

DISCUSSION PAPERS IN ECONOMICS

Intellectual Property Rights and Multinational Firms' Modes of Entry

Thitima Puttitanun

Department of Economics

University of Colorado at Boulder

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Abstract

This paper studies the relationship between intellectual property rights (IPR) of a country and the modes of entry to the country by multinational firms. A model is developed that allows firms with new technologies to choose among three modes of entry: exporting, foreign direct investment (FDI

finding in the literature, an increas

profit from each mode of entry, a multinational firm is able to choose the mode that awards the highest profit. In other words, a multinational firm will choose the entry mode i in country

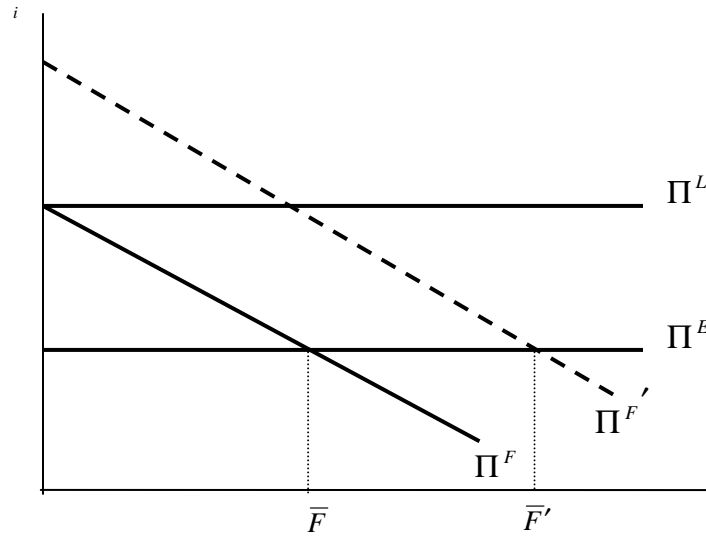
country and the firms. If a firm chooses FDI, it transfers the knowledge outside the source country but holds the knowledge within the firm. However, when a firm licenses

The instantaneous monopoly profit from exporting, FDI and licensing¹⁴ is summarized below, respectively:

$$E \quad c \quad (4) \quad ($$

Proposition 1 : Given a level of β^i , there exists \bar{F} such that $\Pi^{E*} = \Pi^{F*}$. When $F < \bar{F}$, $\Pi^{E*} < \Pi^{F*}$; and when $F > \bar{F}$, $\Pi^{E*} > \Pi^{F*}$. At the fixed cost level \bar{F} , total profit in both FDI and export modes are the same.

Figure 1: Relationship between total profit and fixed cost



$$\text{iii) } \frac{\partial \Pi^E}{\partial t} < 0.$$

$$\text{iv) } \frac{\partial \Pi^F}{\partial F} < 0.$$

$$\text{v) } \frac{\partial \Pi^E}{\partial w^{US}} < 0, \frac{\partial \Pi^F}{\partial w^n} < 0, \frac{\partial \Pi^L}{\partial w^n} < 0.$$

Proof: See Appendix B and C.

That is while profits under all modes increase in IPR, and market size in country n , they decrease in the effective wage. Moreover, profits under export decrease in the transportation cost and profits under FDI decrease in the set up cost of a plant in another market (fixed cost).

Strong IPR augments the ownership advantage of the MNEs in the foreign market by providing legal protection against imitation of their assets. Consequently, the protection of MNEs' knowledge assets enhances MNEs' control over and returns to its knowledge assets. This effect can be interpreted in terms of market expansion. The market expansion concept states that strong IPR expands foreign markets available for servicing by ensuring exclusive rights over knowledge that flows to the foreign country. Such knowledge is embodied in exports, FDI, or licensing. In the absence of strong IPR, firms reduce their bilateral exchange to countries where they expect imitation of their knowledge. Thus, under market expansion concept, there is a positive relationship between strong IPR and bilateral exchange, and we should expect this positive relationship when imitative abilities are strong.

It can also be noted that the size of $\frac{\partial \Pi^i}{\partial \alpha}$ depends on β^i and $\beta^{i'}(\alpha)$. That is, the size of the effect of IPR protection on the MNEs' profit of each mode depends on profit dissipation rate of each mode and how sensitive these rates are to a change in IPR protection. Therefore, there are many possible cases. For example: If $\beta^L > \beta^F$ and $\left| \beta^{L'}(\alpha) \right| \leq \left| \beta^{F'}(\alpha) \right|$, then $\frac{\partial \Pi^L}{\partial \alpha} < \frac{\partial \Pi^F}{\partial \alpha}$. This condition can be translated to: an increase in IPR affects FDI profit more than it affects licensing profit if the profit

dissipation rate when licensing is higher than when FDI but this profit dissipation rate is more sensitive to a change in IPR when FDI than when licensing. (For more cases, see Appendix C). Thus, the argument here is that the effect of IPR on modes of entry might

