Resource Allocation within Multi-divisional Organization

:The Case of the Multinational Enterprise

by

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Abstruct

In this paper, we are concerned with an exchange of a pattern of resource allocation within a multi-divisional organization. Especially, we focus our glasses on an allocation of firm-specific human resource within multinational enterprise.

Our conclusions, which are alternative interpretations to Edostrom and Galbraith [3], [12], are

(1) When the headquarter of our multinational enterprise does not know the marginal productivity of human resource at each division, he has to change a pattern of human resource allocation as long as he intends to maximize his sales or profits.

(2) If there is the increasing return to scale in human resource, the headquarter has the possibility to fail in attaining global efficiency though he may change the pattern of human resource allocation.

1. Introduction

In the traditional analysis, the multinational enterprise has been analyzed from the viewpoint of capital investment or international capital movement. In those analyses, two aspects of the multinational enterprise have been missed, which are the organizational structure of the firm and the human resource allocation within the firm. Caves [1] and Cohen [2] discussed these overlooking and both concluded its cause by pointing out the analytical framework to study the multinational enterprise by means of capital concepts. Therefore, it is still a problem to consider the relationship between the peculiar behavior and the organization structure of multinational enterprise as multi-divisional organization.

As results of many case studies by themselves, Galbraith and Edstrom [3] shows that it is a notably observable phenomenon that an exchange of a pattern of human resource allocation within the multinational enterprise has occur frequently.

The purpose of this paper is to explain an economic meanings of this exchange of an allocation pattern of human resource within the firm. Especially, this paper focuses a sight on the relationship between the exchange within the multi-divisional structure of the firm and its profit maximization behavior. And, it is showed that the exchange of those allocation pattern may be consistent with the profit maximization behavior of the multi-divisional firm under some conditions.

Main conclusions of this paper are,

(1) When the headquater of the multinational enterprise does not know the marginal productivity of a human resource in each division, he has to change an allocation pattern of human resource frequentry as long as he intends to maximize his sales or profit.

(2) If there is the increasing return to scale in human resource at each devision, the firm has the possibility to fail in attaining a global efficiency though he may exchange the allocation pattern of the human resource.

It is an assertion of this paper these conclusions (1), (2) may explain the some phenomenon of the human resource transfer within the multinational enterprise pointed out by Galbraith and Edostrom [3].

The plan of this paper will be as follows. Section 2 will briefly describe some assumptions and their economic backgrounds. Section 3 will introduce a model of human resource allocation process within the multinational enterprise which posseses n production divisions in foreign countries and argue some properties of the process. Section 4 will discuss a firm-behavioral implication of the model. Section 5 will be concluding remarks.

2. Assumptions

A multinational enterprise of which production divisions are set up in foreign countries is regarded as a typical firm to possess a multi-divisional structure.

(On the form of this multi-divisional structure, see Chandler [4], and Williamson [5].)

In this paper, we will concentrate our interest on the relationship between the human resource movement across each division and the profit maximization behavior of the multinational enterprise. This multinational enterprise is a firm which has one headquater (or general office) in a native country and several production divisions in various foreign countries. We will consider that there is a differentiation of an informational function between the headquater and each production division. That is, each divisionhead who has a full knowledge on the regionally varied environment of the production division manages various information of the environment of the production in the foreign country and a headquater or general office in the native country adjusts a various resource allocation to the profit maximization by an utilization of the information trasmitted from each division-head.

Such informational differentiation between the headquater and each division-head is a characteristic common to all firms which posses a multi-divisional structure.[1] Particulaly, the tendency of these differentiation will relatively manifest itself in a multinational enterprise. For, there are two economic reasons. The first is a difference of the production envioronment of each division between in the native and in the foreign country. The second is an institutional restriction of informational transmission which the multinational enterprise peculiary holds. This restriction can be considered to be based on the internationality of multidivisional structure.

