PROPERTY RIGHT OF OPERATIONAL TECHNIQUE AND ECONOMIC WELFARE

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I.

Recently some interesting economic issues have come to the fore with the development of the so-called high-technology products that require their users to command new operational techniques. Technical skills to manipulate a computer, for example, have attained such a high level of sophistication that the users are not able to fully utilize it unless they have received some training in learning how to run it.

The training of users for this kind of product implies some cost. In many cases its producer pays the cost, looking on it as an educational investment.

No problem would arise, should the market be perfectly monopolistic. When a new competitor emerges in the market, however, a problem will come about concerning how to protect the educational investment which the existing firm makes. Namely, if the operational technique of a newcomer's product is not compatible with that of the existing firm's product, the users who are trained by the existing firm will continue to be the customers of that firm. But if both products are compatible, a kind of externality arises; i. e., the newcomer's product can be sold to the users who have been taught how to operate the product at the existing firm's cost, thus becoming a free rider.

Let us take an example. YAMAHA, which produces musical instruments, opened music schools throughout Japan and has been teaching children how to play the piano, aiming to promote the sales of their pianos. However, the customers who are taught at YAMAHA Music School can buy other producers' pianos, KAWAI's, for instance. In this case, KAWAI becomes a free rider, drawing YAMAHA's prospective customers in the market. The reason for such a phenomenon is based on the following facts: The technique for playing the piano is universal and all the pianos have the same function; accordingly, the technique of playing one piano is compatible with that of playing any other producers' pianos. Besides, YAMAHA

which has paid the cost of educational investment cannot force the customers to buy its pianos, for to do so would involve extremely high cost.

We can find similar phenomena in other cases, too. The purpose of this paper is to put these phenomena in order and to clarify the problems associated with them including the property right of computer software and the efficiency of educational investment.

Next, we will classify in section 2 different types of users' technical skills. Then, in section 3 we will clarify the characteristics of operational technique which can be regarded as a kind of public goods. We will further analyze in section 4 the reasons why an innovator who invented a new product allows the operational technique of the product to become compatible with other producers' products to the extent that he encourages others to enter the market. Perhaps there are some reasons for this behavior that could be analyzed from a view point of rational behavior of the innovator. Finally, in section 5, we will examine a problem of externality brought about by the turnover of a worker, i. e., his leaving for the second firm after having been trained by the first firm, for it implies similar problems to the cases concerned with the property right of operational technique.

II. TYPES OF TECHNICAL SKILLS FOR CUSTOMERS

As stated before, although advancement in the production of high-technology products has brought with it much convenience and benefit to many customers, it has become necessary for the users to receive some educational training in learning how to operate them. Our daily life abounds today in the same kinds of products. The fact that high cost has to be paid to provide an operator of a machine with educational training in a technical skill means that the technique itself constitutes a scarcity, which is an economic value. It also means that the technique or technical information can be an object of trade. If it is to be traded in the market, the property right has to be recognized to it. The patent right has already been recognized to the production of goods. However, rarely is the property right recognized to the technical skill that the users have to acquire; or even if it is recognized, such a right takes only ambiguous shape mostly, ambiguity from which various problems come about in economics. We can consider several types of cases in this connection. One extreme case is the trading of technical skill in the market as private goods; the other extreme case is that the technique has a nature of public goods without having the innovator's interest returned to him; and cases in between the two.

Let us list the following cases concerning the question and then examine the specific characteristics of technical skills involved by categorizing them under basic types.

Case 1: The computer and its operational technique.

*The technique is so highly sophisticated that requires the cost of training its operator.

*The technique is closely linked with the machine.

*It can have either compatibility or noncompatibility with other producers' machines.

*The programming of the computer can be easily copied or reproduced, which causes some problems.(1)

Case 2: The automobile and driving skill.

*It requires training cost, but has compatibility.

*The market has been established for educational training in learning the skill.

Case 3: The piano and playing skill.

*Roughly the same as case 2.

Case 4: The typewriter and typing skill.

*This is also similar to cases 2 and 3.

Other cases: Operational techniques of various new products that use computers (e. g. word processors)

*It is likely that even if the product of one producer does not have compatibility or adaptability with the products of other producers, the technique will become universal eventually like typing skill.

