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Intellectual Property Protection, Internalization, and Technology Transfer

Michael Nicholson
Department of Economics, University of Colorado at Boulder
Boulder, Colorado

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Center for Economic Analysis
Department of Economics

University of Colorado at Boulder
Boulder, Colorado 80309

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Michael W Nicholson
Department of Economics
University of Colorado, Boulder
nicholso@colorado.edu

Abstract:

I analyze the manner in which multinational enterprises facilitate technology transfer from the North to the South, and the role played by the protection of intellectual property. Different industries respond to changes in intellectual property protection (IPP) regimes differently, and will alter their mode of entry accordingly. Firms with complex but easily imitable products will tend to internalize production through foreign direct investment, but firms that face a lower risk of imitation will tend to license production to non-affiliated Southern firms. Changes in IPP alter the level and the composition of technology transfer, depending on the value of the firm's proprietary asset.

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1. Introduction

Technological advancements and access to technology are concentrated in the industrialized countries of the world. For example, the fifth of the population living in the wealthiest countries on the planet have 74% of the world's telephone lines and 93.3% of

the preferred mode of entry depends on industry-specific characteristics of the firm. Stronger protection of intellectual property leads to an overall increase in technology transfer, but changes its composition.

I define technology transfer in two ways. Firms that undertake foreign direct investment (FDI) by building affiliated overseas plants for the production of newly innovated goods are transferring the *location* of that technology. Firms may also directly license the *control* of technology to non-affiliated plants in the South.[1] These different types of transfer may affect the host economy in different ways. Mansfield (1994), as discussed below, shows that a firm's response to IPP, whether to license or internalize and whether to transfer the latest technology, depends on the industry of that firm.[2]

This paper addresses the mode of entry, the role of IPP, and the subsequent effects on technology transfer. Each firm begins with a monopoly on the latest quality innovation for its particular good and decides among three ways to service the Southern market - exporting, licensing, and FDI. The influence of IPP on this decision follows the market imperfections surrounding the new innovation. The firm's knowledge of this technical innovation is the proprietary asset that gives it an ownership advantage.[3] This knowledge is non-rival, and if the firm cannot preserve the monopoly, others can use it in direct competition. Monopolistic power of the proprietary asset can only exist as long as the good is excludable, which relates directly to the level of IPP.

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[1] Imitation of goods could be considered a transfer from location to control.

[2] The actual impact of FDI or licensing on a host country's growth and/or welfare is a huge question outside the scope of the present paper. I contend that the differences in technology transfer matter, and show the policy implications of IPP on the mode-of-entry decision. Aitken, Hanson, and Harrison (1997) offer a good example of a paper investigating the impact of spillovers from MNE activity. Haddad and Harrison (1993) describe how these effects may differ across industries. Grossman and Helpman (1991), chapter one, provide an excellent discussion of the importance of technology for a host country.

[3] Dunning (1981) describes the OLI paradigm of MNE theory, which outlines the primary advantages necessary for a firm to engage in FDI as ownership, location, and internalization advantages.

Imperfect protection allows for this knowledge to leak to competing firms. Commonly, this dissipation of the proprietary asset is referred to as imitation. It could embody the direct copying of an existing good, or the development of a "knock-off" product. A wider scope, or breadth, of IPP prevents imitation. Weaker patent laws allow for closer substitutes to be marketed against the original commodity. An imitating firm must establish a larger distance from the original good in technology space.

Firms can protect the organizational advantage in two ways, either by keeping the knowledge secret, or by patenting and relying on legal means. I assume no reverse engineering of imported goods, so an exporting firm faces no risk of dissipation (although I do include an Appendix that discusses the implications of reverse engineering). Firms choose to shift production overseas if the Southern wage is low enough relative to the North. This relative wage is the location advantage. Firms that shift production to overseas affiliates patent their good to protect new technology. There exists the possibility that Southern firms will be able to develop a knock-off product that dissipates the proprietary asset. The level of IPP in the South affects the probability that this imitation will successfully infringe on the MNE's ownership advantage.

Firms internalize production, rather than license, for various reasons. Often discussed in the literature are information asymmetries - a firm has a superior product, but cannot find a suitable contract for licensing due to its inability to successfully signal this quality.[4] Another major factor for the internalization decision, and the one I use, is the fear of the defection of the licensee. Because of the non-rival nature of the technical knowledge, a licensee could defect with the proprietary asset in hand

[4] Ethier (1986), Horstmann and Markusen (1987), Gallini and Wright (1990), Vishwasrao (1994), and Yang and Maskus (2000c) are all examples of models that use information asymmetries.

and compete with the licensor. Due to this threat, any licensing contract signed will be self-enforcing, wherein terms of the contract are such that the licensee will be better off not defecting. If a self-enforcing contract cannot be found, firms will undertake FDI.[5] The level of IPP directly influences the conditions on which these contracts can arise.

1.2 Industry Differences

Both the location and the internalization decision by a firm are sensitive to the preservation of their intellectual property. Moreover, this sensitivity depends on the type of industry to which the firm belongs. Maskus (1998b) argues that the main effect of IPP on FDI is the extent to which the regime affects a firm's return on its proprietary asset, which will vary across sectors. Firms with complex but easily imitated technologies will be very sensitive to the level of IPP in the host country, but firms with older or less imitable products will not.

The impact of IPP on firm entry decisions differs considerably across industry, depending on inherent characteristics of the product itself. The greater the imitability of the product, the more important the non-exclusive imperfection. New pharmaceuticals, for example, embody considerable R&D efforts in the composition of each drug. This composition, however, can be mimicked fairly easily. Without adequate protection of the intellectual property embodied by the innovated good, competitors could produce and sell an imitated product and steal the market. A firm producing a good without this easy imitability, such as in metals or machinery, does not have this same fear of imitation and thus less of a dependence on IPP.

The dependence of a firm's decision to transfer technology on IPP differs across industries.

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[5] Ethier and Markusen (1996), Markusen (1999), and Yang and Maskus (2000a) are models that use this self-enforcing

Mansfield (1994) surveyed 100 U.S. firms in six manufacturing industries to compare the impact that the IPP levels of various developing countries have on the decision to transfer technology. He found very little correlation across industries for each country, but considerable positive correlation across countries for each industry. That is, within each country, there was no solid relationship between two different industries as to the importance of the IPP regime. Each industry, however, generally felt a similar dependence on IPP for all the countries. For example, the percentage of chemical firms that said IPP is too weak to permit licensing of their latest technology was highest or second-highest among the six industries for all 14 of the developing countries listed. In the same question, the percentage of metals firms were the lowest of the six for all but one country. Mansfield (1995), a follow-up survey, shows that these industry relationships also hold for German and Japanese firms.

