R & D BEHAVIOR AND MARKET ENTRY OF THE INFORMATION VENTURE BUSINESS

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I Introduction

"Technological development enlarges the production scale" is an established theory of economics, and it has been sustained by many scholars such as Marx and Galbraith (1967).

About the role of technological innovation within the economic development processes, J. Schumpeter (1950) denoted that the age of innovative, and private entrepreneurship would be superseded by big business through dynamic evolution of economy with "the scrap and build," and that systematized research and development became the main culture medium for technological innovation.

As he put it, speaking of the sources of economic progress in a capitalistic society: "As soon as we go into the details and inquire into the individual items in which progress was most conspicuous, the trial leads not to the doors of those firms that work under conditions of comparatively free competition but precisely to the doors of the large concerns." (Ibid., p. 82) And such remarks became a ground of oligopoly bulwarks. Concerning the relationship of industrial concentration and R & D activities, the verification of the Schumpeter-Hypothesis is made by many scholars such as J.S. Worley (1961), D. Hamberg (1964), F.M. Scherer (1965), E. Mansfield (1968), A.C. Cooper (1964), and K. Imai (1969), M. Uekusa (1973), A. Goto (1974), N. Doi (1977, 1978), E. Hatta (1978) *et al.*

Most of these researchers either depend on algebraic methods aiming to find parameters of regression co-efficients between the firm size or industrial concentration and level-score of R & D (such as Expenditure for R & D, Number of Technologists, Capital value of R & D) or R & D

results (such as Number of Patents, etc.) as independent variables; or they depend on statistical methods to find correlation co-efficients of each other as well. However, as Markham (1965) and Goto (1974) assert, the concept of Schumpeter is very inclusive; he defined the concept of innovations broadly enough to include, among others, mergers, new organization, new advertising campaign, new product, the new process. Only the last two are logical consequences of technical research and development activities conducted inside a business firm. What Schumpeter really meant was that uncommitted balances were a prerequisite to engaging in highly uncertain commercial activities. In the context of his basic thesis he left no room for doubt that he regarded a "large firm" as synonymous with a "large firm with market power."

Therefore, whether the verification methods of technological innovation are suitable or not, they yield the irreparable gap between the total figure of Schumpeter's concept and its verifiers' results. Hence, multi-dimensional verification is essential.[1]

II Multi-dimensionality of condition existing in the analysis of the correlation between the innovative capacity and firm size

Technological development is achieved through the process of "technological innovation" which is introduced into real production processes by investment. For that purpose, new capital equipment is necessary to be embodied by invention. On the other hand, in the case of productivity improvement which is caused by administrative control on management or product processes such as factory innovation, no new capital goods are necessary except for equipment. The improvement of labor productivity through process innovation is an important factor for strengthening the production function. Thus, if we intend to verify the effectiveness of corporate activities by means of the former criteria, the hypothesis that small business may be more effective than big businesses because of the Penrose Constraint can be verified.

On the other hand, we ought to pay attention to the case where the big business is much more efficient than small businesses, in accordance with labor-saving effect (by the newly equipped automatic factories).

And if we choose the process innovation effect as the main innovative factor, on account of sufficiency of R & D expenses and moreover high risk-adaptability for merchandising, we must make sure whether or not the big business may be better off than small businesses.[2]

Secondly, owing to the difference in the industrial structures, merits or demerits may occur between the process industry and knock-down industry. Especially in regard to the productive innovation, big businesses are obviously advantageous in the economies of scale than small or middle sized firms in respect of process industry. This is true even if neither of these structures shows the relational difference level of significance with each other in the case of big businesses.

Thirdly, if we define the innovation level with the phase of 'quality' in view (let the level of quality be the function of universality or generality, — this is the concept corresponding to the level of the 'basic' research of R & D), big businesses will be in a more advantageous position in respect to the risk-allowance.[3]

Analytical results can differ, on the one hand, by the selection of dependent variables such as managerial scale or business-concentration, etc.; namely, such factors as productive elements (the number of employees, plottage, floorage) or managerial indices (profit, value added rate, etc.), and so on (Robinson and Clark 1940; Crum 1939).