Let us look into kinds of problems these cases imply in economics. No problems would arise if the users can operate a newly developed product without receiving any educational training. Also, no market failure would come about when the operational technique is applicable only to the innovator's product and the product has no compatibility. If the new product is available only through a firm specialized in providing technical services, we can assume that there is no market failure, for transactions go through the market which consists of the producer, the firm providing technical services and the customer.

In reality, however, an innovator provides initially customers with educational training for a product; and, with ongoing simplification of its operational technique, it attracts new entrants to the market, which allows the trained customers to purchase newcomers' products. As long as the innovator enjoys a monopoly, the problem does not arise. But once a competitor or competitors appear in the market, and if the technique is compatible, newcomers can take advantage of the information provided by the innovator for the customers and can sell their products without paying the cost of customers' training, or much cost of market cultivation, i. e. they become free

riders. The situation is such that the customers who have learned how to play the piano in YAMAHA Music School come to purchase KAWAI's pianos.

This kind of problem can take place commonly except in the case where the operational technique is exclusively linked to the innovator's product without compatibility. This implies a market failure more or less.

A market failure can be avoided in limited cases where there is no compatibility or when the operation is handled through a firm specializing in providing technical services; i. e., when the market of the operational technique is formed only to the limited extent. Unless the producer and the firm providing technical services are combined, there is a possibility that a market failure occurs. In many cases, the initial firm's educational training is provided and the operational technique embodied by the customers is applied to utilizing other competitors' products, not the initiator's products. To avoid a free ride of this kind, the producer has to be able to control the firm specializing in providing technical services.[2]

III. CAUSES OF MARKET FAILURE

Let us examine in detail the case of a product whose operational technique or technical skill is embodied by the users of it to the extent that it has a nature of public goods and gives rise to a market failure, too basic reasons and two additional considerations being mentioned as follow:

First, that which is embodied can become a "stock". That is, the technique supplied for the users through educational training can be embodied and stored by them. The problem leading to a market failure will be eliminated if all the makers of similar products provide operational services at the same time, or if the technique in point becomes obsolete as a result of improvements made on them, making it unnecessary for the users to have an operational technique.

Secondly, compatibility is another reason for a market failure. When the operational technique can be applied not only to one producer's product but also to other producers' similar products, the technique bears a nature of public goods. The larger is the extent of compatibility, the more the technique appears as public goods. Of course, with decreasing compatibility the nature of the technique approaches closer to private goods. An example for perfect compatibility can be found in the case of the piano, whereas limited compatibility can be found in the case of the computer. No market failure will result if compatibility does not exist, and so both the product and the operational technique are controlled by one producer.

Thirdly even if the two foregoing reasons exist, a market failure could

still be avoided if the producer can enforce the users who acquired the technique to use only their products. However, when the market has expanded to a large scale, it is hard to maintain such enforcement and doing so would incur high cost. Now let us look at this from the users' side. If their number is small enough, it would be possible to restrain them. A restricted trade is posssible between the producer providing technical training and the users of its product, if they represent a limited number of large-scale enterprises.[3] Cases of the restricted trade may happen more often when the technique has little compatibility. In this connection, we can point out one characteristic which is reversely related with the compatibility of a product. If this characteristic is high, it is difficult to form a market for the technical skill for the product through which the result of educational investment can be adequately returned to the producer who invested.

In the case of a compatible technique, even if an agreement is made for a user to purchase one producers' product in return for educational training, with the result that it is violated later, the high cost of trial or difficulty of pinning down the nonfulfilment of the agreement may discourage the producer after all from preventing the spillover of the effect of the educational investment.[4]

Fourthly, as the cost of acquiring the technique decreases, the propagation of the technique is accelerated and free riders are called in. In general, techniques with larger compatibility cost less than otherwise.

Then, what are ways in which a market failure is forestalled in these cases? First, as has been examined earlier, no market failure will come about if a product and its operational technique are inseparable and share no compatibility with other producers' products. Thus, to keep the operational technique in this condition is one way to eliminate a market failure. However, it is more likely that the noncompatibility of the technique is not so perfect that a new competitor could enter the market.

Secondly, the users whom the producer has trained may be restricted, which is possible to some extent when the number of them is small. When the number increases to the level looked on as at large, the cost of enforcement of restriction rises so high that the restriction will become inefficient.