The actual impact of IPP on activities such as research and development varies across industries as well. Levin, et al (1987) shows that, while many industries are greatly responsive to IPP regimes, some, such as the aircraft industry, are hardly affected. In a survey by the U.S. International Trade

internalize production depends on the ease with which their products can be imitated, which is also related to their dependence on protection of their intellectual property. My model shows how industry differentiation of MNEs affects the relevance of IPP policy in the South.

There are two types of firms in the model, differentiated by the relative ease with which their product may be imitated. Some products, such as pharmaceuticals, may embody great technical sophistication but can be easily replicated. I call firms that produce these goods P firms. On the other hand, M firms, such as metals or machinery industries, produce goods that cannot easily be replicated. In the model, different firms choose different modes of entry due to this relative imitability. The products of M firms are by nature difficult to imitate, no matter the legal backing of intellectual property.

Moreover, P and M firms differ in their reactions to IPP levels. Stronger IPP should encourages firms to prefer overseas production due to the expanded protection on their ownership advantage. M firms tend to choose licensing, and P firms to choose FDI, but stronger IPP may cause firms to substitute one for the other. Not only is there an increase in FDI and licensing with stronger IPP, but there is also a change in the composition of technology transfer, depending on parameters.

1.3 Literature review

Theoretical papers on MNEs and IPP generally assume a positive correlation between IPP and foreign direct investment (FDI) flows from the North to the South. Firms that engage in FDI face the risk of the diffusion of their proprietary asset via Southern imitation. In most existing models, IPP makes this imitation more costly, which increases the marginal benefits for FDI. Helpman (1993) models IPP as an explicit reduction in the rate of imitation, while Lai (1998) models it as a percent reduction in an existing rate of imitation. Glass and Saggi (1995) incorporate IPP as increasing the cost of imitation.

Ethier and Markusen (1996) present a model where firms choose between exporting, licensing,

clear illumination of the breadth of protection.

The empirical literature generally supports this positive correlation between IPP and MNE activity, although studies in this field suffer from the inherent difficulties in assigning quantitative values to various countries' IPP levels.[6] Ferrantino (1993) uses membership in international patent agreements as a proxy for IPP, and finds that stronger IPP leads to increased licensing royalties. Mansfield (1995) constructs a measure of IPP using the percentage of firms that felt patent protection affected their decision to engage in a joint venture or licensing arrangement with their latest technology. In a simple econometric study, he finds statistical support that stronger IPP, as represented by a lower percentage of firms affected by patent levels, leads to greater FDI outflows from the United States. Maskus (1998a), using the Ginarte-Park index, finds that IPP has a positive, and statistically significant, impact on various U.S. MNE activities in developing countries, including the stocks of sales, exports, and assets held by the affiliates.

Yang and Maskus (2000b) investigate the effects of IPP on both affiliated and unaffiliated licensing. They find that IPP has a significant and positive impact on arms-length royalties and licensing fees, but less significant impacts on intra-firm activities. This latter finding is consistent with

If a firm chooses to license, it avoids any explicit fixed costs or risk of dissipation. These costs and risks are covered by the firm offering a self-enforcing contract to the licensee, so that remaining under contract is more attractive to the producing firm than defecting and starting a rival plant. The costs of this plant, and the risk of defection, are thus implicitly covered in the rent-sharing contract.

Exporting	• Pay no fixed costs • Face no risk of dissipation • Earn full rents	• Pay higher marginal cost w>1
Licensing	• Pay lower marginal cost • No explicit fixed costs • No explicit risk of dissipation	• Earn r% of rents, with implicit fixed costs and implicit risk of dissipation
FDI	• Pay lower marginal cost • Earn full rents	• Pay fixed cost F • Face risk of dissipation m

The incentives for exporting decrease with the relative wage between the North and the South. The higher this relative wage, the lower the rents achieved with Northern production, and the more likely for a firm to shift production overseas. The relative wage serves as the primary determinant for the location of production.

The decision between licensing and FDI depends on other variables, independent of the relative wage since both use the same costs of production. The incentives for licensing increase as r increases, and the incentives for FDI increase as F or m decrease. As shown below, the incentive for FDI relative to licensing also increases with the rents from overseas production.

Each time period breaks down into two stages. The first stage involves a two-part decision by the firm whether to export or shift production depending on the relative wage. If the firm decides to shift production, it chooses between licensing and FDI. In the second stage, a firm that has chosen overseas production faces the risk of dissipation. For a licensing firm, the rent-sharing contract is set so that this never occurs if the contract is accepted. For a firm that has internalized production, this imitation risk occurs at probability m, which is determined in part by the level of IPP.

Exporting yields rents E in each stage.[13] Production overseas as a monopoly earns rents R, while production overseas after dissipation earns duopoly rents D. Licensing firms earn R in each stage, but receive only r% of the rents. MNEs earn the rents (R-F) in the first stage, when the asset is protected, but earn R with probability (1-m) and D with probability m in the second. I assume firms are risk-neutral, so they are indifferent between the expected returns and the actual returns. That is, a firm considers the expected return (1-m)R + mD to be equivalent to the actual value (1-m)R + mD.

A firm will choose to shift production if the returns to exporting 2E are lower than either the returns to licensing and FDI. MNEs that engage in FDI earn first-stage rents (R-F) and the second-stage rents (1-m)R+mD. Licensing firms earn total rents r(2R). Thus, the firm will choose to shift production if the following two conditions hold

(1) $(R-F) + (1-m)R + mD > 2E$

and

(2) $r[2R] > 2E$.

If both inequalities for (1) and (2) hold, the firm will choose between licensing and FDI based on the expected returns from both. The firm will choose to license if:

(3) $r[2R] > (R-F) + (1-m)R + mD$.

2.3 Profit Equations

Following Grossman and Helpman (1991), both the quantity and the quality of each good consumed provides utility for the time period t. Consider, across all goods, the instantaneous logarithmic utility function and budget constraint,

[13] I assume no discounting occurs within time periods (i.e., between stages).

(4) $$\log u(t) = \int_0^1 \log[\sum_k q_k(j) x_{kt}(j)]dj \qquad s.t. \int_0^1 p_j x_j dj = w_s L_s ,$$

where $q_k(j)$ is the quality level k of good j consumed, and x_j

$$\text{Profit} = (p_j - w_j) * \frac{L_s}{p_j} \quad (6)$$

The only difference between exporting profits (E) and MNE profits (R) is the wage paid, since the price p_j does not change. Define the relative wage $w \equiv w_n/w_s = w_n$ so that

$$E = (q * w_s - w_n)\frac{L_s}{q * w_s} = (1 - \frac{w}{q})L_s \quad (7)$$

$$R = (q * w_s - w_s)\frac{L_s}{q * w_s} = (1 - \frac{1}{q})L_s \quad (8)$$

With this Bertrand competition, a second competitor bids the price down to cost. In this case, duopoly profits following imitation go to zero. Note then,

$$D = 0 \quad (9)$$

$$R - E = (w - 1)\frac{L_s}{q} \quad (10)$$

- = From (1), firm-

to induce overseas production.

