, disadvantages that may possibly be sustained would be the following:

In a technology transfer case, the property value of the technology transferred would decline (for instance, if the IP protection available is not strong enough, the value of the technology may not be retained even in case of exclusive licenses.) When it comes to the direct investment, on the other hand, difficulty would entail in keeping the superiority of the business based on that technology as well as in assuring return of the investment actually made. Furthermore, in both, technology transfer and direct investment, burden required for proper maintenance of confidentiality would be very large too.

To us it is one of our major concerns that IP protection should be properly attained in any country for our technology transfer and direct investment, and we have been doing our best to meet that objective.

An executive of a major Japanese chemical and pharmaceutical company responded as follows:

Particularly, in case of transferring technology to developing countries in which their system of patent and trade secret protection is not built up enough or is weak, it is rather difficult for us to transfer high-technology or advanced technology as compared with our competitors' technology to such countries. Therefore, in such case we will often transfer second or third grade technology to them.

Accordingly, the transfer of the top-grade technology is possible only to the subsidiaries on the following three terms and conditions:

- 1) the majority of which stocks we own.
- 2) to which we may dispatch key persons and
- 3) which may fully control technology of production disclosed and/or transferred by us.

However, even in this case we have difficulty in controlling a "trade secret".

As stated above, we are not willing to transfer the top-grade technology to such developing countries as being weak on their system of patent and trade secret protection.

Therefore, as an inevitable consequence, the amount of investment by us becomes small and we are obliged to expand our investment little by little while taking in the situation in such countries.

A top executive of a German pharmaceutical firm responded as follows:

The strength or weakness of a developing country's system of IPR has a substantial effect on the kinds of technology my firm will transfer. We are not prepared to transfer high technology into a country in which our IPR is not protected and in which we will lose control of it.

The strength or weakness of a country's system of IPR is not the only criterion of our decision where my company will make direct investment but it is certainly one of the decisive factors. If we have the choice between two countries having nearly the same political and economic framework, we would certainly prefer the country with the more reliable IPR system.

The general manager of international operations of a major Japanese electrical equipment producer stated the following:

If the country does not have an adequate system or practice to protect intellectual property rights, our technology transfer to that country will be limited and we protect our rights in the following way. We will ensure, in the technology transfer agreement, that the important or core technology will not be transferred without adequate consideration. For example, necessary parts will be supplied from our factory.

In the case of software, our agreement of transfer of technology specifically provides for the obligation of the transferee to protect such intellectual rights. Also, considering the difficulty of protecting the rights, we will restrict the kind of information transferred and ensure that sufficient consideration will be collected.

The general manager of the overseas department of a Japanese computer manufacturer reported that:

We may refrain from transferring our technology to the country where the intellectual property protection system is weak. [However,] the weakness of the country's system of intellectual property protection has no substantial effect on our investment in that country, as far as our intellectual property is not included in that investment.

An executive of a large Japanese pharmaceutical firm responded that:

Generally speaking, the weakness of a developing country's system of intellectual property protection discourages our business desire in the market.

The director of the intellectual property department of a large Japanese chemical firm stated:

We can not help hesitating to transfer our technology to developing countries if the trade secret of high-technology can not be protected in those countries. Although laws and regulations for protecting trade secret are being arranged recently in developing countries, it is difficult to transfer high-technology to those countries where it is not widely recognized as social justice to respect intellectual property rights.

Our company has been investing directly to many overseas joint-venture companies, but most of them are for manufacturing commodity products. Concerning transfer of high-technology, we are still hesitating as stated above.

Also, the manager of planning and coordination of a huge Japanese electronics firm added the following point:

A Japanese company receives royalties for a limited period when it transfers technology. In due course, though, the recipient integrates the technology. The Japanese company

may then experience a so-called "boomerang effect." This point must be considered before a technology transfer occurs.

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

While most of the executives we contacted felt that intellectual property protection is important, a substantial minority did not share this view. The top executives at a major German chemical firm stated that:

Both the transfer of technology as such and the value of the transferred technology itself are determined not by the quality of patent protection in the developing country concerned. The most important determining factors are the commercial status of the potential licensee, the geographical position of the market and, in particular, the interests of this company in the respective region.