Human factors, such as those of researchers or developers should never be ignored. R & D of semi-conductors which originate in transistors is now in full mature period, but when in the exploitation period, a responsible main researcher of M Electric Co. resigned, as a result of friction in the system, serious damage was done to research staff and much precious time was wasted before they recovered the usual attainment level, and we also know about the case of S Industry where the president did not understand the feelings of inventors and failed to prevent the stagnation of the system. As is seen from these cases, human factors are to be counted among the long range questions of system control.

Research by Kenkyu-Kaihatsu Kiko[4] (The Organization of Research & Development) which raised research level so highly as to produce the "System incentive analyses," created a stir on an achievement concerning

R & D.

With regard to newly applicable factors:

(1) As for unquantifiable factors, apply strict psychological scales (Multi-dimensional scales such as 'Method of successive categories', etc.) and verify validity.

(2) By adding the so-called 'Hypothetical Scale' test, evaluate technological ability of the technologists in the same area of the rival firms, vis-à-vis.

(3) Verify 'Reliability' through a second research.

(4) Carry out "Multi-dimensional analyses," by taking business scale indices as dependent variables and integrate both quantifiable and unquantifiable data.

(5) As is mentioned in the research comments, first analyze the side of financial conditions and the number of patent-acquisition, and then on the basis of these results, make research into the consciousness of managers for R & D.

(6) Finally, remember that one of the important problems of R & D is a cross connection of human incentive factors with business environmental factors.

According to the social research done by Institute of Economics of the Kikai Shinko Kai (1981), the characteristics of "job attainment incentive" of firms with capital stock of over ten-billion yen is referred to as "National project-oriented" feature. But, in the case of firms of 100 million to 9.9 billion yen (capital stock), the incentive is oriented to "Patent numbers." In the case of businesses of less than 100 million yen, "Favorable-dealings" by administration are the main incentive to job attainment.

We expect the verification of these results to be made again, because these factors are important and effective in connection with the intensity of influence over research-productivity of research professionals.

III The character of information venture business and particularity of "information" as the economic goods

Because enough has been said for the moment concerning the prob-

lems of firm size vs. R & D, we will develop an analysis of the character of "Information-Industry," especially of the scarcity of information such as that of economic goods. Information industry has now been highlighted as one of the star industries with the knowhow-intensive tendency and high value added inclination of industry structure.

It has commonly been held that information is capable of duplicating and for that reason sources cannot be expunged; in addition, aside from costs of duplication and transfer, users can increase in number infinitely without much cost. Namely, in accordance with the quality of public goods, marginal social cost has been considered to come to zero. But when we define many information industries with this quality in view, we cannot but recognize the fact that they range from "nearly-public-goods" producing industries to the industries which are defined by Y. Noguchi (1974), "By suitable legal protection, their right of 'Exclusivity' (from Imitating) must be held systematically, . . ."

Now, we shall need to get hold of the character of information as 'Economic Goods.' As is shown in many cases where information is privately owned and also has an 'Exclusivity,' actually the Information does not necessarily become the public goods. At the same time, "Irreversibility" in the dealings has never been paid attention to as to its character. Once leaked out, information instantly becomes worthless, and can never be "compensated." In addition, strong external effects often occur. "The utility of certain information for some particular individual is influenced not only by the amount of [information] holdings of his own, but by that of others." (Noguchi; 1974, p. 46). Usually, certain systematized information has, as a whole, the definite value, and if cut apart it results in a merely worthless matter (Indivisibility of Information).

Especially in the case of "Software," this possibility may be very high. In addition to the above character, the "uncertainty" pertaining to the production and consumption of "Information goods," cannot help accelerate the tendency to keep secret the contents of information. The stronger the tendency of business to handle the "Intelligence" or know-how strategically, the higher the possibility to consume them only

within its own groups. We must never disregard the function of information as a trigger for strengthening systematization of industries.

In retrospect, if it were not for diffusion of computer, no progress of information industry could be made. Now, Japan ranks second to US in the computer holdings, and even during the post oil-deficit crisis, growth rate of gross sales had been higher than 20% per year.

In the mid 1970s, software industry which was capable of developing computer programs or software appeared on stage in Japan. Many of these managers were technologists who had formerly been computer makers and entrepreneurship was still kept vividly alive. The originators of new ideas on software development were usually the managers or members of the board of directors, so, they had high risk-adaptability to an unexpected situation. On winning the victory over rival businesses through producing and selling the "Intelligence" (Software), the venture enterprise must yield more than one high quality 'Software' which is superior to that of other businesses.