(12) can be simplified with division by (q-1), without changing the relationship between the variables. Since there is no loss of generality, I will continue to refer to w/(q-1) as the relative wage. This division yields

$$(13)\quad \frac{w}{q-1} > \frac{1}{q-1} + \frac{F}{2R} + \frac{m}{2}.$$

Thus, an increase in the rents of overseas production R lowers the relative wage w necessary to induce FDI over exporting.

From (2), firms choose licensing over exporting if rR > E. Plugging in for R and E yields

$$(14)\quad r\frac{L_s}{q}(q-1) > \frac{L}{q}(q-w)$$

which simplifies to

$$(15)\quad > - (-1)$$

and the royalty rate, but decreases with the rents from overseas production.

If the relative wage is such that only one of (13) and (16) hold, the firm chooses the mode of entry determined by that wage. If (16) holds but (13) does not, the firm prefers licensing to exporting, and exporting to FDI. This suggests that

$$\frac{1}{q-1}+\frac{F}{2R}+\frac{p}{2}>\frac{w}{q-1}>\frac{q}{q-1}-r \quad (18)$$

which can be rearranged to show that (17) also holds. That is, if licensing is preferred to exporting, and exporting to FDI, then licensing is preferred to FDI.

Similarly, if (13) holds but (16) does not, the firm prefers FDI to exporting, exporting to licensing, and thus FDI to licensing. The firm would choose FDI. If neither (13) nor (16) hold, the firm chooses to export. If both equations hold, the firm chooses to shift production, deciding between FDI and licensing depending on the relative values of (17). Notice that the relative wage does not affect this decision - in this case, the Southern wage is low enough relative to the North that the firm will not export at all, and only decides how to utilize Southern labor.

2.4 The royalty rate

The royalty rate r implicitly captures elements of the licensing contract. For licensing to occur, the firm must be able to set a self-enforcing contract so that the returns to it, based on the royalty rate, are greater than the returns to FDI or exporting. I set up a simple exposition of this contract, based on Markusen (1995, 1999).

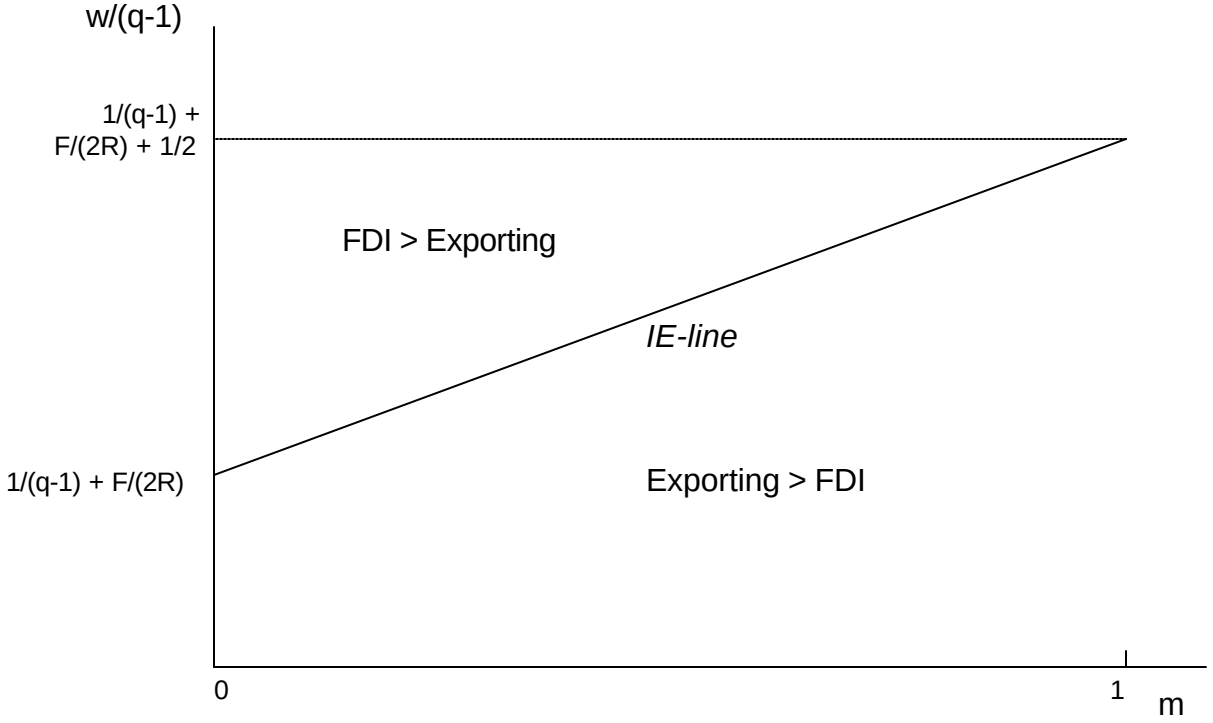
I assume there is no cost to the contract, and that the royalty rate must be set at the same value of r for both periods. As part of the contract the licensee always pays the production cost G, earns the rents from production, but pays a percentage r to the licensor. In the first period, the licensee thus earns

(1-r

$$\frac{w}{q-1} = \frac{1}{q-1} + \frac{F}{2R} + \frac{m}{2} \quad (22)$$

Graph 1 depicts this relationship, drawing w/(q-1) on the vertical axis, and m on the horizontal axis. The IE line (I for "internalize") maps all the points at which a firm is indifferent between exporting and FDI. If the relative wage is below this line, the difference in factor costs between the two regions is not large enough to shift production, and the firm chooses to export. If the relative wage is above this line, the firm prefers FDI to exporting. The slope of the line is 1/2.

Graph 1:FDI versus Exporting



A firm knows the value of F, q, and R, in addition to m. Using this knowledge, it bases the IE decision on the relative wage prevailing in the economy. I call this the *actual wage* w*, which the firm takes as given.