These aspects are ultimately decisive in determining investments in these countries. As to the question in which specific country of a geographical region investments are to be made, a further important parameter is the financial expenditure for the existing required work force or how well they are qualified to perform the tasks intended.

As you can infer from our remarks, the decision for or against a developing country is determined primarily by commercial aspects. Questions regarding patent law are not in any way decisive.

The manager of corporate planning of a major Japanese food company said:

[While] we are concerned about the situations of intellectual property protection when we intend to transfer our technology to developing countries or invest in them, they are not substantial factors by which we make decisions whether we should do so or not. Rather such general market situations as level of per capita GDP and market shares of competitors, the prospects of particular enterprises and the existence of credible partners are regarded as more important factors for technology transfer and direct investment.

The general manager of a leading Japanese electronics firm stated that:

The strength or weakness of a developing country's system of intellectual property protection does not have a substantial effect on the kinds of technology that we will transfer to that country.

The strength or weakness of a developing country's system of intellectual property protection does not have a substantial effect on the composition and extent of our direct investment in that country.

The manager of intellectual property at a major Japanese computer firm said:

Intellectual property protection systems of developing countries are not sufficiently effective to protect electronic technology of this firm from being used without any right granted by this firm. If required and compelled by economic reasons, this firm will invest in developing countries, even if their intellectual property protection systems are not sufficiently strong.

The director of patents of a leading Japanese pharmaceutical firm stated:

Investment is decided in view of many other factors than intellectual property protection, e.g. the political stability, availability of educated workers, tax system, etc.

Perceptions of U.S. Firms

A sample of U.S. executives in the chemical industry (where intellectual property protection is regarded as particularly important) were contacted to determine their views concerning the differences, if any, between Japanese and German firms, on the one hand, and U.S. firms, on the other, with regard to the importance of intellectual property protection in technology transfer and investment decisions. Most seemed to emphasize the similarities rather than the differences.

One chemical executive commented as follows:

The issue of intellectual property protection covers two areas: whether a developing country has adequate intellectual property laws, and given such legislation, whether the country enforces its laws appropriately to encourage direct investment by companies residing in developed countries. Germany and Japan are similar to the U.S. in having concerns over this issue related to developing countries. At a meeting in Beijing last year several Japanese companies expressed their concern about direct investment in China, including consumer products, unless that country's government would take a stronger position on enforcement of the newly established legislation (within the last 5 years). The recent problems with China revolved around violation of existing laws in trademark protection. The major German companies are as concerned as U.S. companies (our experience more with chemical and biotechnology operations) concerning this issue. In conclusion, given the two countries in question, I feel that both countries are similar to the U.S. concerning the strength of the intellectual property system and its influence on technology transfer and direct investment.

The director of international marketing at another major U.S. chemical company said:

I think they are all equally concerned and, if anything the Japanese and German firms may be more stringent in their desire for protection.

A leading patent attorney at one of the U.S. chemical giants stated:

I know from my contact with Japanese and Europeans in working on high minimum standards of protection of intellectual property in the GATT that their companies are concerned about protecting their intellectual property...

The chief patent counsel of another major chemical producer said:

As you know, many factors in addition to the viability of the intellectual property system affect differences in technology transfer/investment policies between German and Japanese firms on one hand and U.S. firms on the other hand. These factors include export control regulations, financing availability, technology owner's business strategy and liability concerns. My opinion is that these factors far outshadow any differences caused by the viability of the intellectual property system of the developing country, and in fact, cause any perceived differences, especially in the chemical industry.

While unquestionably the viability of a developing country's intellectual property system influences whether, and if so, what, technology will be transferred, my experience in the chemical industry is that that factor alone does not materially distinguish a U.S. firm from one in Japan or Germany.

However, not all of the U.S. chemical executives felt that the Japanese and German firms were concerned in the same way as U.S. firms about intellectual property protection. A patent attorney at one major chemical firm said that German and Japanese firms relied more heavily than U.S. firms on controlling information sent to subsidiaries in developing countries by putting German or Japanese personnel, rather than personnel from the host country, in key positions. Also, he said that Japanese and German firms are more likely to conform to the local business climate and custom, rather than act strictly in accord with the customs at home. He underscored the tentativeness of these remarks, which he said were based only on anecdotal evidence. Obviously, they should be treated with appropriate caution.

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