Next, we will assume that the human resource accumulated in the multinational enterprise is a firm-specific labor in the meanings of labor economics. This assumption depends on the series of the case studies by Franko [7], Yasumuro [11] and Behrman and Wallender [8]. These studies show two aspects of the resource allocation within multinational enterprise. The one is a tendency that

the real capital investment to a foreign production division is decreasing after the initial investment. The other is a fact that the human resource movement occurs continuously even after the initial real investment. These facts mean that the human resource allocation fulfills its function as an adjustment of production among the estabilished divisions instead of the real capital. Furthermore, Yasumuro [11] shows that this human resource has been concretely composed of the factory manager and the assist-manager. These labor-service are the firm-specific laber trained in the firm and it is impossible for each division to employ those labor at the foreign labor market. These observational facts imply that those human resource may become a bottleneck of expanding production for the each division-head.

Through the above considerations, we will employ following assumptions;

[A-1] The multinational enterprise has n production divisions in various countries and produces one output.

[A-2] The headquarter in the native country makes a decision to allocate a human resource to each division. Then, he does not know previously the productivity of the human resource at each division. While the division-head has a full knowledge on the productivity and transmits it to the headquarter.

[A-3] There exists a human resource constraint such that the headquarter has a possibility to increase his sales even if he efficientlly allocate a human resource to each division.

[A-4] The headquarter behaves as price-taker in the facter and product market.

3. Model

Let y_i be the production funtion of i-th division such that

$$y_i=f_i(x_{i1}, \bar{x}_{i2}) \qquad i=1, \cdots\cdots, n$$

$\bar{y}_i=f_i(0,\ \bar{x}_{i2}),\ y_i\geqq\bar{y}_i$ for $^{\forall}\ x_{i1},\ \bar{x}_{i2}\geqq 0$

where y_i is the output and x_{i1} is the input of human resource and $\bar{x}_{i2}$ is of another input service of i-th devision and is assumed to be constant value for simplicity. f_i is assumed to be twice continuosly differentiable for $x_{i1}\geqq 0$, but not strictly concave. That is, says [A-4], there exists a possibility of the increasing return in human resource.

We may now state formally the objective of the headquarter of the multinational enterprise. The objective is to find a human resource allocation which maximizes sales, i.e.,

$$\text{Max, } R\left(\sum_{i=1}^{n} y_i\right) \quad \text{s.t, } y_i=f_i(x_{i1},\ \bar{x}_{i2})$$

$$\sum_{i=1}^{n} x_{i1}=D_1,\ \sum_{i=1}^{n} \bar{x}_{i2}=D_2 \qquad \cdots\cdots(1)$$

$$x_{i1}\geqq 0,\ \bar{x}_{i2}>0 \text{ for } {}^{\forall}i$$

Where D_1 is a quantity constraint of human resource and $R(\cdot)$ is a revenue function to be assumed a strictly concave, $R(0)=0$ and $R'(0)>0$.

If the headquater previously acquired an accurate information on the shape of f_i for all i, he can solve the constraint maximum problem of (1), But, [A-2] makes it impossible for him to solve the problem directly. He must design a human resource allocation process to find $x_1=(x_{11},\ \cdots,\ x_{i1},\ \cdots,\ x_{n1})$ which maximizes $R(\sum y_i)$.

It is noted that in this model the necessary condition for sales maximization of [1] is equivalent to for profit maximization. The headquarter who allocates an already accumulated firm-specific human resource within the firm will recoganize his profit Π as follow, i.e,

$$\Pi=R\left(\sum_{i=1}^{n} y_i\right)-\sum_{i=1}^{n} w_i\bar{x}_{i2}$$

where w_i is the unit price of input survice in foreign factor market.

Therefore, the necessary condition for profit maximization for the headquarter

is equivalent to for sales maximization, i.e.,

$$\frac{d\Pi}{dx_{i1}}=\mathrm{MR}\cdot\frac{\partial f_i}{\partial x_{i1}}-w_i\cdot\frac{d\bar{x}_{i2}}{dx_{i1}}=\mathrm{MR}\cdot\frac{\partial f_i}{\partial x_{i1}}=\frac{d}{dx_{i1}}\mathrm{R}\left(\sum_{i=1}^{n}x_{i1}\right)=0,\quad \text{for } {}^{\forall}i.$$

3-1. Allocation rules of human resource

The allocation process of human resource defined as follows is composed of several rules which are introduced by Heal [9].[2)]