Π^i

Π^F

$\Pi^{F'}$

Π^L

Π^E

when $\beta^L > \beta^F$ and

$$EX = f(\alpha_n, A_n, t_n)$$

$$FDI = f(\alpha_n, A_n, F_n, w_n)$$

$$LIC = f(\alpha_n, A_n, w_n)$$

Where α_n

where the vector x_n and z_n contain the observed country characteristics, δ and γ are the compatible vectors of unknown parameters to be estimated, and ε_{mi} is the stochastic term associated with each choice and firm. The introduction of the stochastic term aims to capture unobserved firm-specific characteristics, and unobserved choice-specific attributes.

Given the stochastic nature of the profit function, the probability that mode i is selected by any firm m can be written as

$$P_{mi} = \text{Prob}(\ln \Pi_{mi} > \ln \Pi_{mj} \quad \forall i \neq j) \quad (9)$$

To specify a particular discrete choice model, a particular joint distribution of the stochastic term should be selected. The common specification is the multinomial logit model, which assumes that ε_{mi} values are drawn from independent and identical extreme value distribution. The estimated results in the next section that are based on this multinomial logit model provide a set of probabilities for the choices of a firm facing country characteristics x_n . These probabilities¹⁶ are

$$P_{mi} = \frac{\exp(\delta'_i x_n + \gamma'_i z_n)}{1 + \sum_{i=0}^2 \exp(\delta'_i x_n + \gamma'_i z_n)}, \quad \text{for } i = 1, 2 \quad (10)$$

and

$$P_{m0} = \frac{1}{1 + \sum_{i=0}^2 \exp(\delta'_i x_n + \gamma'_i z_n)} \quad (11)$$

This means that the coefficient estimates give the marginal effects of x_n and z_n on the estimated log-odd ratios, which can be computed as

$$\ln \left[\frac{P_{mi}}{P_{m0}} \right] = \hat{\delta}'_i x_n + \hat{\gamma}'_i z_n \quad (12)$$

That is, the estimated coefficients, $\hat{\delta}'_i$ and $\hat{\gamma}'_i$, give the effects on the odds of choosing the i mode over the base choice, say $i = 0$, of changes in the explanatory variables. To obtain

¹⁶ I assume that $T = \infty$ for simplicity. This assumption will be dropped in the future research.

the estimated marginal effects of the regressors (x_n) on the probabilities, one should compute

$$\frac{\partial P_j}{\partial x_n} = \left[\frac{\beta_j}{1 - \exp(-\beta_j)} \right]$$

coverage, membership in international patent agreements, provisions for loss of protection, and enforcement measures. This index ranges from 0 to 5, with higher numbers reflecting stronger levels of protection. I chose to use the 1990 Ginarte and Park index because it allows for a time lag between the IPR measure (1990) and data on modes of entry (1995). This lag ensures that IPR are exogenous with respect to the modes of entry.

I use GDP of the recipient country as a measure of country n 's market size. This data is collected from the World Development Statistics CD-ROM. For data on effective wage rate of country n , I use wage rate, collected from Occupational Wages Around the World Database¹⁹ by Freeman and Oostendorp, which is downloaded from NBER website, along with labor productivity or unit labor input requirement, which is calculated by dividing real GDP with labor force data that are collected from the World Development Statistics CD-ROM as well. Distance from country n to the US is a good measure to use as a proxy for transportation costs. Therefore, the distance in kilometers from each country's national capital to Washington D.C., obtained from <http://www.indo.com/distance/index.html>, is used. In fact, one might think that distance variable might be translated to capture the fixed cost variable when MNEs engaging in FDI. Distance can be used to portray the difference in culture, the custom of doing business or even language barrier. The further the countries are, the more differences they might have, and therefore, the higher the fixed cost of setting up a plant there. Another variable that might well captures the fixed cost variable is an economic freedom index. This data is collected from the Economic Freedom of the World 1997, Annual Report (Gwartney and Robert, 1997). The economic freedom index ranges from 0 to 10 with a higher index indicating a higher level of economic freedom. The central elements of this index are personal choice, freedom of exchange and protection of private property, and provision of a stable infrastructure. Therefore, the higher the economic freedom index should relate to a lower fixed cost variable. Another possible measure for fixed cost is the investment cost index developed by Carr, Markusen, and Maskus(2001). This index is an average of ten indices of perceived impediments to investment, reported in the World

¹⁹ For more detail about this data set, see Freeman and Oostendorp(2000).

Competitiveness Report of the World Economic Forum. This index is computed on a scale from 0 to 100, with a higher number indicating higher investment costs.

