

An Analysis Model on Marketing Channel Structures

—Rational Modification and Cost of Communication Network in Vertical Market—

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Abstract:

In this research, we construct a model to analyze the real structures of marketing channels theoretically and to obtain important hypotheses. In order to derive testable hypotheses from our model, we assume a reasonable communication network, and include communication density as well as communication cost as variables in this model.

Key words:

communication cost, model, fixed cost, variable cost, information, market segmentation, information network, communication overlapping ratio

1. Purpose

Aiming at constructing the basic model of communication in the market, I already started looking at Hall's link principle (Hall 1971, 169-170) and reviewed the models by Balderston (Balderston 1958, 154-171), Baligh and Richartz (Baligh and Richartz 1964, 667-689) and Naert (Naert 1970) and then modified the parts of those models for improvement. The base of my model construction⁽¹⁾ is the model by Baligh and Richartz.

Their model includes (i) variables for communication cost, which are divided into two groups: one for the fixed cost q of information exchanges and the other for the variable cost p by the number of information exchanges or the volume of information exchanged (Nishimura 1995, 179-182), (ii) variables for market segmentation (Nishimura 1995, 182-185) and (iii) variables for investment cost (Nishimura 1995, 185-189).

In this paper I attempt the construction of a more realistic communication model in a marketing channel upon the reexamination of the above variables. Concrete subjects to be discussed are rational modification of a communication network under market segmentation and its relationship with cost.

(1) Nishimura. see eq.(5-32) or (5-33). 188.

2. Rational Modification of Information Network under Market Segmentation and that of Network Cost

This study has assumed that market segmentation actions by manufacturers are as shown in Figure 1. But here again we examine how market segmentation actions affect a communication model. First, let us assume that market segmentation actions are taken under the M - N market structure and then communication links are formed as in Figure 1.

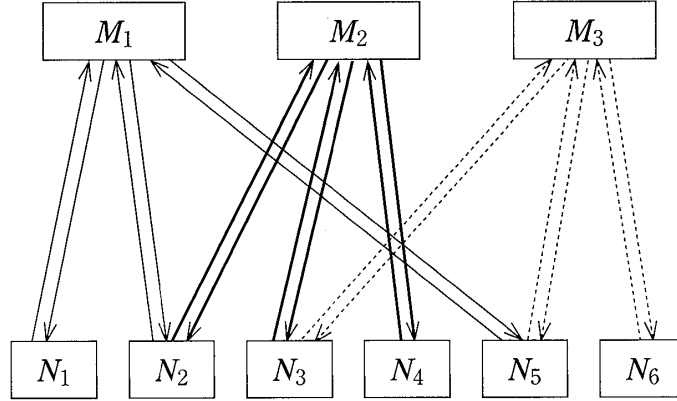


Figure 1 Communication Links when Market Segmentation Actions are taken in the M - N Market Structure

Here it is assumed that each manufacturer is interested in selling to S_M ultimate consumers, in average, of the total n ultimate consumers and tries to communicate with them. In the case of Figure 1, S_M is 3 and market segmentation ratio, S_M/n , is $1/2$. Incidentally, in my basic model⁽²⁾ the socio-economic total cost of communication in the M - N market structure, TC_M was expressed as the following, which is,

$$\begin{aligned} TC_M &= (qmn + 2pmn) \times \frac{S_M}{n} \\ &= mS_M \times q + mS_M \times 2p. \end{aligned} \quad (1)$$

In this equation $mS_M \times q$ is regarded as the fixed cost part in the M - N market structure, labeled F_0 ⁽³⁾ and $mS_M \times 2p$ the variable cost part, labeled V_0 . Then the next equations hold:

$$F_0 = mS_M \times q \quad (2)$$

(2) Nishimura. see eq. (5-20). 184. For example, in Figure 1, manufacturer M_1 gives N_1 a unit of information and N_1 gives M_1 a unit of information. So the number of information units exchanges between M_1 and N_1 is $2p$. Since there are mS_M links, $V_0 = mS_M \times 2p$ follows (refer to Figure 1).