Thirdly, the technique itself may be made an object of transaction in the market. So long as the technique developed by an innovator is marketable, this would mean that the property right to it is recognized. Even in this case, however, he had paid the cost of initial educational investment with the expectation that the investment will be returned as an expansion of sales. But if the technique is compatible, it carries always a risk of inducing free riders.

Under these circumstances, would a producer prefer to develop a non-

compatible technique to prevent a market failure? In many cases a demand for a product expands as its operational technique is simplified. When it is not simple, the demand increases with an increase in the number of the persons who learn the technique. It requires the expansion of educational services, a demand for which starts increasing once a competitor appears; this is more so if the compatibility of the original product is larger.

In general, this tendency induces a producer to develop a product that can be used with a highly compatible operational technique rather than the one which requires a special technique unique to its own. The next section will examine this process in detail.

IV. PRODUCERS' RATIONAL BEHAVIOR

We see many cases in which a product with a complicated operational technique is developed and its producer provides educational training initially; then, as the product spreads, new competitors enter the market. Then, newcomers can enjoy a free ride so long as the cultivation of the market and educational training are concerned. Basically, the only way to avoid it is to develop a noncompatible technique. Other methods enable a market failure to be prevented only partially; and in cases other than the cases in which users are limited in number and are closely linked to the innovator, a market failure is unavoidable more or less. Even so, in many cases the technique in point is compatible or universal and the market sees a new entrance. Why, then, the innovator develops a technique that could be compatible and provides educational training to the users, allowing newcomers to enjoy the benefit of free riding?

The following reasons can be considered:

i) It is likely that a compatible operational technique is simpler and attracts more demands, i. e. the merit of market expansion is larger than the risk of new entrants.

ii) Assuming that a technique is not compatible, if a competitor develops the same kind of product with a different operational technique, a benefit of having a noncompatible technique arises only when the innovator's market share is considerably high. If the share becomes lower, the merit will diminish. Moreover, the operational technique of an entrant's product may be more simplified and may deprive the innovator of some of his share and attain the majority of shares in the market.

iii) It is difficult to expand the market if the cost of educational investment becomes too large. Also, if a similar product is developed with a simpler operational technique which can be provided by lower educational cost, the initial innovator will lose his customers. This motivates the in-

novator to simplify the operational technique.

iv) In any case, if it is difficult to recognize the property right to an operational technique, it is also difficult to prevent new entrants from enjoying a free ride. Even if the property right is secured, the cost of restricting the users is high. When this cost and another cost to keep the operational technique noncompatible for preventing diffusion may be compared with the expected benefit drawn from this strategy. If the benefit comes out smaller than the cost, the reason for keeping the technique noncompatible loses its ground.

Among the points examined above, i) and ii) cause a demand to shift rightward and downward, respectively. Both cases increase the demand for the product, but at the same time induce new competitors to enter the market.

V. OTHER SIMILAR ISSUES

W. J. Baumol pointed out a case in which unskilled workers are trained in a firm as an example of depletable externality.[5] Firms employ many workers every year and provide educational training for them during their employment to improve productivity. Let us assume that the workers can keep working for h years on the average, but move from one firm to another every w years on the average.

Thus $w<h$. If we assume that the educational training accrues b dollars of contribution to the marginal productivity during following h years, the current discounted value of b dollars that one worker will earn in his entire working period is obviously larger than the marginal social benefit for the firm.

The discounted current value of the marginal revenue for the firm is $\sum_{t=1}^{w} b/(1+r)^t$, where t=period and r=interest rate. This is naturally smaller than the value that the worker will earn by working h years, i. e. $\sum_{t=1}^{h} b/(1+r)^t$. The firm will supply training for a worker until the marginal cost of training for him becomes equal to $\sum_{t=1}^{w} b/(1+r)^t$. The discounted current value of the marginal revenue for the rest of the period is absorbed either as wages paid to the worker or as a larger revenue of a firm by which the worker will be employed next. A free ride occurs at this point, for a firm that can employ trained and skilled labor can reduce the cost of training for its employees. Thus, when a firm predicts that the worker will leave the firm in w years, it will provide training for him until the marginal cost of training becomes equal to $\sum_{t=1}^{w} b/(1+r)^t$. As w becomes large, the cost of training

also increases. Of course, a firm can invest the largest training cost in the case of life time employment.