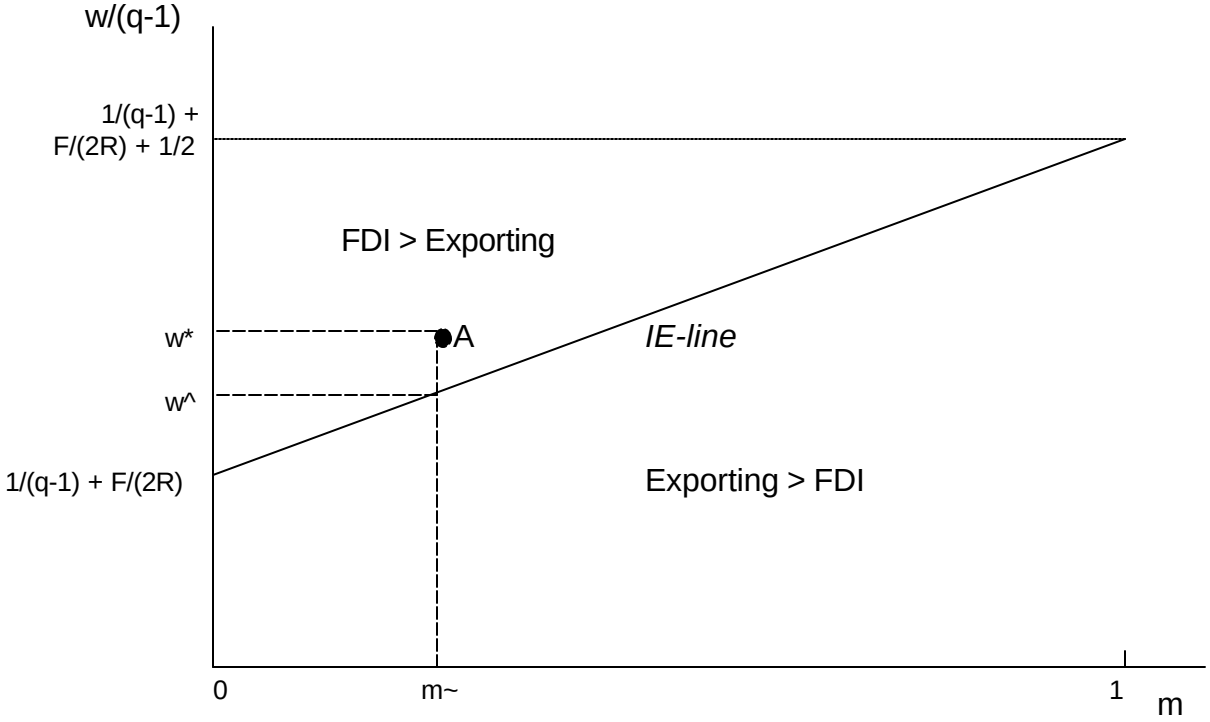
The parameters F, q, and R determine the IE-line in graph 1. For each value of m, there is a corresponding value of w that would make the firm indifferent between exporting and FDI. I call this

the *indifference wage* w^. The wage w^ can be solved from (22), for a given set (F, q, R) and for any value of m The IE-line plots the values for w^.

If w* > w^, then the actual wage faced by the firm is greater than the wage which would make it indifferent between exporting and FDI at that probability m. This higher wage makes FDI attractive to the firm. The set of these wages are in the region of graph 1 where FDI > Exporting.

Suppose a firm faced the probability of imitation m~, as shown in graph 2, with an actual wage w*. The point of decision is point A. For this m~, the relative wage that would make the firm indifferent between FDI and exporting is w^. Since as drawn w* > w^, the firm will choose FDI.

Graph 2: Choosing FDI over Exporting



If w^ > w*, then the actual wage is lower than the indifference wage, and the firm would choose to export. This set of points is in the Exporting > FDI region of graph 1. If w* = w^, equation (22) holds, the firm is on the IE-line, and is thus indifferent between FDI and exporting.

The effects of parameter changes can be seen in graph (2). If the fixed cost increases, then the IE-line shifts upward. This raises w^ - a higher wage is necessary to induce FDI. Firms are now more likely to export for a given w*. If the shift in the IE-line moved w^ above w*, the firm would no longer engage in FDI in the presence of the higher fixed cost.

An increase in m also diminishes the tendency for a firm to choose FDI over exporting. If firms face a higher risk of imitation, a higher indifference wage is necessary for (22) to hold. Consider a shift to the right for m~ in graph (2). The indifference wage w^ rises along the IE-line, and if the shift is large enough then the firm will eventually choose to export.

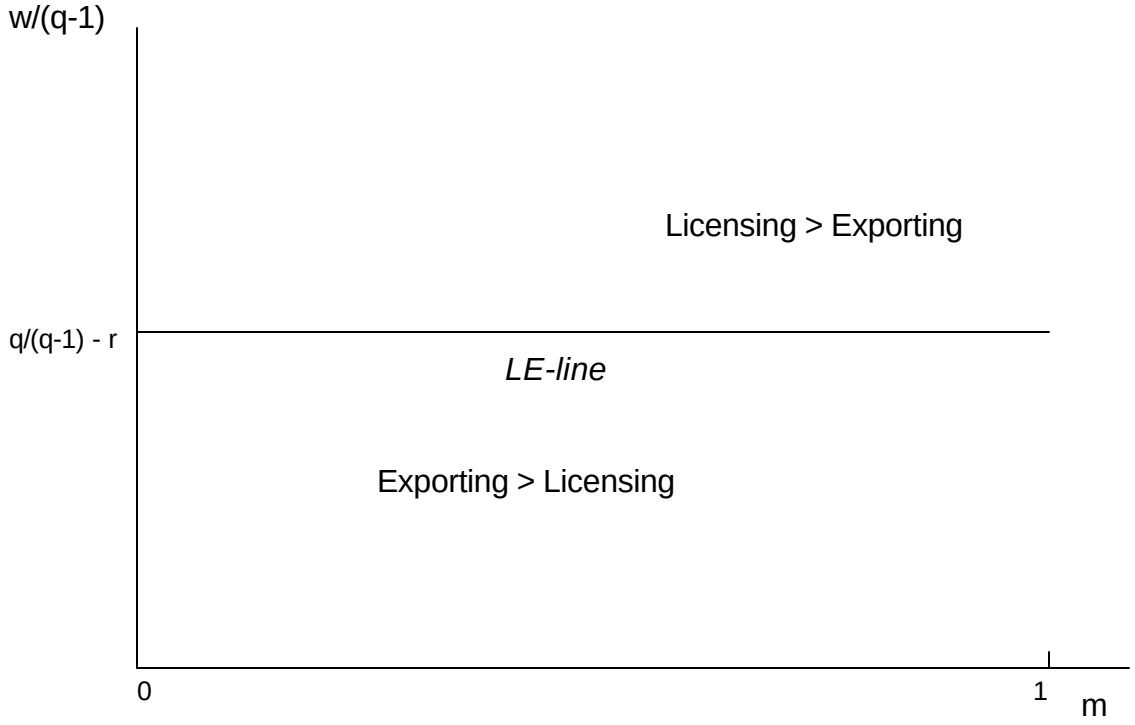
2.5.2 The LE decision

A firm is indifferent between exporting and licensing if (16) holds with equality, when

(23) $$\frac{w}{q-1} = \frac{q}{q-1} - r \quad .$$

This relationship is independent of m, thus the LE-line is horizontal in graph 3. If the relative wage faced by the firm is above this line, the firm prefers licensing to exporting, and if the wage is below this line the firm prefers exporting.

Graph 3: Licensing versus Exporting



Since m does not affect the returns to licensing or exporting, it does not affect the LE decision. For any given m, a firm will choose L or E based entirely on the relative wage. Thus, the licensing indifference wage is fixed at q/(q-1) - r.