(3) Because $F_0 = f(mS_M, q)$, or $F_0 = mS_M q$, F_0 is not purely fixed cost, rather, should be considered as variable cost. But since q is defined, at the early stage of this study, as fixed cost per link (for example, fixed salary of salespeople working as a means of communication, the monthly basic charge of telephone or salary of workers forwarding and collecting the direct mail.), we used the word 'fixed' for convenience. The same can be said for V_0 , F_1 in the M - W_1 - N market structure and V_1 .

$$V_0 = mS_M \times 2p \quad (3)$$

mS_M in eq. (2) indicates the number of information exchanges by the communication function in the M - N market structure, i.e. the number of links for humane contact, while $mS_M \times 2$ in eq. (3) indicates the number of information units exchanges. For example, in Figure 1, manufacturer M_1 gives N_1 a unit of information and N_1 gives M_1 a unit of information. So the number of information units exchanges between M_1 and N_1 is $2p$. Since there are mS_M links, $V_0 = mS_M \times 2p$ follows (refer to Figure 1).

When the former is called Y_{F0} and the latter Y_{V0} , the following equations can be held:

$$Y_{F0} = mS_M \quad (4)$$

$$Y_{V0} = mS_M \times 2. \quad (5)$$

On the other hand, the fixed cost part, F_1 , and the variable cost part, V_1 , in the M - W_1 - N market structure defined in my previous paper⁽⁴⁾ are as follows:

$$F_1 = qmn_{i1} + qw_{i1}n = (m+n)qw_{i1} \quad (6)$$

$$\begin{aligned} V_1 &= pn \left(m \times \frac{S_M}{n} + 1 \right) + pm \left(n \times \frac{S_M}{n} + 1 \right) \\ &= (2mS_M + m + n)pw_{i1}. \end{aligned} \quad (7)$$

In this case the number of links, Y_{F1} , and the number of information units' exchanges, Y_{V1} , are as follows:

$$Y_{F1} = (m+n)w_{i1} \quad (8)$$

$$Y_{V1} = (2mS_M + m + n)w_{i1}. \quad (9)$$

Figure 2 shows how many times information units are exchanged when market segmentation actions are taken in the M - W_1 - N market structure.

In Figure 2, N_1 receives a manufacturer's information in an overlapping way from W_{11} and W_{21} . The same happens for N_2, N_3, \dots, N_6 . Each consumer receives the overlapped information through different channels from an manufacturer and gives the same consumer information to two middlemen. Hence, the "overlapped transmission" of the same information is a problem of this information network. Such transmission occurs not only between W_1 and N but also between M and W_1 .

Therefore the information network such as Figure 2 cannot be a rational one because of its way of transmitting market information to all ultimate consumers and collecting information from all of them. Although overlapped communication actions may exist in some markets⁽⁵⁾, such markets would explain only a small part of the whole picture.

This is because such irrational markets would be eliminated sooner or later if the principle of competition worked. But if such markets actually existed, these cases would be dealt with in the overlapping concept model.

(4) Nishimura. see eq. (5-21). 184.

(5) This is considered to exist, for example, under high variance on price or a market in keen competition.

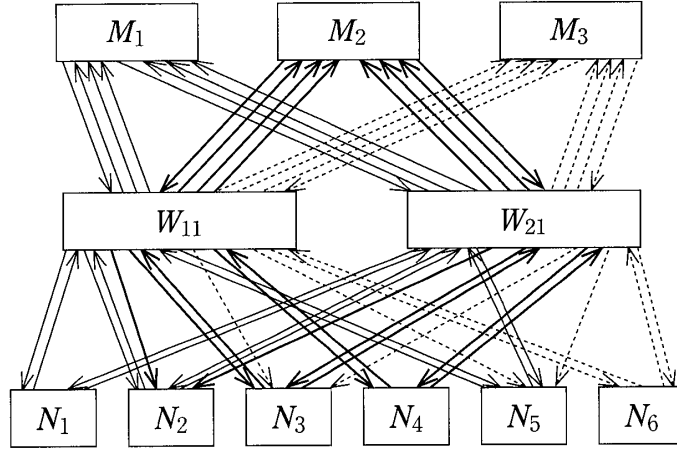


Figure 2 The Number of Unit Information Exchanges when Market Segmentation Actions are taken

Now let us consider a market having an ideally rational network, in which information is transmitted to all ultimate consumers and is collected from all of them.