□ The initial rule; The headquarter proposes an arbitary allocation of human resource among each division $\{x_1^0\}$ which satisfies

$$\{x_1^0\}\in\{(x_{11},\ \cdots,\ x_{i1},\ \cdots,\ x_{n1})\mid\sum_{i=1}^{n}x_{i1}=\mathrm{D}_1,\ x_{i1}\geqq 0 \text{ for } {}^{\forall}i\}$$

□ The response rule of each division; In responce to this proposal $\{x_1^0\}$, i-th division-head than reports to the headquarter the marginal productivity of the human resource such that

$$\left.\frac{\partial f_i}{\partial x_{i1}}\right|_{x_{i1}=x_{i1}^0}\quad \text{for } {}^{\forall}i(=1,\ \cdots,\ n)$$

□ The adjustment rule of the headquarter; In the light of the information transmitted from each division, the headquarter adjusts its proposed allocation governed by the following equation, i.e.,

$$\dot{x}_{i1}=\begin{cases}\dfrac{\partial f_i}{\partial x_{i1}}-\dfrac{1}{|\mathrm{K}|}\displaystyle\sum_{j\in\mathrm{K}}\frac{\partial f_j}{\partial x_{1j}}, & \text{for } {}^{\forall}i\in\mathrm{K}\\ 0, & \text{for } {}^{\forall}i\notin\mathrm{K}\end{cases}\qquad\cdots\cdots(2)$$

where $|\mathrm{K}|$ denotes the number of elements in the set K. And K is formed as following procedure;

step 1; The headquarter calculates

$$\mathrm{Av}(\mathrm{A}^0)=\frac{1}{|\mathrm{A}^0|}\sum_{i\in\mathrm{A}^0}\left.\frac{\partial f_i}{\partial x_{i1}}\right|_{x_{i1}=x_{i1}^0}$$

where A^0 is a set such that $\mathrm{A}^0=\{i\mid x_{i1}^0>0\}$ and $|\mathrm{A}^0|$ is the number of elements.

step 2; He chooses an i, says i', such that $i'\notin\mathrm{A}^0$ and i' is the index number of $\arg.\max_{i\in\mathrm{A}^0}\left.\dfrac{\partial f_i}{\partial x_{i1}}\right|_{x_{i1}=x_{i1}^0}$, and

(i) if $\left.\frac{\partial f_{i'}}{\partial x_{i'1}}\right|_{x_{i'1}=x_{i'1}^0} \leqq \mathrm{Av}(A^0)$, then sets $K=A^0$

(ii) if $\left.\frac{\partial f_{i'}}{\partial x_{i'1}}\right|_{x_{i'1}=x_{i'1}^0} > \mathrm{Av}(A^0)$, then forms a new set

$A'=A^0 \cup \{ i' \}$.

He repeats the above step with the set A^0 replaced by the set A' and continues this procedure.

□ The action rule; The headquarter adopts an allocation pattern at time T when he stops the above procedure, and actually allocates human resource with $\{x_{1i}^T\}$

These rules mean that the headquarter increases the allocation of human resource to those divisions where its marginal productivity is above the average. And also, he must avoid decreaseing the allocation to the division where its marginal productivity is below the average if the allocation to that division is already zero.

To sum up the above allocation process, the headquarter proposes an allocation derived from the equation (2); in responce, the devision heads inform it of marginal productivity, and the allocation pattern is exchanged by the headquarter in the light of the information from the divisions.

3-2. Several properties of the allocation process

We are now in a position to state several properties which the allocation process defined above posseses.

In the first place, we prove the following lemma.