An increase in the royalty rate improves the tendency towards licensing. If r increases, the q/(q-1) - r decreases, and the LE-line shifts down. For a given equilibrium wage, the firm is more likely to choose licensing.

2.5.3 The IL decision

A firm chooses between FDI and licensing based on the probability of imitation, and is indifferent if equation (17) holds with equality,

$$\frac{F}{2R} + \frac{m}{2} = 1 - r \quad (24)$$

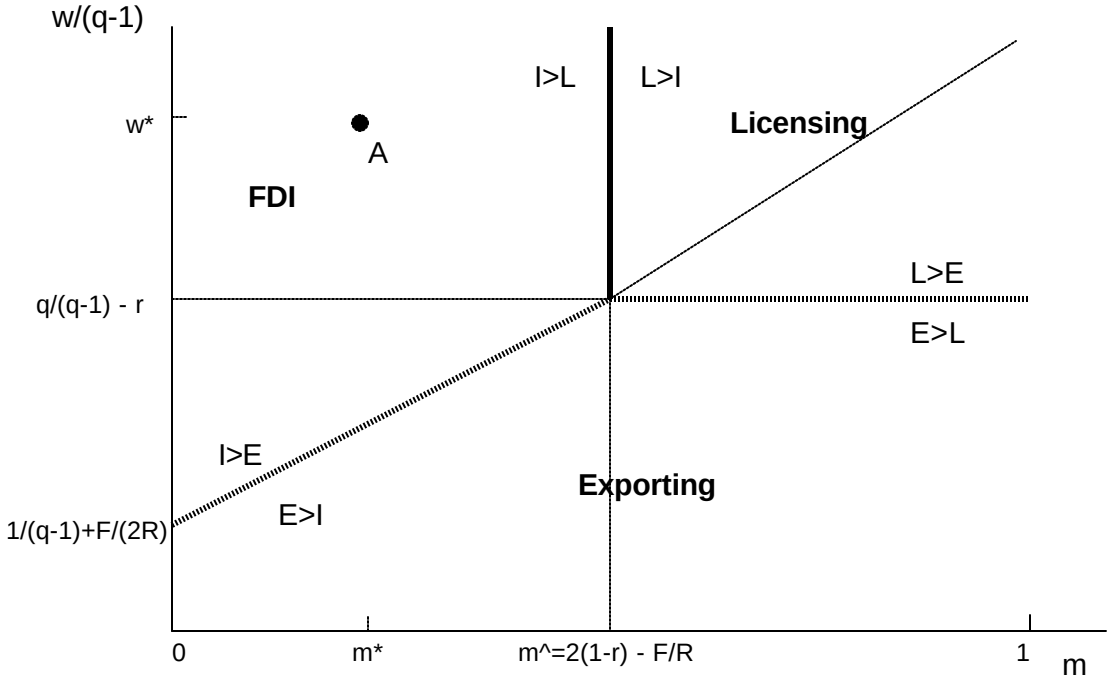
which gives the indifference probability

firm will be more likely to license.

Tri-entry decision

The full decision for the firm includes all three of these relationships. Graph 5 shows the necessary relationships between w and m for a firm to license, export, or engage in FDI.

Graph 5: FDI, Licensing, and Exporting



natural barriers to imitation, and are thus relatively free from the threat of imitation, no matter the level of

As industries differ according to the fixed cost F they realize different relative wages that would make them indifferent between FDI and exporting. The indifference wage w^ depends on industry-specific parameters. Whether this wage is higher in the M or the P industry depends on the magnitude of dm/dF.

The IE indifference wage, as shown in (22) above, depends on (F, q, R) as well as m. That is, w = w(F,m,q,R). Since the parameters of interest are F and m, this can be rewritten

(26) w = w(F, m(F); q, R).

Differentiating w with respect to F gives

(27) $dw / dF = \partial w / \partial F + \partial w / \partial m * dm / dF$.

From (22) it is obvious that / 0

Thus, the sign on dw/dF depends on the magnitude of dm/dF relative to 1/R. This gives the following three cases:

Case (i): $dw/dF > 0$ if $|dm/dF| < 1/R$

Case (ii): $dw/dF = 0$ if $|dm/dF| = 1/R$

Case (iii): $dw/dF < 0$ if $|dm/dF| > 1/R$.

In case (i), the higher fixed cost dominates the lower probability of imitation, so that M firms will need a higher relative wage to engage in FDI. In case (iii), the effect on the probability dominates, so that firms will engage in FDI at a lower relative wage. For P firmst on tD/

their indifference wage before the shift. That is,

$$\frac{w^*}{q-1} = \frac{\hat{w}}{q-1} = \frac{1}{q-1} + \frac{F}{2R} + \frac{m}{2} \quad (31)$$

for both industries.

Both firms, formerly indifferent between FDI and exporting, now realize a preference for one over the other. Whether the decision is exporting or FDI depends on the magnitude of dm/dF. In case (i), an increase in F leads to an increase in the indifference wage. Thus, for M firms,

$$\frac{\hat{w}_M}{q-1} = \frac{1}{q-1} + \frac{F_M}{2R} + \frac{m_M}{2} > \frac{w^*}{q-1}. \quad (32)$$

Notice that since F increases for M firms and decreases for P firms, each will have an opposing tendency towards each activity. For P firms in case (i),