As an appropriate example, we can consider such a market as in Figure 3 with a rational information network, in which market segmentation actions by manufacturers are taken into account. This market is a vertical market having such a special feature that the concept of dividing the ultimate consumer market among middlemen is introduced. (This concept can be regarded as market segmentation by middlemen.) As seen by calculating my basic model⁽⁶⁾, middlemen form a rhombus structure. On the other hand, in the case of a vertical market with information network as in Figure 3, middlemen form an isosceles structure. This difference is important because the latter is closer to the existing market structure.

Different from Y_{F1} in eq. (8), the number of links for the structure in Figure 3, Y_{F1} , is

$$Y_{F1} = m \times w_{i1} + n \quad (10)$$

Therefore fixed cost, F_1 , is

$$F_1 = (mw_{i1} + n)q. \quad (11)$$

On the other hand, the number of information units' exchanges between M and W_1 is

$$mS_M + mw_{i1} \quad (12)$$

and that between W_1 and N is

$$mS_M + n. \quad (13)$$

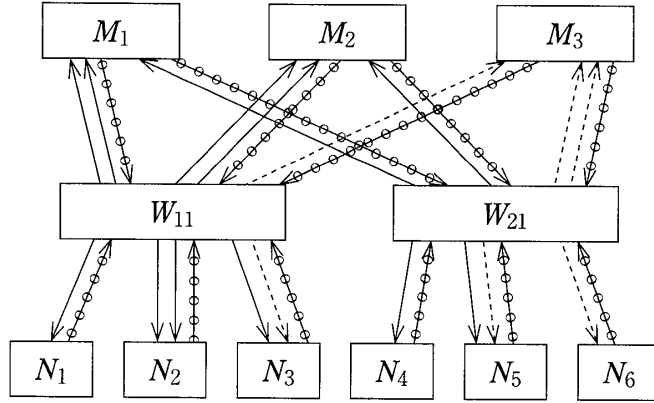
Therefore the number of information units exchanges, Y_{V1} , is

$$Y_{V1} = (mS_M + mw_{i1}) + (mS_M + n) = 2mS_M + mw_{i1} + n. \quad (14)$$

Therefore variable cost, V_1 , is

$$V_1 = (2mS_M + mw_{i1} + n)p. \quad (15)$$

(6) Nishimura. see eq. (5-23) or (5-24). 182-185.



($\circ-\circ-\circ-\circ-\circ$) indicates flows of information that middlemen receive from their business transaction partners.)

Figure 3 Number of Information Units Exchanges in a Rational Information Network under the M - W - N Market Structure

Hence the saved amount of communication cost achieved by switching an information network from the one in Figure 2 to the one in Figure 3, π_C , is obtained from eq. (6), eq. (7), eq. (11) and eq. (15) as follows:

$$\begin{aligned}\pi_C &= \{(m+n)qw_{i1} + (2mS_M + m+n)pw_{i1}\} - \{(mw_{i1}+n)q + (2mS_M + mw_{i1}+n)p\} \\ &= (nq + np + 2mS_M p)(w_{i1} - 1).\end{aligned}\quad (16)$$

In eq. (16), when $w_{i1} = 1$, π_C becomes zero, which means no cost is saved. So saving effect on communication cost is obtained when $w_{i1} \geq 2$. Therefore because of the saving effect obtained when $w_{i1} \geq 2$, the equilibrium number of middlemen would become greater than the number in Figure 2.

Let us calculate this equilibrium number of middlemen. (Investment cost is neglected.)

Because $TC_M - TC_{w1} = 0$,

$$\begin{aligned}0 &= (mS_M q + 2pmS_M) - \{(mw_{i1}+n)q + (2mS_M + mw_{i1}+n)p\} \\ \therefore w_{i1} &= \frac{mS_M q - (p+q)n}{m(p+q)} = \frac{q}{p+q}S_M - \frac{n}{m}.\end{aligned}\quad (17)$$

In order to make w_{i1} in eq. (17) greater, p and n should be smaller and S_M , q and m should be greater because of the condition that $p, q \geq 0$ and S_M , m and n are natural numbers⁽⁷⁾. And a condition for middlemen's existence is

$$mS_M - (p+q)n \geq m(p+q)$$

or

$$\frac{q}{p+q}S_M \geq \frac{n}{m} \text{ when } 0 \leq \frac{q}{p+q} \leq 1 \text{ and } \frac{n}{m} \geq 1. \quad (18)$$

The smallest m and n satisfying eq. (18) are

$$m = 2, n = 2$$

but only when $S_M = 2$ and $p = 0$.⁽⁸⁾ Hence when fixed cost p and variable cost q do

not vary according to structure of vertical markets and when $m < 2$ and $n < 2$, socio-economic cost of communication function is less in the $M-N$ market structure than in the $M-W_1-N$ market structure. That is, the former structure is more desirable. This is a point little different from the model by H.H. Baligh and L.E. Richartz (1964).