Lemma: The maximization problem (1) is mathematically equivalent to of (1′) under [A-3].

$$\text{Max.} \sum_{i=1}^{n} y_i \quad \text{s.t.} \quad y_i=f_i(x_{n1}, \bar{x}_{i2})$$

$$\sum_{i=1}^{n} x_{i1}=D_1,\quad \sum_{i=1}^{n} \bar{x}_{i2}=D_2 \quad \cdots\cdots(1')$$

$$x_{i1}\geqq 0,\quad \bar{x}_{i2}\geqq 0$$

proof; Let Max $R(Y)=R(Y^*)$. We have the following inequality from [A-3].

$$\sum_{i=1}^{n} y_i < Y^* \text{ for } {}^{\forall}x_1\in\{(x_{i1},\ \cdots,\ x_{in}) \mid \Sigma x_{i1}=D_1,\ x_{i1}\geqq 0\}$$

From the strict concavity of the revenue function $R(\cdot)$ and $R(0)=0$, $R'(0)>0$, we can show

$$\underset{x_i\in D_1}{\text{Max}} \sum_{i=1}^{n} y_i=\sum_{i=1}^{n} y_i^*$$

where y_i^* satisfies

$$\underset{x_1\in D_1}{\text{Max}}\ R(\Sigma y_i)=R(\Sigma y_1^*) \text{ for } {}^{\forall}i. \qquad \text{Q.E.D.}$$

This lemma says that the model of a human resource allocation within the multinational enterprise is mathematically equivalent to the resource allocation process introduced by Heal [9].[3] Heal [9] and Hori [10] showed that this process has several important properties. Followings are those;

[P-1] If the initial allocation $\{x_1^0\}$ is feasible with respect to the quantity constraint such that

$$\{x_1^0\}\in\{x_{11},\ \cdots,\ x_{1n}) \mid \Sigma x_{i1}=D_1,\ x_{i1}\geqq 0\}$$

then the differential equation of [2] has at least a solution path. (See, Hori [10] Theorem 1)

[P-2] The allocation process defined by [2] converges a critical point in infinite process time span.

[P-3] Total output of the firm Σy_i is monotonically increasing. (Therefore, in our assumptions, $R(\Sigma y_i)$ is also monotonically increasing.)

[P-4] The process operates even if there exists an increasing return in human resource.

[P-5] The human resource allocation $\{x_1^T\}$ at arbitrage process time is feasible allocation for the headquarter if the initial allocation $\{x_1^0\}$ is feasible.

These properties make it possible for us to interprete the human resource allocation within the multinational enterprise variously. [P-1], [P-3], and [P-5] assure the headquarter that there exists the possibilty which he finds the allocation pattern to be compatible with his target, i.e., the profit maximization. Also, [P-3] ensures him to be able to attain a more desirable allocation as long as he continues the allocation process. And, [P-4] guarantees that the above allocation process is consistent with the existence of the increasing return of human resource such that [A-4].

However, as Heal [9] showed, when there exists the increasing return in human resource, the headquarter can attain the revenue corresponding to a critical point of this allocation process at most if he operates this process at infinite time span. That is, there exists the possibility that the headquarter can not attain even the local-maximum profit. (For in detail, see the example in footnote.)

Moreover, the system of allocation has a charactaristic that the headquarter can always find a set of an initial allocation V with the following properties. (See, Hori [10] p.463.)

[P-6] The set V is a non-empty subset of $\{(x_{11}, \cdots, x_{1n}) \mid \Sigma x_{1i}=D_1, x_{1i}\geqq 0\}$

[P-7] A solution of (2) starting from a point in V diverges from a local-sub-optimum.

[P-8] A local-sub-optimum point lies on the boundary of V.

The above properties give some comfort to the headquarter since those show that the possibility of convergence to locally sub-optimum point is somewhat limited. That is, the existence of the set V implies that the headquarter can avoid this convergence by employing the perturbation routine around such local-sub-optimum point.[4)]

4. An interpretation of the human resource allocation

The adjustment time of the system of the allocation process (2) is in infinite horizon. That is, it needs an infinite process time that the process starting from an arbitary point converges some critical point. (See, Figure 1). However, it is impossible for the multinational enterprise under the real environment to operate its adjustment process of human resource allocation in infinite horizon. Therefore, we assume that the headquater is enforced a cource of action which his adjustment process must be stopped at a finite time span. That is, it is assumed that the procedure of the adjustment of human resource is workable as following proceeding; the headquater proposes an arbitrary allocation to be feasible, i.e, $\{x_1^0\} \in \{(x_{11}, \cdots, x_{1n}) \mid \Sigma x_{i1} = D_1, x_{i1} \geqq 0\}$.