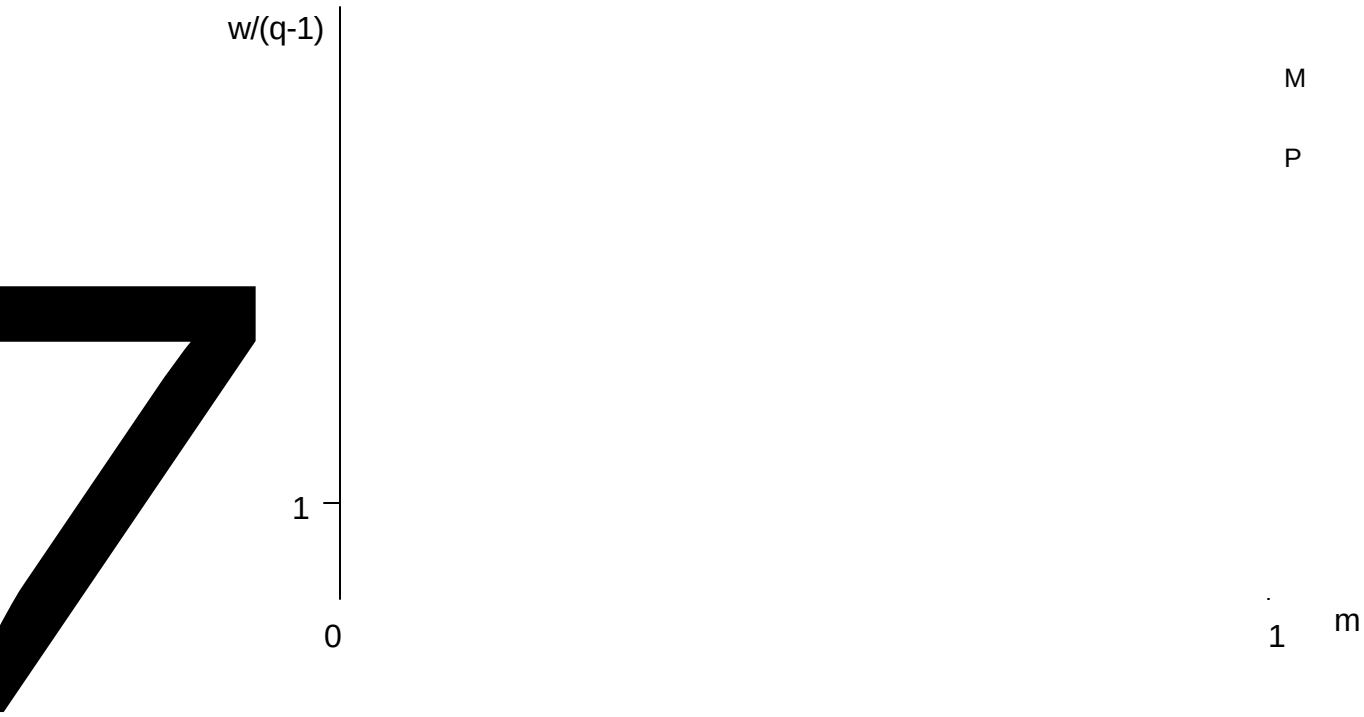
$$\frac{\hat{w}_P}{q-1} = \frac{1}{q-1} + \frac{F_P}{2R} + \frac{m_P}{2} < \frac{w^*}{q-1}. \quad (33)$$

Graphically, changing F from a point of indifference means shifting the IE-line. For P firms, the line shifts right, and for M firms it shift left. On this new graph, however, the probability of imitation m also moves, since it depends on F. The actual decision of each firm – whether to export or engage in FDI – depends on which changes more, m or F.

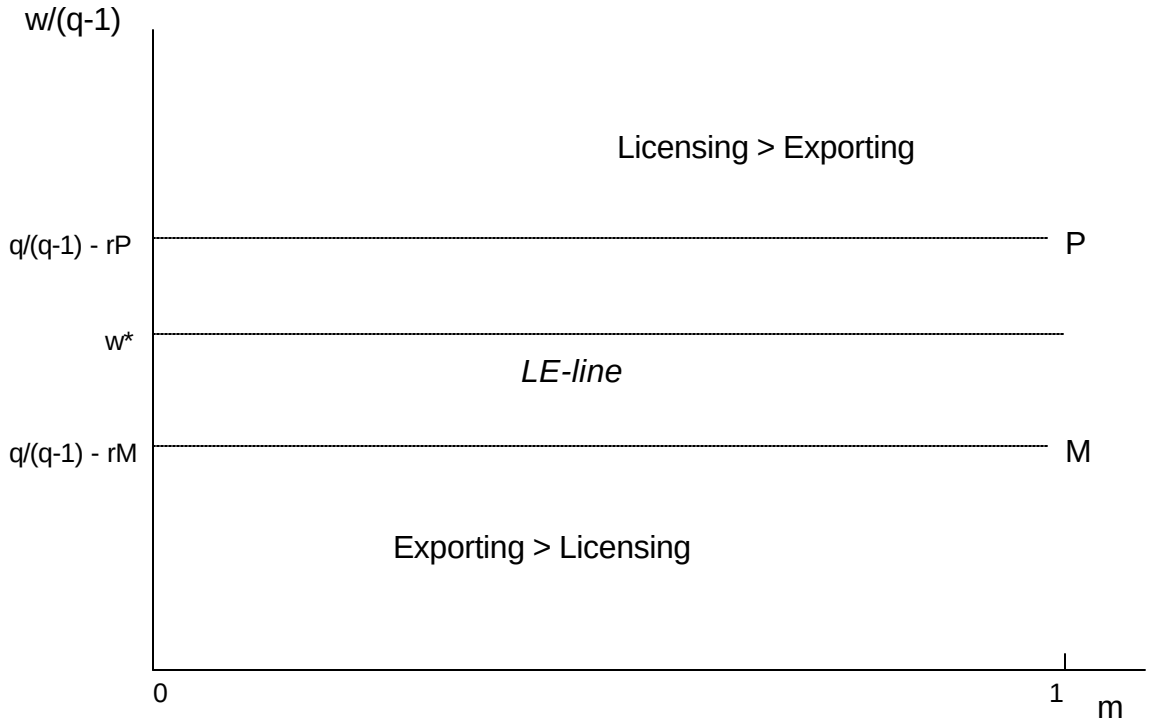
In case (i), $|dm/dF| < 1/R$, and an increase in F leads to an increase in the indifference wages. For M firms, this means the indifference wage is now *higher* than the relative wage, and they will choose to export. The point of decision for M firms in case (i) is X^1. As can be seen in graph 6, it is a point where m_M does not change as much as F_M when shifting from indifference.

For P firms, the opposite is true. In case (i), although m_P does not shift as much as F_P, the

indifference wage is *lower* than the relative wage, and the point of decision Y^1 clearly lies in FDI space. P firms choose to engage in FDI.



Graph 7: The LE decision with industry differentiation



3.2.3 IL changes

The effects of industry differentiation on the decision between FDI and licensing is slightly more complicated, due to the effects on both modes of entry. Again, start with two firms that are both on their indifference line. That is, for both firms, the probability of imitation they face is the same as the indifference probability,

$$m^* = 2(1-r) - \frac{F}{R} \quad (34)$$

Notice that the term on the right-hand side of (34) has been defined as m^ in (25) above. The firm actually faces probability m*, which in general can be higher or lower than the probability m^ that makes it indifferent between FDI and licensing. Industry differentiation changes both m* and m^, with the effects on the decision of the firm depending on which changes more. As discussed, these decisions are affected both by the change in F, which changes m, and the change in G, which changes r. I discuss

each of these effects in turn.

Consider first the effects of industry-specific changes in F from the point of indifference along the IL-line, leaving r constant. Like the IE case above, the underlying factor is the magnitude of dm/dF relative to the monopoly rents R. Fully differentiating (34) with respect to F yields

$$dm / dF = -\frac{1}{R} \quad (35)$$

or

$$\frac{1}{R} - | dm / dF | = 0 \quad (36)$$

.

