KOREAN MANAGEMNT REVIEW
Vol. Ⅷ, February, 1979
Printed in Korea

THE DISTRIBUTABLE RETURNS FROM A TECHNOLOGY TRANSFER AGREEMENT

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Ⅰ. ISSUES IN THE TRANSFER OF TECHNOLOGY TO LESS INDUSTRIALIZED COUNTRIES

The two issues that have received the most recent attention in the literature concerning the transfer of technology to the less industrialized countries are: (1) the appropriateness of the technology being transferred; (2) its cost to the technology importer. Since the appropriateness and costs of technlogy tranfer depend considerably on the alternatives available, the bulk of the literature has also been addressed to issues concerning alternative channels for transfer of technology as well as alternative technologies.

It has been argued that technologies transferred to less industria-

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Note: Financial support for this research was provided by The Korean Traders Scholarship Foundation.

lized countries are often inappropriate to those countries' conditions. The technology imported may be inappropriate because it is too much capital intensive; or because it introduces the sale of totally inappropriate new products such as luxury products.

As far as the cost of imported technology to less industrialized countries is concerned, the most important question in the literature seems to be: How can less industrialized countries obtain foreign technology on as favorable terms and conditions as possible ? One of the most promising ways to answer this question is to develop a negotiation framework for technology importers in less industrialized countries since the specific details of each technology tansfer prject take place basically within a bargaining context.

If the technology "product" is sold in a perfectly competitive market, the price will be automatically determined by the market mechanism. The situation of determining the price of proprietary technology, however, is quite different from that of the equilibrium price reached in a competitive market. Since the international market for proprietary technology is highly complex and imperfect. the price of the technology "product" is not automatically determined by the market mechanism. Instead the price is subject to negotiation. and the distribution of gains from the transaction of proprietary technology depends upon exercise of bargaining power.

Because technology is in essence a body of knowledge, the negotiation range within which the possible price for proprietary technology can be determined is relatively wide. Technology is a good, the use of which involves the owner in no marginal cost; it is non-exhaustible since it is not used up through use.[1] Its value to the buyer, on the other hand, may be great indeed since the cost of embarking himself on the research and independently evolving the technology will be substantial. In other words, the stock of knowledge is like an indivisible investment and average costs diverge

1) Vaitsos, Constantine, "Transfer of Resources, and Preservation of Monopoly Rents," *Economic Development Report No.* 168, (Harvard University, June, 1970).

widely from marginal costs.[2] Consequently there usually is a big difference between the incremental cost to the owner of the technology parting with it and the value to the firm wishing to acquire it.

Hence, there is a large gap between the minimum "returns" a technology exporter will accept while still finding a given technology transfer profitable, and the maximum "returns" he can enjoy and make it still worthwhile for the technology importer to acquire the technology.[3] Since the final price in the wide range between these two limits is determined by negotiation (no world prices exist for proprietary technology), proper exercise of bargaining power on the part of a prospective technology buyer is important in order for him to secure maximum possible gains from a given technology transfer.

Among other things, the exercise of bargaining power depends on the awareness of the size of π or the distributable returns from a proposed technology transfer, since it represents the conceptual boundary of the range of bargaining. Accordingly, we analyze how the licensee should identify the size of the distributable returns.

Special attention will be given to product technology, rather than process technology. Furthermore we will only consider contractual transfers of technology between independent parties, i.e. licensing agreements, because we can not expect full exercise of bargaining power in technology transfer between parent companies and subsidiaries.

Ⅱ. DISTRIBUTABLE RETURNS

It has been found that the amount of resources devoted to the production of new technology by firms depends heavily on the profitability of its use.

2) Streeten, Paul, "The Theory of Development Policy," in J. Dunning (editor), *Economic Analysis and the Multinational Enterprise*, (New York, Praeger, 1974), p.273.

3) Streeten, ibid., pp.266~275.

Econometric studies indicate that the total amount that a firm spends on research and development is determined in large degree by the expected profitability of the R & D projects under consideration, and that the probability of its accepting a particular R & D project depends heavily on the project's expected returns.[4]

Likewise, on a prior grounds, one would expect *the most important factor* underlying a given technology import to be its expected profitability. In fact, the worth of an imported new product technology to a licensee lies in its contribution to the profit stream from sales of the new product to produced by utilizing the technology, the profits from the technology can be regarded as the potential payoff that a prospective licensee can obtain through bargaining.

However, we should also recognize that there is a resource cost involved in the transfer of technology. The resource cost is defined as the cost of transmitting and absorbing the relevant firm, system. and industry specific knowledge to the extent that this is necessary for the effective transfer of the technology.[5] In identifying the notion of the distributable returns from a given technology transfer, therefore, we should deduct the resource cost of technology transfer from the profit stream.