3. The Overlapped Transmission of the same information

Here we need to notice another irrational point of the communication model in which market segmentation is adopted. For example, when information is exchanged by sales persons in the $M-N$ market structure of Figure1, sales person⁷, M_1 , would be able to transmit the information of M_1 to N_1 and receive the information of N_1 by a single visit. Even when telephone calls are the means of information transmission, a single call would be enough, in general, for transmitting the information of a manufacturer to a consumer and collect information of the consumer.

In short, one link and one contact communication may be enough for several exchanges of information units shown in the previous model. If so, it may physically be possible to complete the communication function by the one link- one contact exchange. However, compared with the information exchange in one-way direction (that is, for example, a link is used only for transmitting a unit of information of M_1 to a customer and not for collecting information of the customer), time for transmitting information would become longer in the one link-one contact exchange because the ‘density’ of information exchanges becoming higher.

(7) This is proven as follows:

First, we assume $w = f(S_M, p, q, m, n)$.

Then, in order to increase

$$dw \frac{\partial f}{\partial S_M} dS_M + \frac{\partial f}{\partial p} dp + \frac{\partial f}{\partial q} dq + \frac{\alpha f}{\partial m} dm + \frac{\alpha f}{\partial n} dn,$$

dp and dn have to decrease and dS_M , dq and dm have to increase since

$$\frac{\partial f}{\partial S_M} = \frac{q}{p+q} (\geq 0)$$

$$\frac{\partial f}{\partial p} = -\frac{q}{(p+q)^2} S_M (\leq 0)$$

$$\frac{\partial f}{\partial q} = -\frac{p}{(p+q)^2} S_M (\leq 0)$$

$$\frac{\alpha f}{\partial m} = \frac{n}{m^2} (> 0)$$

$$\frac{\alpha f}{\partial n} = -\frac{1}{m} (> 0).$$

(8) If $p > 0$, eq. (18) would hold when $m = 2$, $n = 3$, $S_M = 2$ and $q \geq 0$. Therefore when $p \neq 0$, $m = 2$ and $n = 3$ are the minimums.

Therefore it is thinkable that link cost is higher in the one link-one contact information exchange than one link-two contacts exchange, in which information units are sent and received at different times. It is, however, reasonable to think that the one link-one contact exchange will heighten productivity more than the one link-two contacts exchange, in which a sales person goes out every time information units are needed to be exchanged and this eventually lowers the average cost per information unit.

The above point is also applicable to the $M-W_1-N$ market structure. In some cases in Figure 3 three overlapped contacts for the exchange of information units are observed. Therefore this is the problem that should be kept in mind. Again, in the $M-N$ market structure previously mentioned, the one link-two contacts exchanges were conducted. The number 'two' in this case indicates the number of information exchanges overlapped in a unit link, or the density of contact through communication in a unit link. We call this number the average overlapping ratio or the average density of information exchanges per a unit link (T). The product of T and the total of links in a market is the total exchanges of information units in the market structure⁽⁹⁾.

So, when the average overlapping ratio of communication in the $M-N$ market structure is T_{M-N} and that between M and W_1 and that between W_1 and N in the $M-W_1-N$ market structure are T_{M-W_1} and T_{W_1-N} , respectively, the total exchanges of information units for the two market structures are given as follows:

For the $M-N$ market structure, from eq. (5),

$$T_{M-N} \times mS_M = 2mS_M. \quad (19)$$

For the $M-W_1-N$ market structure, from eq. (14),

$$\begin{aligned} (T_{M-W_1} \times mw_{i1}) + (T_{W_1-N} \times n) &= 2mS_M + mw_{i1} + n \\ &= (mS_M + mw_{i1}) + (mS_M + n) \end{aligned} \quad (20)$$

Incidentally, when the product of the above T and p (set to be constant) is \bar{p} , \bar{p} is the average cost of communication actions per unit link regarding the part of variable cost. Then we can assume relationship between \bar{p} and T as in Figure 4. The \bar{p} curve shows that the average cost of a unit link does not increase proportionally when the overlapping ratio or the density of information units exchanges in a unit link increases.