In case (i), (36) is positive, so that an increase in F leads to a larger increase in the left-hand side of (34) than the right-hand side. The rising fixed costs dominate the lowered probability. The indifference probability for M industries grows larger than the actual risk of imitation they face. Thus, m* > m^ and licensing is preferred to FDI, as given by

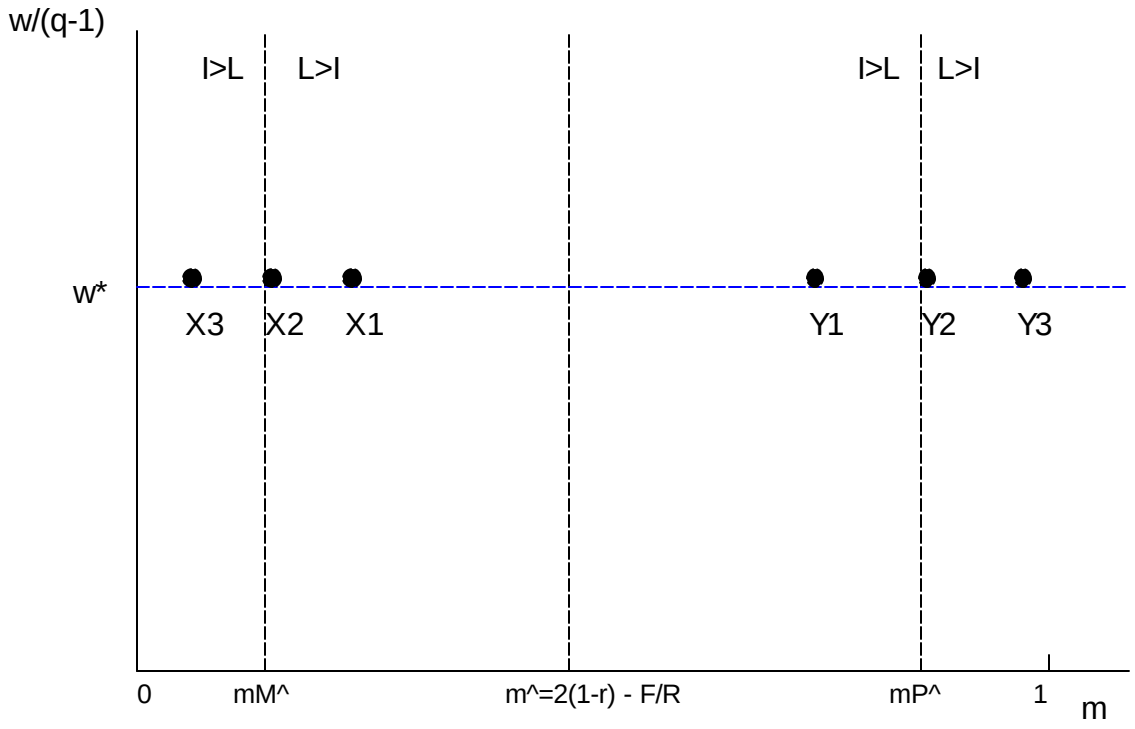
$$m^*_M > \hat{m}_M = 2(1-r) - \frac{F_M}{R} \quad (37)$$

M firms are affected more by the increased fixed cost than the lowered probability. For P firms, however, in case (i) a lowered fixed cost means the indifference probability drops more than the actual risk of imitation, and they are more likely to choose FDI, as given by

(38)

with industry differentiation when r is held constant. Notice that after industry differentiation, both firms face different indifferent probabilities m^ as well as different actual probabilities m*. This differs from the IE decision, in which industry differentiation leads to changes in the indifference wages w^ but does not affect the equilibrium wage w*.

Graph 8: The IL decision with Industry Differentiation



licensing more attractive to M firms and FDI more attractive to P firms. The shift in the full lines in graph 8 put X^2 in licensing space, and Y^2 in FDI space.

In case (iii), the changes in the royalty rate work contrary to the influences of the changes in F. In graph 8, the m^ lines for both the M firms and the P firms move closer to the points X^3 and Y^3. At some point the effects of the royalty rate will dominate.[16] Under this condition, M firms will *always* prefer licensing to FDI, and P firms will *always* prefer to internalize. I call this the "internalization effect".

3.2.4 Full Effects of Industry Differentiation

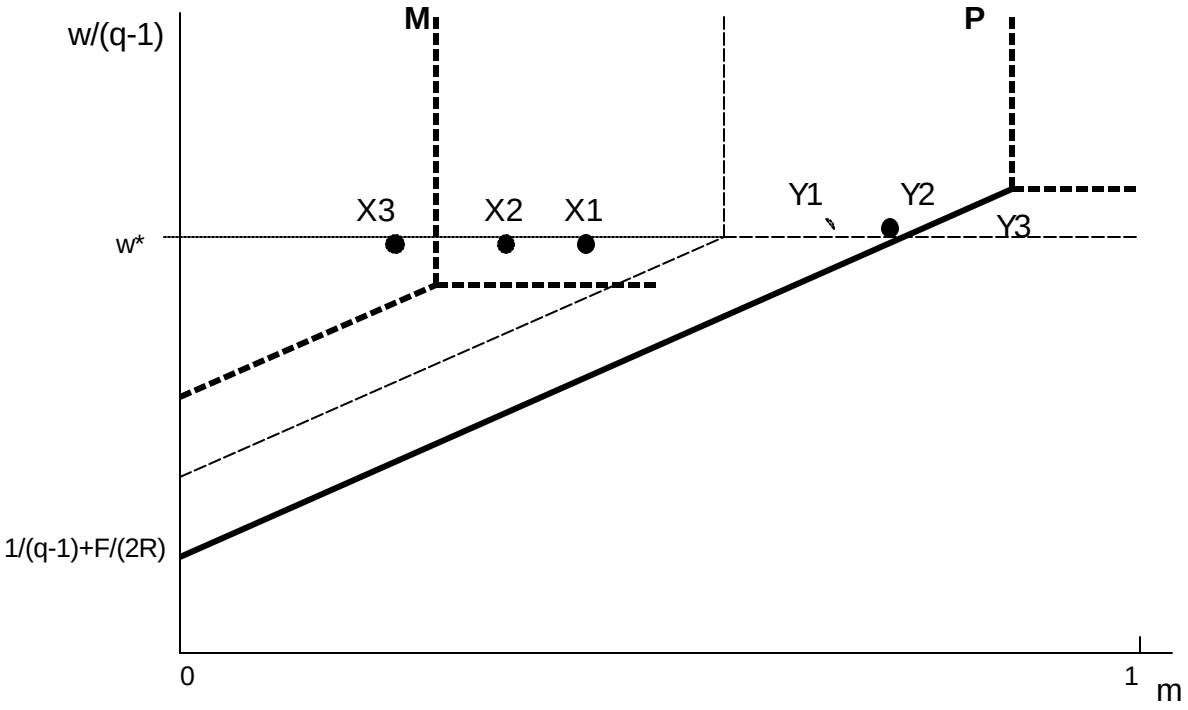
The full effects of industry differentiation for the three cases are shown in table 2, with the ultimate decision of the firm shown in the bottom row. In case (i), licensing dominates for M firms and FDI dominates for P firms. In case (ii), licensing again dominates for M firms. For P firms starting from a point of indifference, a lowered fixed cost and raised royalty rate will still leave them indifferent between exporting and FDI. This divergence follows the special property of case (ii), where the effects on the fixed cost and the relative wage are off-setting, leaving firms on the EI-line.