Therefore, the present value of π can be defined as:

π=PVP-PVC, where

PVP=the present value of licensee's profit stream from sales of a new product to be produced by utilizing a given new product technology

PVC=the present value of the resource cost

4) Mansfield, Edwin, "Technology and Technological Change," in J. Dunning (editor), *Economic Analysis and the Multinational Enterprises*, New York: Praeger, 1974, p.148.

5) Teece, David J., *The Multinational Corporation and the Resource Cost of International Technology Transfer*, Cambridge, Mass. : Ballinger, 1976, pp.34~38.

Ⅲ. RESOURCE COST OF TECHNOLOGY TRANSFER

The various participants in international technology transfer prefer to view the costs from their own perspectives. The licensee country may view the foreign exchange costs and costs in terms of externalities as the essence of technology transfer costs. Foreign exchange costs are perhaps the most obvious cost item especially to less industrialized countries, both because foreign exchange is particularly scarce in many of those countries and because the import of technology frequently involves substantial foreign exchange outlay over a period of time. Costs in terms of externalities are those costs which do not accrue directly to any specified project of technology import but indirectly to the rest of the economy.[6] For example, the introduction of foreign technology may discourage local R & D activities. The licensor country, on the other hand, may consider the erosion of its technological lead in strategic industries as the key element of technology transfer costs.

The technology buyer may view direct charges such as royalties, technical assistance fees, etc., indirect charges through tying various non-technological inputs, and restrictive clauses as technology transfer costs. The licensor on the other hand is likely to consider the erosion of its technological lead, loss of export sales, time of managerial and technical personnel spent in transfer activities, and additional R & D expenses in adapting technology to local conditions as being the key element in any calculation of transfer costs.

Although the various participants view the costs of technology transfer differently, only one set of activities is involved in a given technology transfer. In this sense, there is only one true technology transfer cost. This can be called the resource cost of technology

6) United Nations Conference on Trade and Development, *Guidelines for Study of the Transfer of Technology to Developing Countries*, New York, 1972, pp.33~37.

transfer.

Since we want to develop the concept of distributable returns from a given technology transfer, we will employ the above definition of resource cost of technology transfer. All the relevant costs should be included to the extent that they are necessary for the effective transfer of a given technology, irrespective of which entity initially or eventually incurs them.

The definition of the resource cost presented at the conceptual level can be translated into operational measures of transfer costs by considering the nature of activity and the costs involved. Indentification of the nature of activity and the costs involved in a given technology transfer can be possible through use of a technology transfer matrix as suggested by Behrman and Wallender.[7]

According to them, technology transfer occurs over seven distinct phases: Proposal & planning, product design, plant design and construction, start-up, value engineering and controls, product development, and external support. For each type of technology, different mechanism will be found appropriate. There are five general mechanisms of transfer:

(1) documentation in the form of manuals, specifications, layouts, designs, and so forth; (2) instruction programs that is, formal education and on-the-job training; (3) visits and exchanges of technical personnel; (4) development and transfer of specialized equipment; (5) and continuing oral and written communication on whatever problems may arise.

On a well-defined product technology, the relationship of different phases of technology to be purchased and the mechanisms available to transfer them can be conceptualized in a matrix form. The matrix can be of considerable value to licensee (as well as licensor) seeking to determine what kinds of technology is wanted and what the

7) Behrman, Jack N. and Wallender, Harvey W., *Transfers of Manufacturing Technology Within Multinational Enterprises*, Cambridge, Mass. : Ballinger Publishing Co., pp.4~6.

problems are of precluding transfers of specific types of technology.

Accordingly, for effective transfer of a given technology, certain combinations of various phases of the technology with specific mechanisms of transfer can be selected. Then the resource cost can be regarded as the costs involved in realizing the particular way of transferring the technology.

Ⅳ. EXPECTED BENEFITS OF TECHNOIOGY TRANSFER

In this section, we will identify various factors influencing the PVP and will discuss how to evaluate it.

Ignoring taxes, the PVP will be theoretically determined by following equation:

(1) $\mathrm{PVP}=\int_0^{\infty}[p(t)-c(t)]q[p(t),t]e^{-rt}dt$

where,

$p(t)$ = price of output to be produced by the imported technology,

$c(t)$ = cost of production and marketing,

q = quantity to be sold by licensee firm as a function of its price and time,

r = discount rate

The size of PVP from a given technology import, therofore, will be determined by $q(p(t),t)$ which in turn depends on the market and competition in the licensee country. Because of the execution of import-substituting strategies of many less-industrialized countries the original importer of a given product technology can often achieve a monopoly position initially for the product newly introduced to the licensee country. Hence, the licensee firm may enjoy a monopoly position at least in the short-run through tariff and non-tariff protection offered to it.