Hence, \bar{p} can enjoy the economy of scale with information exchange density per link when the overlapping ratio or the density of information exchanges in a unit link increases.

(9) The overlapping rate, T , can be understood as the average unit contact (negotiation) time per link used for exchanging information with customers. Then, in this case, the product of T and the number of links is regarded as the total contact (negotiation) time of certain contacting structure of certain market structure. In other words, it is considered that the increase in the number of contact affects contact time in proportion.

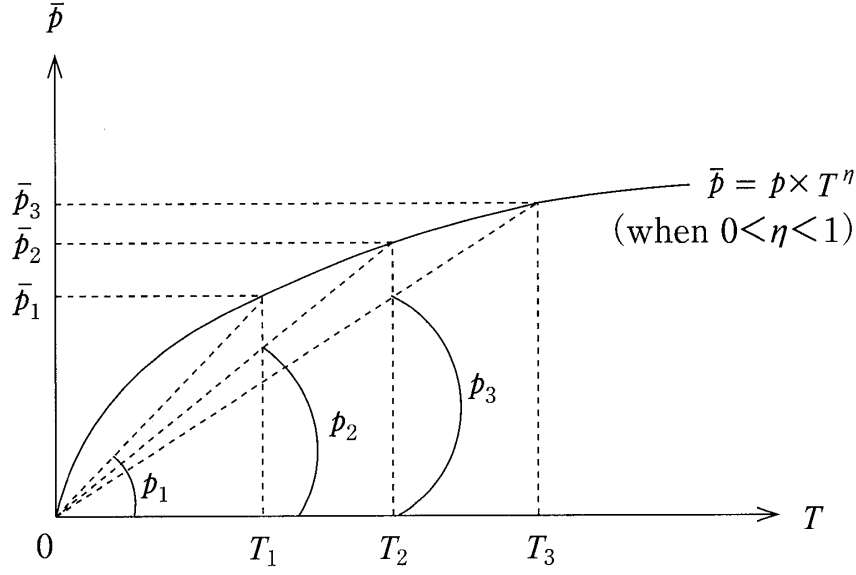


Figure 4 \bar{p} vs. T ($0 < \eta < 1$)

The above point is clear in Figure 4 because the average cost per information unit, \bar{p}/T , decreases as seen from $p_1 > p_2 > p_3$ when T increases. Here let us assume the following relationship:

$$\bar{p} = p \times T^\eta \quad (21)$$

Here η is a parameter for the elasticity of the cost function and η takes a range of $0 < \eta < 1$ when the economy of scale with information density per link works. For example, when η is $1/2$, by eq. (19),

$$T_{M-N} = \frac{2mS_M}{mS_M} = 2. \quad (22)$$

$$\text{Then } V_0 = p(T_{M-N})^\eta mS_M = p2^\eta mS_M. \quad (23)$$

Therefore V_0 in the $M-N$ market structure is

$$V_0 = p2^{1/2} mS_M \doteq 1.4pmS_M.$$

This indicates that the introduction of the overlapping concept lowers the average communication cost \bar{p} per link from $2p$ to $1.4p$. The case of $\eta = 1$ (see Figure 5) corresponds to V_0 in eq. (3). This could be understood easily from the equation below.

$$V_0 = p \times 2^1 mS_M = 2pmS_M. \quad (24)$$

On the other hand, in the $M-W_1-N$ market structure, the overlapping ratio between M and W_1 , which is T_{M-W_1} , and that between W_1 and N , T_{W_1-N} , are, by eq. (20),

$$T_{M-W_1} = \frac{mS_M + mw_{i1}}{mw_{i1}} = 1 + \frac{S_M}{w_{i1}} \quad (25)$$

$$T_{W_1-N} = \frac{mS_M + n}{n} = 1 + \frac{S_M}{n} \quad (26)$$

when $m > 0$, $n > 0$, $w_{i1} > 0$.