The division-heads inform its marginal productivity. The headquarter exchanres an allocation pattern derived from the system of [2] and continues the adjustment in this fashion. He stops this process at time T and adopts the allocation pattern at the stopping time.

It is noticed that the allocation $\{x_1^T\}$ at time T is feasible for the headquarter. (See, [P-5]). But, he may not pass a fair judgment whether the adopted allocation $\{x_1^T\}$ is efficient or not even if locally, since there exists the increasing return to scale in human resource. That is, he may perceive it by operating the process for sufficientlly long. (Of cource, $\{x_1^T\}$ is never an optimal point because the adjustment process stops at a finite time. See, Figure 1).

If the headquarter perceives the existence of the increasing return provided that the adjustment time to be a logical one is sufficientlly large, he is aware that there exists a possibility of the existence of more efficient allocation. Therefore, choosing another initial allocation $\{\tilde{x}_1^0\}$ from the set V, he can find the new allocation pattern, says $\{\tilde{x}_1^T\}$. Then, if

$$R(\dot{\Sigma}\tilde{y}_i) > R(\Sigma y_i)$$

where $\tilde{y}_i=f_i(\tilde{x}_{i1}^T, \bar{x}_{i2})$ and $y_i=f_i(x_{i1}^T, \bar{x}_{i2})$, the headpuarter must to change the adopted allocation pattern $\{x_1^T\}$ into $\{\tilde{x}_1^T\}$. If $R(\sum\tilde{y}_i)<R(\sum y_i)$, then $\{x_1^T\}$ is not exchanged.

In this place, it is noticed that there exists a more efficient allocation $\{\tilde{x}_1^T\}$ rather than $\{x_1^T\}$ if $\{x_1^T\}$ is not locally efficient. (See Figure 1. Of cource, we assume that $\{x_1^T\}$ is not globally efficient.) This fact implies that the headquarter has an incentive to change the human resource allocation pattern to maximize his profit.

From the above consideration, we now state following two propositions.

Proposition-1 : If $\{x_1^T\}$ is not globally and locally efficient, there exists a more efficient allocation rather than already adopted allocation. Then, the headquarter has the possibility to find it and the incentive to change the allocation pattern.

Proposition-2 : If the headquarter fails to choose the initial adjustment point $\{x_1^0\}$ which attains a globally efficient allocation, then there exists the possibility which he can not find the global maximum profit eternally.

These proposition deeply depends the properties of the tatonnement process defined by the system of allocation. They give some comfort to us to interpret the human resource movement within the multinational enterprise.

Proposition-1 says that the human resource movement is consistent with the profit maximization behavior of the firm. Galbraith and Edström [3] interprets the movement as (1) the efficient utilization of managerial resource, (2) the job-training within the firm. Futhermore, Edström and Galbraith [13] asserts that the movement is necessary for the headquarter to control the divisions by socialization.

Proposition-2 gives us a theoretical explanation of the concept of the organi-

zation failure which is introduced by Williamson [5] to expound the situation that the multidivisional structure fails in attainig a globally efficient resource allocation. That is, there exists a possibilty that under some condition of the informational differentiation and the increasing return, the multidivisional structure causes the firm to fail in attaining the grobal efficiency.

5. Concluding remarks

In the above sections, we have seen the human resource allocation within the multinational enterprise being consistent with the maximization behavior of the firm. It has been showed that the movement of the human resource is working as if the quantity tatônnement process within the firm attains an efficient allocation. But, it has been also seen that there exists a possibility for the firm to fail in attaining a global maximum of profit.

We here present the following conjecture on the property of the multinational enterprise in this model.

Conjecture; When there is the increasing return to scale in human resource, the possibility for the firm to achieve a global maximum profit is decreasing, according to the increasing of numbers of division.

If this conjecture is strictly defined as the demonstration of a proposition, we may be able to introduce the concept of the optimal number of division for the analysis of the maltinational enterprise. Stopford and Wells [13] shows that recently several multinational enterprises have reorganized their foriegn divisions into the regional managing sectors. The concept of the optimal munber of division may give a theoretical explanation to their case studies.