However, it is also important to recognize that there will be an erosion of the monopoly position through time. The returns generated by such a monopoly position of the original licensee will induce

potential new entrants by imitation and/or repetitive imports of the same technology, assuming that the licensee country allows repetitive imports of technology. The important factors of these monopoly-diluting forces appear to be, first, the size itself of potential returns that newcomers foresee in copying the original producer, and second, the degree of the complexity that new processes or products imply for such imitators.[8] Legal barriers and government policies are also important.

If a complete export restriction is imposed by the licensor (so licensee only sells domestically) and import of the product to the licensee's country is not allowed because of the execution of import-substituting strategies, the quantity sold by the licensee firm at any point of time in the future will be equal to the domestic demand less the output which will be sold by local competitors. Therefore, the quantity to be sold by the original licensee at any specific time in the future will be found by substracting the output of the competitors from the total demand of the domestic market. That is,

(2) $p(p(t),t)=f(p(t))-x(t)$

where,

$f(p(t))$ = initial demand curve in the domestic market, and

$x(t)$ = quantity of rival sales in the domestic market at time t

If no complete export restriction is imposed by the licensor, then

(3) $q(p(t),t)=f(pt))-x(t)+g(p_e(t))$ where p_e is the export price of the product.

The specific functional dependence of domestic sales on time will be determined by the nature of the entry phenomenon by local competitors. Denoting a dot over a variable as its time derivative, $(\dot{x}(t))$ or the rate of entry of rival producers will be determined by their expected rate of return. Assuming that potential imitators view current product price as a proxy for *future* price and that the relationship between rate of entry and current price is linear, the

8) Vaitsos, Constantine V., *Intercountry Income Distribution and Transnational Enterprises*, Oxford: Clarenden Press, 1974, p.12.

functional form of the change in output by imitators can be shown as

(4) $\dot{x}(t)=k(p(t)-\bar{p})$ with $x(t=0)=x_0$, $\bar{p}\geq c$

where,

$\bar{p}$ = constant limit price which is defined as that price level at which net entry is equal to zero. If the technology importer sets a price above the limit price, imitators will enter

k = response coefficient

x_0 = initial output of the rival producers. Since the original licensee is the sole producer initially, $x(t=0)=x_0=0$.

It should be noted that the difference between the limit price and the licensee's average total cost is a measure of the cost advantage, if any, enjoyed by the licensee firm.

In the case in which k is high, the PVP will be small. The sophistication of the technology, the strength of the patent system and of trade secrets, the mobility of technicians in an industry, the extent of skill diversification and specialization of potential imitators, and the overall business orientation and propensities of the business community to translate scientific and technological knowledge into products [9] will determine k.

Since the PVP of the original licensee will be determined by the rate of entry of rival producers and the rate of entry itself in turn depends on the price of the new product incorporating the respective technology, a decision regarding $p(t)$ is an important factor in determining the size of PVP. If the original licensee firm seeks short-run profit maximization by charging a high monopoly price, it would have to ignore the reality of induced entry. Conversely, if the firm charges the limit price, it has to be convinced that its market share is optimal. Noting that there has been no analytic

9) For example, see *OECD on Gaps in Technology*, Vaitsos, ibid., pp.12~13, and Magee, S. P., "Technology and the Appropriability Theory of the Multinational Corporation," in the *New International Economic Order: The North-South Debate*, ed. J. Bhagwati, Cambridge, Mas. : M.I.T. Press, 1977.

justification for this strategic dichotomy, Gaskins developed the optimal model which would entail a balancing between short-run profits and future market share.[10]

According to Gaskins, with the simplifying assumptions that the initial demand curve is downward sloping and twice differentiable with respect to output, it is possible for a dominant firm to determine the optimal strategy for a given cost of production and marketing, c. That is, we wish to maximize equation (1) subject to equation (4).