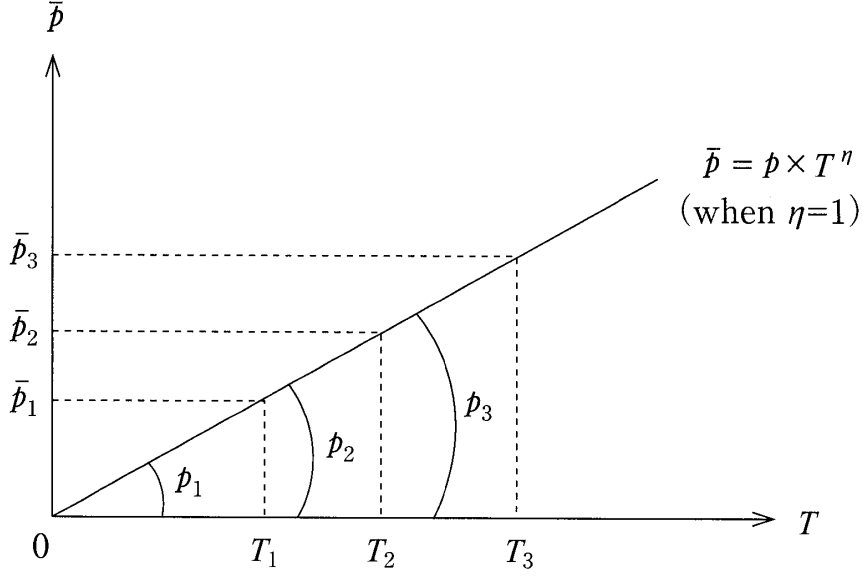


Figure 5 \bar{p} vs. T ($\eta = 1$)

Hence when the variable cost part between M and W_1 is called V_{M-W_1} and that between W_1 and N_1 is called V_{W_1-N} , the total variable cost part in the $M-W_1-N$ market structure, V_1 , is:

$$V_{M-W_1} = p \times (T_{M-W_1})^\eta \times mw_{i1} = p \times \left(1 + \frac{S_M}{w_{i1}}\right) \times mw_{i1} \quad (27)$$

$$V_{W_1-N} = p \times (T_{W_1-N})^\eta \times n = p \times \left(1 + \frac{mS_M}{n}\right) \times n. \quad (28)$$

Therefore,

$$\begin{aligned} V_1 &= V_{M-W_1} + V_{W_1-N} \\ &= p \left(1 + \frac{S_M}{w_{i1}}\right)^\eta mw_{i1} + p \left(1 + \frac{mS_M}{n}\right)^\eta n \\ &= p \left\{ \left(1 + \frac{S_M}{w_{i1}}\right)^\eta mw_{i1} + \left(1 + \frac{mS_M}{n}\right)^\eta n \right\} \end{aligned} \quad (29)$$

or

$$V_1 = p \{ mw_{i1} (T_{M-W_1})^\eta + n (T_{W_1-N})^\eta \}. \quad (30)$$

For example, in the case of Figure 3, $T_{M-W_1} = 2.5$ and $T_{W_1-N} = 2.5$ and when we assume the average cost per information link, \bar{p} , has the economy of scale with information density and $\eta = 1/2$,

$$\begin{aligned} V_1 &= p \{ mw_{i1} (2.5)^{1/2} + n (2.5)^{1/2} \} \\ &= 1.6p (mw_{i1} + n). \end{aligned}$$

The case of $\eta = 1$ (see Figure 5) in eq. (30) corresponds to eq. (15), in which the overlapping concept is not introduced yet.

Next, let us examine what relationship the overlapping ratio T of the $M-N$ market structure and that of the $M-W_1-N$ market structure have. Here we assume elasticity η for both cases are constant and $0 < \eta < 1$.

The overlapping ratio in the $M-N$ market structure, T_{M-N} , takes the constant value, which is 2, regardless of m , n and S_M . That is, this case shows two-way exchanges of information. In the $M-W_1-N$ market structure, on the other hand, when the average information exchanges (the number of links) per consumer of the $M-N$ market structure is called T_{M-N}^n ,

$$T_{M-N}^n = \frac{mS_M}{n} \times 2. \quad (31)$$

And the larger the value of T_{M-N}^n is, the larger the value of T_{W_1-N} is. This can be said because T_{W_1-N} is, by eq. (26),