The share of sales concerning software development and programming within the total sales, however, is less than nearly 40% and the venture enterprises can just tide over difficulty because of the share of above 30% by charging for accounting or by visiting job as software programmer.[5]

Moreover, the greater part of the software which is developed by these software industries is of "Application softs," and the venture enterprises have not yet been able to cope with major hardware firms (Main-framers) in the area of "Basic softs." Not to mention the shortage of funds, the main reason lies (still) in the lower estimation of software quality than that of America's, and "Un-bundling" (the software whose price is separated is sold distinctly from hardware price; in America, IBM did away with 'bundling' practices in 1970,) has not yet been prevalent in Japan, so software is still treated as goods of 'free of charge.' From now on, in proportion to the diffusion of office computer and routinization of distributed-processing, the development of various "End-user oriented" application software can be prepared. And the growth in the area of data-base will be expected through the diffusion of big capacitive com-

puter and also extension of communication networks.[6]

IV The scheme of market entry of venture business

The market where venture business intends to penetrate is supposed to be the kind of market with imperfect competition where numerous firms sell (or serve) substitution goods "software," and systematization of firms gradually permeates throughout the market. "Softwares," which are evidently different goods from each other with different properties,

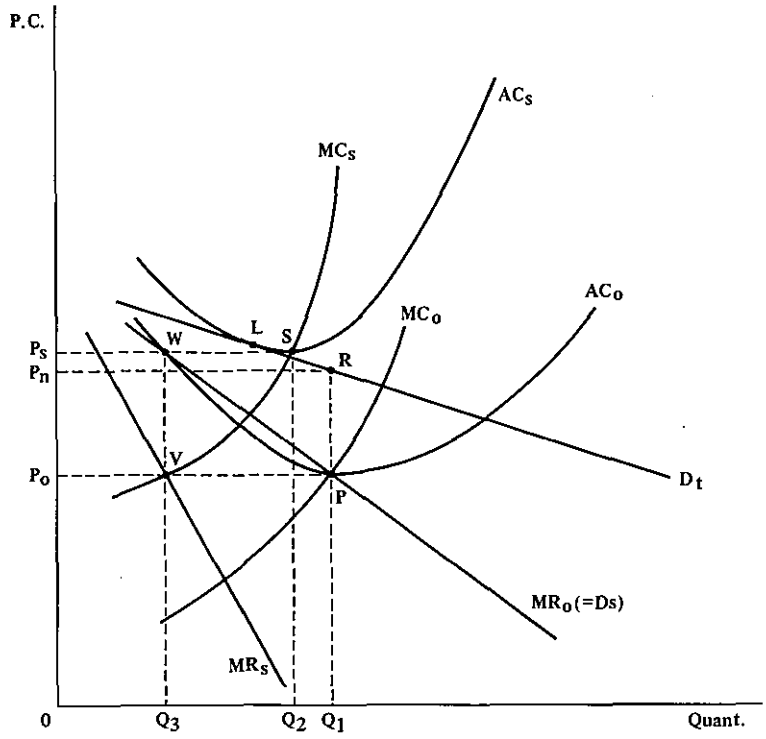

Figure 1

may monopolize a portion of the market, and substitution goods possibly appear a short time later. Then, these suppliers are usually in a competitive position with each other.

Let the short-range average cost curve of venture business be AC_S, marginal cost curve be MC_S, and these curves of big businesses be AC_O and MC_O respectively. The primary fixed costs of newly entering firms (computer-rentals, loan interests, etc.) are obviously higher than those of the established industries.

Though the average price must be set at P_S, the price under the cutting off price P_O must be held until venture business achieves the market fame.

Then, with all its excellent productive capacity greater than Q_3, venture business has to put up with increasing deficits $\overline{P_O,V,W,P_S}$ (square measure), though it has been accumulating "High-grade knowhow productive abilities" within the enterprise. At this stage, entering venture business has to guard against any possibility of being affiliated with big businesses.

By the way, simple geometry may be incapable of handling the concept of an industry which produces a "multi-dimensional differentiated product."

Simple algebra and calculus contain no such limitation. We start with the case where all product differences are composed of variety and "intelligence-grade" which sometimes determine the way of managerial strategy.