In the final place, we must point out the weak points of this paper. The first is just our assumption that the headquarter maximizes the profit by means of only human resource. The second is that we exclude from the analysis the trade between divisions. These aspects set the limit to this paper. Therefore, it

is still a problem for us to analize the human resource allocation by considering these aspects.[5)]

Footnotes

1) Williamson [5] presents a noticeable argument on these aspects.

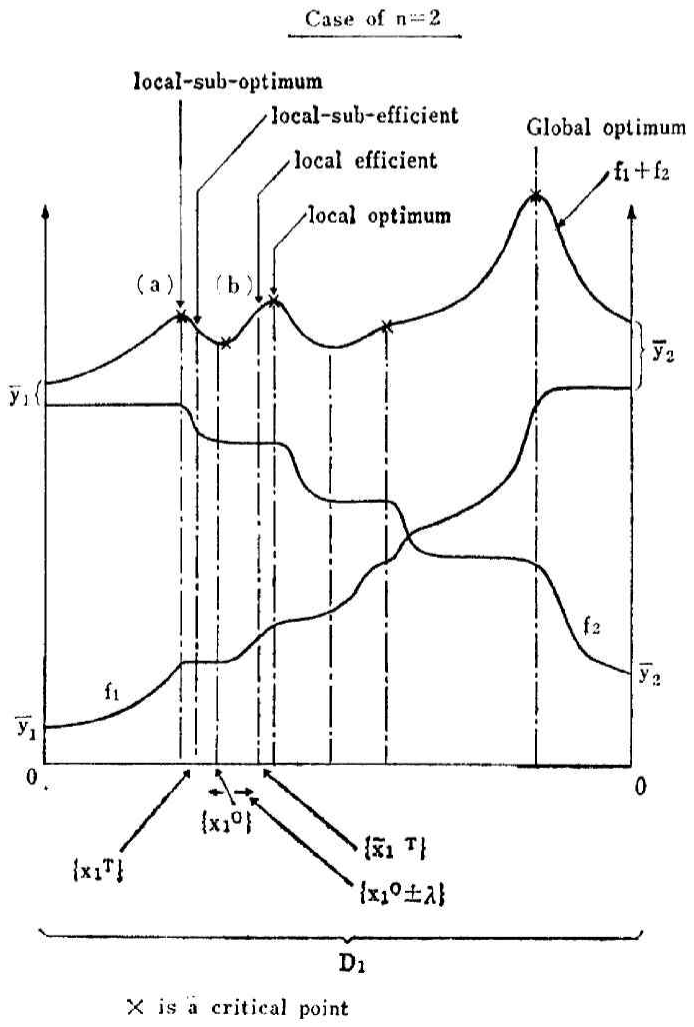
2) The original form of this resource allocation process is called "Heal's process" in the economic planning theory.

3) In our model, $\bar{x}_{i2}$ is an another service which has been already invested in each division, that is a shift-paramerter of the production function of i-th division. Let g_i defined as followes.

$$g_i = y_i - \bar{y}_i = f_i(x_{i1},\ \bar{x}_{i2}) - f_i(0,\ \bar{x}_{i2})$$

Then it is easy to see that the allocation process in this paper is equivalent to the original from in Heal [9] w.r.t. $\dfrac{\partial g_i}{\partial x_{i1}}$.

4) Simple example of the allocation process; the case of two divisions. We here show the above properties of the process geometrically. In Figure, the case of two divisions is described. f_1 and f_2 are production function of each division and their shapes imply that there exists the increasing return in human resource.



× is a critical point

The adjustment process starting from $\{x_1^0\}$ converges (i) a local sub-optimum point (a critical point (a) in Figure) in infinite time span; (ii) a local subefficient point in finite time span T.

After the perturbation of $\{x_1^0\}$, the process starting from $\{x_1^0 \pm \lambda\}$ converges (i) a local optimum in infinite time span; (ii) a local efficient point in finite. (a point (b) in Figure)

5) The another revised version of this paper which consist of the first version were written with co-auther, Mr. Tomofumi Anegawa. (Yale Univ. USA)

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