To study how technology level difference affects entry mode decisions, I use the R&D expenditure to separate data into two groups: high technology group and low technology group. This R&D index is measured by using all costs related to the development of new products and services and it is collected from Nicholson (2001).

Descriptive Statistics of the data set are summarized in Table 1. More detailed Statistics on means and standard deviations of independent variables separated in each mode are summarized in Table 2.

Table 1: Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Export	8370	1.560	3.954	0	59
FDI	8370	1.910	5.719	0	117
License	8370	0.449	1.518	0	22
IPR	62	3.049	0.938	0.33	4.24
Econ Freedom	62	5.885	1.315	1.7	9.3
GDP	62	8.22e+11	1.19e+12	1.85e+09	5.10e

Table 2: Mean and Standard Deviation in each mode

Variable	Export	FDI	License
IPR	2.873 (1.002)	3.188 (0.850)	3.068 (0.965)
Econ Freedom	5.758 (1.395)	6.031 (1.228)	5.705 (1.316)
GDP	7.30e+11 (1.19e+12)	8.76e+11 (1.13e+12)	9.13e+11 (1.42e+12)
Effective Wage	0.036 (0.019)	0.035 (0.012)	0.036 (0.014)
Distance	8058.001 (4356.043)	7216.121 (4097.315)	8261.518 (4039.932)
Investment Cost	41.856 (9.136)	38.960 (7.714)	41.544 (8.583)
Observations	62	60	59

Note: Means are shown together with standard deviations in parentheses.

Table 2 contains some interesting statistics that are worth noting. We can see that out of all three modes, the average value of IPR are higher in FDI and licensing compare to that of the export mode. Economic freedom index is the highest in FDI mode. Moreover, investment cost in FDI mode is the lowest. However, more can be said with the regression analysis in section 4.

4. Empirical Analysis

I start the empirical analysis with the negative binomial regression model to both test the signs of the comparative static results in section 2 and to replicate previous studies' results. Table 3 reports results of the specific effect negative binomial regression model on all three modes separately²⁰. The second, third and fourth column show the

²⁰ The investment cost variable is dropped in Table 3 since it is highly insignificant an

coefficient... exports, FDI, and licensing
channel,

Table 3
Negative Binomial Regression Model

Variable	Export (FE)	FDI (FE)	License
Constant	-0.125 (0.072)	-2.283* (0.137)	0.000* (0.000)
IPR	0.170* (0.019)	0.380* (0.021)	0.000* (0.000)
EF	-	0.397* (0.017)	-
DIST	-3.08e-05* (7.2e-06)	-1.15e-05 (1.2e-06)	-
GDP	-	-	3.17e-13* (1.46e-14)
W	-	-	-12.198* (1.225)
N	6042	5453	355

interesting point to make here is that, based on the results in Table 3, IPR has the highest impact on FDI then licensing and export. However, the analysis in Table 3 considers the impacts of independent variables on each entry mode separately and therefore; it might be misleading to compare the size of the coefficients from it.

The best way to compare the size of the effects on each mode of entry is to use the multinomial logit model as explained earlier. Table 4 reports the results with export mode being a based category²¹. The second column shows estimated coefficients, $\hat{\delta}_i$ and $\hat{\gamma}_i$, along with standard errors in parentheses for FDI mode, while the third column shows estimated coefficients with standard errors in parentheses for licensing mode. To aid interpretation, the marginal effects of the covariates on the predicted probability of each entry mode are also presented in column 4, 5, and 6²².

From the second and third column, some results can be drawn. First, the odds of choosing FDI (licensing) mode instead of exports mode will be increased by 1.467 (1.240) times with a one-unit increase in IPR index. Also, a unit increase in economic freedom index will increase the odds of choosing FDI over exports by 1.186 times, but will decrease the odds of choosing licensing over exports by a factor of 0.928.

To make the interpretation easier, we use an average value of all dependent

Table 4
Multinomial Logit Model

(Based Category : Export)

Variable	Model estimates ¹		Marginal effect on probabilities ²		
	FDI	License	Export	FDI	License
			Predicted Probabilities		
Constant	-1.453* (0.185)	-1.621* (0.334)	0.404	0.481	0.115
			Marginal Effect		
IPR	0.383* (0.044)	0.215* (0.038)	-0.0844	0.0837	0.0007
Economic Freedom	0.171* (0.021)	-0.075* (0.018)	-0.0297	0.0468	-0.0171
Distance	-5.92e-05* (4.41e-06)	1.09e-05* (4.36e-06)	1.10e-05	-1.54e-05	4.38e-06
GDP	-7.12e-14* (1.73e-14)	7.86e-14*			

confirms the idea that the lack of knowledge of a foreign market conspires against FDI. An example of this (Contractor(1985)) is the experience of Boots, a British pharmaceutical company, choosing to license the productio