For notation:

- X = outputs consist of various software-services or by charging for accounting, etc. X = sum of 'x_i'
- S = 'creative efforts' (R & D expenditures) expended to differentiate X, especially about software creation. S = sum of 's_i'. $S > 0$.
- u = minimum unit cost of producing X
- v = minimum unit cost at which S can be created in a high-grade software programming division
- Z = profit

$C \fallingdotseq uX + vS$ = total cost; the degree of product differentiation; $t^* = \frac{vS}{uX}$

$R = (M - X) \cdot X$ = total revenue

where $M = A + BS - S^2$; A and B are constants

Hence,

$$R = AX + BSX - S^2X - X^2$$

We assume that both the curve of unit cost of usual software-services and the curve of unit cost of differentiating the product are U-shaped.

Total revenue R can be increased by using resources (high-grade software producing ability) to differentiate the output of the basic product variety X or any part of it. But, since $\partial^2 R/\partial S^2 < 0$, the creation of high-grade product variety is subject to diminishing returns. The assumption, that the demand curve for the product can be shifted upward, albeit at a decreasing rate as sales effort is increased or quality improved, has characterized almost all discussions of monopolistic competition. A linear demand curve of the basic product (usual software services) is employed for the sole purpose of simplifying the notation.

By our assumptions, $\partial^2 R/\partial X^2 < 0$, $\partial^2 R/\partial S^2 < 0$ and there is a fixed cost; hence, stay-out pricing is possible for big businesses. Namely, there is a profit Z ($Z > 0$) for such firms that are low enough to discourage the entry of newly entering firms.

Equilibrium in the industry is achieved when it minimizes

$$C = uX + vS \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

subject to the constraint

$$AX + BSX - S^2X - X^2 - uX - vS - Z = 0 \quad \ldots\ldots \quad (2)$$

This operation is equivalent to maximizing R, subject to the constraint that;–

$$R - C - Z = 0$$

By the method of undetermined multipliers we obtain from equations (1) and (2)

$$u + \lambda (A + BS - S^2 - 2X - u) = 0$$
$$v + \lambda (BX - 2SX - v) = 0 \quad \cdots\cdots\cdots (3)$$

Thus

$$X = \frac{v(A + BS - S^2)}{(uB - 2uS + 2v)} \quad \cdots\cdots\cdots\cdots\cdots\cdots (4)$$

and

$$t^* = \frac{S(uB - 2uS + 2v)}{u(A + BS - S^2)} \quad \cdots\cdots\cdots\cdots\cdots\cdots (5)$$

If $\frac{dS}{dX} > 0$, $\frac{dX}{dS}$ must be positive, *vice versa*

Thus

$$\frac{dX}{dS} = \frac{2uvS^2 - 2(Bu + 2v)vS + v(2Au + uB^2 + 2Bv)}{(uB - 2uS + 2v)^2} \quad \cdots\cdots (6)$$

In equation (6), the denominator is always positive. When the numerator in equation (6) is zero, $dX/dS = 0$. We can set this numerator equal to zero, solve it as a quadratic in S, and discard the negative root of (7).

$$S = (\frac{B}{2} + \frac{v}{u}) \pm (4v^2 - 4Au^2 + B^2u^2)^{1/2} \quad \cdots\cdots (7)$$

The expression in the root is not negative, because S is not expressed by a complex number. While $u > 0, v > 0$.

$$(\frac{B}{2} + \frac{v}{u}) \lesseqgtr 0 \text{ (7)}$$

Let B be negative, and if $|B| > \frac{2v}{u}$, the equation is negative. The production in the neighborhood of the maximum point is determined by the dX/dS tendency. And as is stated in "The Theory of Imperfect Competi-

tion" by D. Dewey (1969), "I believe it not unreasonable to assume that the primary net impact of these efforts is on the location rather than on the shape of the average revenue curve."

It will be better to seek equilibrium values of X and S in terms of the coefficients in equation (2) by substituting the right side of equation (4) for X in equation (2) and then solving for S. Yet, unfortunately, this substitution yields an equation with a term that contains S^5, and a quintic equation has no general algebraic solution. But of course, when numerical values are assigned to A, B, Z, u, and v in equation (2), the equilibrium numerical values for X and S can be found by several methods.

Information venture business is a sort of production goods industry rather than consumption goods producing industry, so that the expansion of demands is not to be made by advertising or sales promotions but by high quality "Intelligence" itself. Therefore, information venture business has to have the ability to cope with the needs of clients for refinement on its quality product.