More realistically, an educational investment to train unskilled workers to become skilled workers is undividable. Therefore, the same amount of educational investment is required no matter whether a worker stays w years or h years in the same firm. The shorter the working years in one firm, the more the result of educational training will spill out to other firms. In many case, skilled labor is a product of OJT (On the Job Training), which is easy to cause the spillover of the result of educational investment when a worker changes the firms. If the worker's technical skill is applicable to his work in the new firm, this kind of spillover is inevitable. This is an economic externality. If a firm wishes to avoid it from happening, the production technique of the firm has to become such that it is applicable only to the production system of the firm. That is, only by reducing the compatibility of the technical skill the firm use for production, the market failure is avoided. However, if the technique has such a characteristic, it may also be easy to become trite rapidly. Techniques that have wider compatibility would require less educational investment and would have better adaptability to the technical advancement.

The educational training causes spillover if the labor market is perfect and the mobility of labor is elastic. In other words, it is a phenomenon that can be called "paradox of a perfect market," where the more perfect is the market, more is the number of market failures caused. In that sense, the result of OJT is efficiently utilized in such a case like in Japan where labor mobility between firms is not elastic but according to which is elastic inside of one firm.

VI. PARETO OPTIMUM AND SOCIAL COST

It is a market failure that the educational investment of an initiating firm is embodied by the users and the following firms can sell their products to the existing market without market cultivation cost. It hampers the efficient allocation of resources in the sense of Pareto optimum. However, if the technique is not compatible, the following firms have to develop their own techniques and cultivate the market with educational investment. If there are many complicated operational techniques, the amount of educational investment will be enlarged. If there are many products with a compatible operational technique, the users can enjoy freedom of choice in a wide range. In the sphere of the national economy, it is more desirable to avoid duplication of investment and to have the users educated with low cost. Here, we see a gap between a Pareto optimum (efficiency of resource allocation)

and welfare of the national economy in a sense of minimizing social cost.

In the discussion of efficiency, the two concepts, allocative efficiency and x-efficiency, have been presented. To state analogically, prevention of a market failure is efficient in Pareto optimum, and it can be achieved when the technique is not compatible or when there is some kind of trade secret or legal protection of the technique such as copyright. However, a compatible technique encourages development of new products and can prevent duplication of investment, which is favorable for the national economy.

To which concept we attach greater importance inevitably has to depend on the consideration of interest of the national economy. Another important factor that was not touched on in this paper is a question. Consideration for the development of new products and advancement of technology and that for the protection of initial investment may not be consistent with each other.

In any case, the solution of this problem is beyond the existing analytical tool of Pareto optimum. It requires a further elaboration of analysis from a viewpoint of both law and economics.

Notes:

(1) When computers were in the early stage of development, they had neither memory devices nor needed programming. Even at that time, the operational technique required high-level skills and the producers had to supply certain educational training for the users. As the computers' capacity increased, programming and computer languages were developed. Computer programs themselves have been vested with a nature of intellectual products produced by programmers, that has brought about a problem of copyright. Therefore, there is a slight difference between the operational technique of a computer and the skills to play the piano or drive a car.

(2) There would be no problems if the firms specializing in providing in technical services belong to a Keiretsu or a group under the same capital. Otherwise, it becomes necessary to control them. In this case, the more remotely is the producer linked with the users, the higher is the cost of control. When the producer provides educational training for the customers directly, forcing becomes virtually impossible, because of high cost (such as forcing students in YAMAHA Music School to purchase YAMAHA pianos).

(3) In this case the producer and the firm providing technical services would belong to a group under the same capital after all, but they are to keep some kind of contracts on the matter.

(4) Forcing the users to abide by the agreement may be possible as a system, but in practice, the firm would abandon it because of the high cost it incurs. The producer would develop a technique that could become compatible

and educate the users, even if it allows competitors to enter the market newly. This is explained in section IV.

(5) "Depletable externality" is an expression used by Baumol and shows strong originality of his own. For example, when some coal is dropped from a train during transportation and somebody tries to pick it up, he becomes a free rider, and it is an externality. But Baumol calls it "depletable externality," for the value of the dropped coal is depleted as much as it is picked up. (William J. Baumol and Wallace E. Oates, *The Theory of Environmental Policy*, Part 1, On the Theory of Externality.)