the results by Smith (2001) and to the traditional thought that licensing should be more responsive to IPR relative to FDI. The belief argues that by licensing, a firm locates their knowledge assets outside the source firm, which increases the likelihood of imitation while the firm can reduce this likelihood of imitation by internalizing their knowledge assets by doing FDI. Therefore, an increase in IPR, which reduces the imitation ability, should increase licensing probability by more than that of FDI. However, based on our comparative static analysis, the size of the effect of IPR on FDI and licensing depend on both β^i , profit dissipation rate due to imitation in each mode, and $\beta^i'(\alpha)$, how sensitive the dissipation rate in each mode to a change in IPR index. It could be the case that $\beta^L > \beta^F$, and $\left| \beta^L'(\alpha) \right| \leq \left| \beta^F'(\alpha) \right|$. In other words, licensing dissipation rate is larger than that of FDI but the dissipation rate of FDI mode is more sensitive to IPR than that of

licensing, which make $\frac{\partial \Pi^L}{\partial \alpha} < \frac{\partial \Pi^F}{\partial \alpha}$

they are confident in IPR protection. If IPR protection is really weak, they prefer exporting.

Table 5
Predicted Probabilities of Entry Modes by IPR Index Level

IPR	Probabilities		
	Export	FDI	License
0	0.659	0.244	0.097
1	0.580	0.315	0.106
2	0.494	0.394	0.112
3	0.408	0.477	0.115
4	0.327	0.560	0.114
5	0.254	0.637	0.109

Note : Predicted Probabilities are calculated by holding other independent variables at their mean levels.

Next, to study how R&D intensity affects the entry mode decision, I separate data according to their R&D intensities and do the same analysis. Table 6 and 7 report the regression results of low R&D group and high R&D group, respectively.

Table 6
Low R&D Group

(Based Category : Export)

Model estimates¹ **Marginal e**

Table 7
High R&D Group

(Based Category : Export)

Variable	Model estimates ¹		Marginal effect on probabilities ²		
	FDI	License	Export	FDI	License
			Predicted Probabilities		
Constant	-1.419* (0.263)	-1.372* (0.540)	0.515	0.311	0.174
			Marginal Effect		
IPR	0.315* (0.074)	0.195* (0.061)	-0.068	0.057	0.011
Economic Freedom	0.157* (0.029)	-0.064* (0.023)	-0.019	0.037	-0.018
Distance	-5.96e-05* (8.38e-06)	-3.22e-06 (5.68e-06)	9.83e-06	-1.26e-05	2.76e-06
GDP	-4.73e-14 (3.45e-14)	7.97e-14 (5.06e-14)	4.34e-16	-1.44e-14	1.40e-14
Effective Wage	-3.425* (1.739)	0.882 (1.106)	0.470		

FDI is larger than an increase in the probability of licensing in the pooled data of all R&D intensities; while in industries with high R&D index, this difference is pretty small. It could be concluded that overall when IPR increases, firms still internalize their knowledge through FDI mode. However, this happens more in the low R&D industries where technology is easier to be imitated. In other words, when it is harder to imitate the technology (in high R&D industries), firms are more willing to license their technology to the licensee.

In sum, we find th

what is thought of in the literature. One possible explanation for this result is that the profit dissipation rate under FDI is more sensitive to changes in IPR than that under licensing, and that the profit dissipation rate is larger under licensing than under FDI. When we divide the data set into a high-tech group and a low-tech group, this result holds for the low-tech group but becomes insignificant for the high-tech group. It appears that MNEs internalize their knowledge assets more in the low R&D group where imitation is easy; this internalization incentive is reduced in the high R&D industries where imitation may become more difficult.

Appendix A

Proof for Lemma 1

$$\pi^{F^*} = p(q^{F^*}) q^{F^*} - c^F(w) q^{F^*}$$

Appendix B

Comparative Static Analysis

Total profit function of each mode of entry:

()

Discount rate (r)

Appendix C

Comparative Static Analysis (cont'd)

Cases on $\frac{\partial \Pi^i}{\partial \alpha}$:

1. If $\beta^E = \beta^F$ and $\beta^{E'}(\alpha) = \beta^{F'}(\alpha)$, then $\frac{\partial \Pi^E}{\partial \alpha} < \frac{\partial \Pi^F}{\partial \alpha}$.
2. If $\beta^F > \beta^E$ and $\beta^{E'}(\alpha) = \beta^{F'}(\alpha)$, then it is ambiguous to determine which effect is larger.
3. If $\beta^L > \beta^E$, then it is ambiguous to determine which effect is larger.
4. If $\beta^L > \beta^F$ and $|\beta^{L'}(\alpha)| > |\beta^{F'}(\alpha)|$, then it is ambiguous.

Appendix D

BEA 3-digit Industry Code

10 Agricultural production--crops

20 Agricultural production--

310 Leather and leather product

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