$$(5)\quad \mathrm{PVP}=\int_0^{\infty}(p(t)-c)\ (f(p)-x(t))e^{-rt}dt$$

subject to

$$\dot{x}(t)=k(p(t)-\bar{p}),\ x(t=0)=x_0$$

Gaskins shows that there exists an optimal path to be followed. He further proved that the optimal price level would always be below the short-run profit maximizing price at every point along the optimal path. It also can be said that the long-run market share of the licensee firm in the domestic market is given by

$$(6)\quad \hat{s}=\frac{k(\bar{p}-c)/r-f'(\bar{p})(\bar{p}-c)}{f(\bar{p})}$$

while the long-run optimal share of imitator sales is given by

$$(7)\quad \hat{x}=(\bar{p}-c)f'(\bar{p})-f(\bar{p})-\frac{k(\bar{p}-c)}{r}$$ [11]

In order to know the effects of variation in the model parameters on the PVP, the equations (6) and (7) can be differentiated with respect to $\bar{p}, c, r, k$, and x_0 and we can get the following results:

(a) $\dfrac{d\hat{x}}{d\bar{p}}<0$

(b) $\dfrac{d\hat{x}}{dc}>0\Rightarrow\dfrac{d\hat{s}}{dc}<0$

(c) $\dfrac{d\hat{x}}{dr}\geq 0\Rightarrow\dfrac{d\hat{s}}{dr}\leq 0$

10) Gaskins, Darius W. Jr., "Dynamic Limit Pricing: Optimal Pricing under Threat of Entry", *Journal of Economic Theory*, 3, 1973, pp.306~322.

11) Gaskins, ibid., p.311.

(d) $\frac{d\hat{x}}{dk} \leq 0 \Rightarrow \frac{d\hat{s}}{dk} \geq 0$

(e) $\frac{d\hat{s}}{dx_0} = \frac{d\hat{s}}{dx_0} = 0$

The condition (a) indicates that a decrease in the limit price $\bar{p}$ increases $\hat{x}$ and lowers $\hat{s}$. The higher the limit price, the higher the long-run advantage of the licensee firm and, hence, its market share. The condition (b) indicates that as c increases, the long-run optimal market share of the licensee firm decreases. The two conditions, (a) and (b), jointly imply that as the cost advantage ($\bar{p}-c$) of the licensee firm increases, less entry of rival producers into the market is likely. Accordingly, permanent long-run profits exist for the licensee firm which can appropriate private returns from a given technology import. Since most technologies ultimately become pure public goods, the long-run share of the licensee firm which enjoys no cost advantage over rival produces, i.e., $\bar{p}=c$, goes to zero. This is so since long-run imitator sales equal market demand, $f(\bar{p})$. In this sense, it is important to start negotiation with a technology supplier who can transfer technology most appropriate to the conditions of the licensee firm since inappropriate technology will decrease the PVP. Otherwise, a prospective licensee needs to negotiate about possible adaption of technology to the conditions of the licensee firm since such adaptation increases the PVP.

The condition (c) indicates that as discount rate increases the long-run market share decreases since a higher discount rate implies that future profits become relatively less important. Lower discount rates raise the PVP since future sales become relatively more important. Licensors, especially multinational firms, with access to many capital markets, usually have lower costs of capital than licensees. Other things being equal, this indicates that future sales are relatively more important to licensor, than to licensee.

The condition (d) indicates that as response coefficient, k, increases the long-run market share also increases. This is so since the

licensee firm must respond to the increased competition by lowering its price. Even though the long-run market share has risen, the PVP is lower. Because any factor which slows imitator entry, or barriers to entry, is reflected in the response coefficient, in the case in which k is high, the PVP will be small because of continuous need for lowering price. The condition (e) merely indicates that the long-run optimal price and market share of the licensee firm are independent of the initial output of rival producers.

We have theoretically analyzed the factors influencing the PVP. The licensees, using their intimate knowledge of the domestic market, are in a position to identify uncertainties which may critically affect the PVP. As analyzed earlier, the principal sources of uncertainty in determining the PVP are the size of the market the licensee will get at a carefully selected price and the time before a competitor introduces a similar product. The licensees can therefore abstract the complex structure of uncertainty into a limited number of relevant developments or scenarios. This reduction or distillation of uncertainty yields a more appropriate basis on which to determine the PVP. As far as the export market is concerned, the only thing the licensee can do is to estimate possible export prices and the probable size of export sales of the products. This is because the licensee cannot control the international market price of the products in most cases.