$$T_{W_1-M} = 1 + \frac{mS_M}{n} = 1 + \frac{T_{M-N}^n}{2}. \quad (32)$$

Furthermore eq. (31) can be rewritten as below:

$$\frac{mS_M}{n} \times 2 = \frac{S_M}{n} \times m \times 2. \quad (33)$$

Then we can make the following statement. That is, since S_M/n indicates the market segmentation ratio, the larger the number of people in a market under segmentation. In other words, the more a market is treated as a single one, (in the case that S_M is large and S_M/n approaches one), the larger the value of T_{W_1-N} . Or, when the market segmentation ratio is constant, the larger the number of manufacturers, m , the larger T_{W_1-N} and the market would enjoy the economy of scale.

Next, let us think about T_{M-W_1} . From eq. (25)

$$\begin{aligned} T_{M-W_1} &= 1 + \frac{S_M}{w_{i1}}. \\ &= 1 + \frac{S_M \times n}{w_{i1} \times n} = 1 + \frac{S_M}{n} \times \frac{n}{w_{i1}}. \end{aligned} \quad (34)$$

Then since in this equation S_M/n also indicates the market segmentation ratio, the larger the market segmentation ratio in the $M-N$ market structure, the larger the value of T_{M-W_1} . Or the more consumers a middleman covers, i.e. the larger n/w_{i1} , the larger the value of T_{M-W_1} and the market can enjoy the economy of scale.

By summarizing the above discussion we can get the socio-economic total cost of communications for the $M-N$ market structure, TC_M , and that for the $M-W_1-N$ market structure, TC_{W_1} , as follows:

$$TC_M = mS_M q + 2^\eta p m S_M = mS_M (q + 2^\eta p) \quad (35)$$

$$TC_{w1} = (mw_{i1} + n)q + p \left\{ mw_{i1} \left(1 + \frac{S_M}{w_{i1}} \right)^\eta + n \left(1 + \frac{mS_M}{n} \right)^\eta \right\}. \quad (36)$$

Here investment cost is neglected for both cases and $0 < \eta < 1$. If we wanted the value of w_{i1} , it could be obtained by setting $TC_M + TC_{w1} = 0$, which is the cooperative condition of my basic model [Nishimura. 1996: 174]. Needless to say, when $\eta = 1$ is allowed, w_{i1} corresponds to the value in eq. (17).

4. Conclusion

Hypotheses for the developed model of the communication function are listed below. Theoretical hypothesis number (1) to (7) was discussed in the process of the model construction or was derived from the developed model itself.

(1) If we assumed a rational communication network, the equilibrium number of middlemen and the equilibrium number of middleman levels form the structure of an isosceles, which is close to reality.

(2) Unless both manufacturers and ultimate consumers were more than two, respectively, the entry of the equilibrium number of middlemen would not occur. In other words, if the number of both levels were less than two, the $M-N$ market structure would lower total social cost of communication more than the $M-W_1-N$ market structure.

(3) If an information network is rational without any overlapping, the equilibrium number of middlemen and of levels in middleman would increase because middlemen's cost of information activities would be saved.

(4) In the $M-N$ market structure more information exchanges per consumer give middlemen more incentives of entry. Therefore the more information exchanges per consumer, the larger the equilibrium number of middlemen and levels in middleman.

(5) The more ultimate consumers in a market segmented by each manufacturer, the more equilibrium number of middlemen enter the market.

(6) The more manufacturers, the larger the equilibrium number of middlemen and levels in middleman.

(7) The more ultimate consumers per middleman, the more the equilibrium number of levels in middleman.

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〔抄 録〕

流通の構造解析モデルの研究 垂直的市場におけるコミュニケーションネットワークの合理的修正とコスト

西 村 文 孝

本研究は、流通の構造解析をするためのモデルの構築及びそのモデルにより生み出される重要な仮説の導出を目的とする。具体的には、先ず市場細分化の下で、合理的なコミュニケーション・ネットワークの仮定とその修正、次いでコミュニケーション活動での情報交換における情報の交換密度概念の変数の導入、さらにその費用構造の変数などの導入により、より現実に近い解析モデルを構築し、そのモデルから有用な仮説を導出することである。

キーワード:

コミュニケーション・コスト, 理論モデル, 固定費, 変動費, 情報, 垂直的市場, リンクコスト, 市場細分化, 情報ネットワーク, 情報重複率