Table 2: The different cases of industry differentiation

	Case (i)		Case (ii)		Case (iii)	
Decision	M firms	P firms	M firms	P firms	M firms	P firms
EI	exports	FDI	indifferent	indifferent	FDI	exports
EL	licenses	exports	licenses	exports	licenses	exports
IL	licenses	FDI	licenses	FDI	FDI/license*	licenses
Prefers:	**Licenses**	**FDI**	**Licenses**	**Export/FDI indifferent**	**I vs L***	**Exports**

[16] This exact point cannot be found without assuming a relationship between F and G.

Graph 11: Full effects of industry differentiation



I have defined two aspects of technology transfer. The shifting of production via FDI is a change in the *location* of technology, while the direct licensing of a product is a shift in *control*.[17] In this model, the M industries are more likely to license their technology, and P industries are more likely to engage in FDI. Note that these tendencies do not depend on the relative wage, as shown in table 3. As w changes, the decision to export or shift production changes, but the manner of shifting production does not change. The decision to license or engage in FDI is independent of the relative wage.

Table 3: Different relative wages

	M firms			P firms		
	case (i)	case (ii)	case (iii)	case (i)	case (ii)	case (iii)
High w	license	license	license	FDI	FDI	FDI
w=w*	license	license	license/FDI*	FDI	Export~FDI	Export
Low w	export	export	export	export	export	Export

* Depends on "internalization" effect

4.2 Intellectual property protection

The Southern government can influence technology transfer through its IPP regime. Two methods exist in the model: 1) altering the ability to imitate products after FDI, and 2) changing the costs

further costs of imitation are involved. In the model, this means that stronger IPP yields a lower m* and a higher r (from the higher d) for both firm types.

Considered independently, any lowering of the imitation rate m* shifts the firms decision point further into FDI space. For firms already engaging in FDI, such as P firms in case (i), the change in IPP does not affect their entry decision. For other firms, such as M firms in case (i), a low enough m* may induce a change from licensing to FDI.

A shift in r (through d) does not change the point of decision, but shifts the lines that define the decision space for the firm. The LE-line shifts down as r increases, and the IL-line shifts left. There is no change along the IE-line, since r plays no role in the direct FDI versus exporting decision. This results in an expansion of the licensing space at the expense of both FDI and exporting space. For firms that already license, this has no effect, but for firms that either export or engage in FDI, this could induce a change to licensing.

The two elements of IPP both lead to higher levels of technology transfer, but have different influences on the composition of technology transfer. If m goes down or r goes up, then both M firms and P firms will be more likely to shift production overseas. M firms generally demonstrate a propensity to license, and P firms to engage in FDI. Whether these tendencies change with IPP depends on parameters of the model.

Consider the situation of case (i) when the relative wage is w*, as depicted in graph 11. Stronger IPP shifts m* left for both types of firms, which increases the tendency towards FDI, but also expands the licensing space for each firm. Before any IPP changes, P firms prefer FDI to licensing because

$$(39)\quad 2(1-r_P)-\frac{F_P}{R}>m_P^*.$$

A strengthening of IPP increases r and lowers m*, so that both sides of (39) decrease. For the tendency towards licensing to increase with a change in IPP, the change in the right-hand side of (39) must grow relative to the change in the left-hand side. Fully differentiating (39) so that the change for

multinationals can choose between FDI and licensing. I extend the present literature to include industry-specific characteristics of the good produced, which affect both the entry decision and the response to varied IPP regimes.

Industries with large fixed costs but a low risk of imitation, such as metals, are more likely to enter a market through licensing, while industries with a high risk of imitation, such as pharmaceuticals, are more likely to enter a market through FDI. Policy changes that affect the scope of intellectual property tend to increase the overall level of technology transfer through FDI and licensing. Moreover, different IPP regimes alter the composition of technology transfer, depending on the monopoly rents of new innovations.

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Appendix A

Appendix A.1 Transportation costs and non-traded goods

For simplicity, I have assumed zero transportation costs in the main model. In this section, I show that including theses costs simply adds a nuisance parameter to the model. Reproduce the fundamental equations (1) – (3) as

(A1) $(R-F) + (1-m)R + mD > 2E$

(A2) $r[2R] > 2E$.

(A3) $r[2R] > (R-F) + (1-m)R + mD$.

Suppose exporting firms had to pay a transportation cost τ for each good sold. The marginal cost for Northern production becomes $w_n\tau$, with a relative cost difference $w_n\tau/w_s = w\tau$. Rewriting the profit equations (7) and (8)

(A4) $$E = (1 - \frac{w}{q}t)L_s$$

(A5) $$R = (1 - \frac{1}{q})L_s .$$

Thus, (10) becomes

(A6) $$R - E = (wt - 1)\frac{L_s}{q} .$$

Plugging this into the IE-line (A1) and the LE-line (A2) yields

(A7) $$\frac{w}{q-1}t > \frac{1}{q-1} + \frac{F}{2R} + \frac{m}{2}$$

(A8) $$\frac{w}{q-1}t > \frac{q}{q-1} - r .$$

The IL-line does not change. Transportation costs simply scale the relative wage upward.

Notice that some values of τ lead to the presence of non-traded goods in the model. This occurs if exporting is preferred to FDI and licensing (neither A7 nor A8 hold) but exporting yields negative rents due to the high transportation costs. If exporting yields negative rents, then

(A11)

(A15) $r[2R] > 2E - \mu E$.

Plugging in for the profit equations yields

(A16) $$\frac{w}{q-1} > \frac{q}{q-1} - \frac{2}{2-m} r .$$

The LE-line shifts down, making firms more likely to prefer licensing to exporting.

As would be expected, the possibility for reverse engineering that lowers the returns to exporting decreases the regions in (w, m) space that firms would be likely to export. An interesting addendum to this discussion considers the possibility that reverse engineering and imitation after FDI occur at the same rate, if $\mu = m$. In this scenario, the IE-line can be written

(A17) $$\frac{w}{q-1} > \frac{1}{q-1} + \frac{F}{(2-m)R}$$

and the LE-line can be written

(A18) $$\frac{w}{q-1} > \frac{q}{q-1} - \frac{2}{2-m} r .$$

The presence of m as a variable in the denominator of the equations of these two lines makes graph 5 considerably more complicated. The IE-line is now increasing and convex, with the IL-line decreasing and concave. The firm's decision-making process, however, does not change.