In order for the licensee to assess the PVP, he should identify and evaluate $\dot{x}(t)$, $\bar{p}$, k, x_0 and p_m in a sequence. The profit streams from the sales of the new product to be produced by utilizing the technology imported have been assumed to be obtainable indefinitely. However, in most cases they will only be generated up to a certain time peried, due to various factors such as the expiration of a patent, saturation of a market, and the end of the product life cycle. The licensee should estimate a profit in each period calculated on an annual basis, with probability assigned to each branch of the uncertainty tree. Then, the averaging-out-and-folding-back process which is often referred to as the process of backwards induction in

the theory of dynamic programming can be applied.[12]

V. IMPLICATIONS FOR TECHNOLOGY IMPORTERS IN LESS INDUSTRIALIZED COUNTRIES

It has been pointed out that, though many less industrialized countries are potentially large and growing markets, the multinational firms (the principal owners and sellers of industrial technology) tend to underestimate the size of the markets due to insufficient foresight in the face of still small markets.[13] The fact that the size of the markets in less-industrialized countries is in fact larger than the market size actually perceived by the technology sellers has important implications for bargaining strategies of the technology buyers in less-industrialized countries. This is because the actual costs to be incurred by a prospective technology buyer in accepting many different terms and conditions that may possibly be demanded by a prospective seller are clearly related to the sales volume to be materialized during the contract period.

For example, running royalties are usually based on sales. Even if running royalties are specified as a payment equal to a certain percentage of value of production, they are clearly related to sales volume since the size of production itself will generally be determined by the size of sales. The costs involved in acception tie-in clauses are also related to sales because the amount of indirect charges through overpricing of imports of raw materials and intermediate goods will be determined by the quantity of such tie-in goods to be purchased and, therefore, ultimately by sales volume. Similarly, the costs involved in accepting restrictive clauses limiting the quantity

12) See for example, Pratt, John W., Raiffa, Howard, and Schlaifer, Robert, *Introduction to Statistical Decision Theory*, New York: McGraw-Hill, 1965.

13) Streeten, Paul, "The Theory of Development Policy", in J. Dunning, ed., *Economic Analysis and the Multinational Enterprise* (New York: Praeger, 1974), pp.272~273.

of sales and/or the quantity of production will also be determined by sales volume to be materialized.

When the seller underestimates the sales volume, he in fact underestimates the profit stream to be realized by imposing on the buyer various terms and conditions that are related to sales volume. In other words, other things being equal, due to insufficient foresight in the face of still small markets he may be willing to reduce his demand on such terms and conditions at a bigger rate than he actually wants to. Considering seller's general overestimation of risks (including political risks) of the markets in less industrizlised countries,[14] his CME(Certainty Monetary Eguivalent) of demanding such terms and conditions may be much smaller than his true CME. As noted earlier, in this case, the licensee should negotiate for a total fixed fee such as lump-sum fee or a fixed amount of installments payable over the period of the agreement. As far as estimation of the size of domestic sales is concerned, the buyers, using their intimate knowledge of the domestic market, are in a position to identify uncertainties which may critically affect the sales volume. In this sense, although the terms on which technology is transferred from the developed to the developing countries reflect partly the bargaining strength of the technology sellers, the prospective buyers in less-industrialized countries can obtain foreign technology on better terms by exploiting systematically the prospective sellers' wrong perception on the size of the markets of the buyer countries. Through rational substitutions among various terms and conditions, licensees can undertake systematic compromise and can secure maximum possible share of net economic benefits from a given technology transfer.

Because of different estimation on factors influencing the PVP, the licensor's evaluation of the π can be different from the licensee's. If the licensor's perception on π is much greater than the licensee's, the licensee may have to concede much in order to

14) Streeten, ibid.

reach an agreement with the licensor. Therefore, in orer to import technology on the best possible terms and conditions, it is important for the licensee to start negotiation for technology transfer with the licensor whose perceived π is estimaed as the samllest among alternative sources of technology available. In this sense, the search for alternatives a prerequisite for obtaining a satisfactory bargaining outcome of technology transfer.

The resource cost of technology transfer will be determined by characteristics of the technology to be transferred, the licensor, the licensee, etcetera. From the licensee's point fo view, the most important factor to be considered is characteristics of the licensor. For exemple, the licensor's experience with technology transfer may well be a prerequisite for effcetive transfer of a given technology. By using a surrogate measure of "number of manufacturing start-ups", for the licensor's experience in transferring a particular technology. Teece estimated that five startups would produce cumulated savings of about 76 percent over the first startup. It was found that especially for chemical petroleum-refining technology transferred abroad without a previous startup, the transfer costs are likely to be substantially higher than the transfer costs of technology that has already been commercialized and undergone several start-ups.[15] Since the licensor's experience with technology transfer influences the resource cost, which in turn determines the π, other things being equal the licensee can achieve better bargain results by negotiation with the licensor with experiences of previous startups.

15) Teece, David J., *The Multinational Corporation and the Resource Cost of International Technology Transfer*, (Cambridge, Mass. : Ballinger, 1976), pp.44~46.