The Figure 2 shows a hypothesis of 'location (impact of effort)' and inflexion-quality of marginal revenue curve MR_S of information venture business. Here, we are to suppose the prime-to-mid range developing period when the venture business may guard against the price policy of established big businesses, and its free competitive pricing will be possible solely through the "Capacity to produce high-quality intelligence."[8]

Let the quantity of supply (Q) of the axis of abscissa increase with the lapse of time, MR_O be the marginal revenue curve of established big businesses and $\overline{DD}$ curve be the gross demand curve of the market, and also let MR_S be the marginal revenue curve of the entering venture business into the market.

As is found in most modern textbooks and treatises on economic theory, the geometry of tangency solution by Robinson and Chamberlin, shows a firm producing an output where a falling curve of unit cost is tangent to the firm's demand curve and a rising marginal cost curve intersects a falling marginal revenue curve. But there is, usually, no specific instruction given for constructing the demand curve of the imperfect

competitor. A very great number of assumptions about the behavior of each rival is possible. Their real-world behavior always involves a certain amount of learning by doing nature, so, it cannot be completely described.

In this situation, if the firm is presumed to have perfect knowledge of the demand for the industry's product, it will regard the residual portion of the industry demand curve as its own. If the firm is presumed not to have this perfect knowledge, then its own demand curve becomes

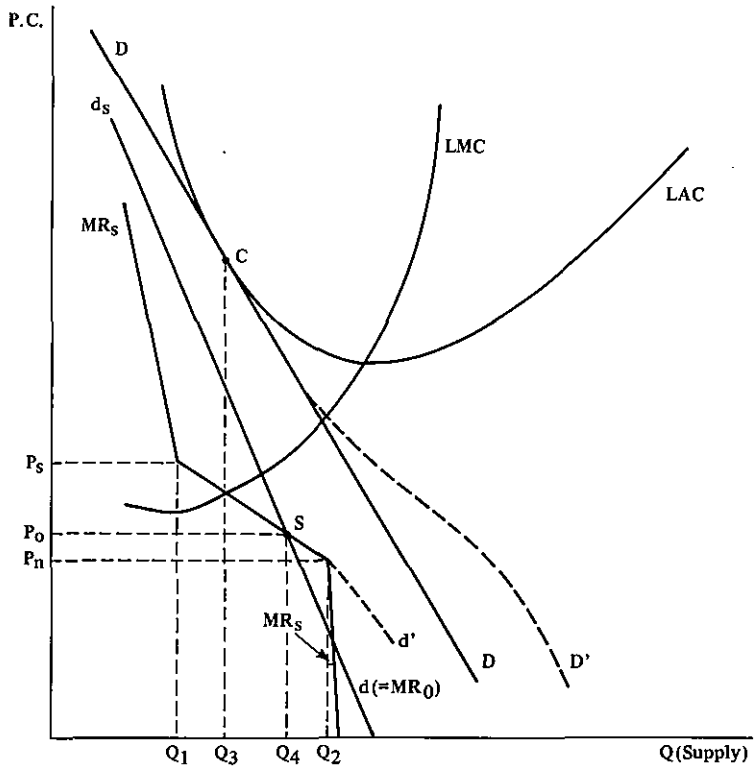

Figure 2 Long range monopolized competitive equilibrium, after the entry of information venture business

an entrepreneurial guess which needs no strict relation to the residual portion of the industry's demand curve. Then, we may say that there is no such thing as tangency solution in the imperfect competitive market.

Innumerable possibilities exist because each assumption about how rival firms react to one another's strategies dictates a different tangency solution. Among many points (Q_1 to Q_r), Q_r is an optimal tangency solution in the 'textbook' and at the primary period of entry of venture business, fixed cost and variable costs are higher than those of established big businesses. Thus, marginal revenue MR_S is still low till Q_3 in which first motive possibly occur in venture business which is absorbed into the affiliated big businesses. While the excellence of software is being estimated in the market, degrees of angle 'theta' of MR_S curve tend upwards and attain the turning point (S) where venture business gains higher profits (MR_S) than MR_O of big firms. Some of the small-sized firms which were not able to improve their marginal profit until Q_2 period, leads to bankruptcy or withdraws from market, or else, may be absorbed into the big firm groups. The intersection point 'S' of marginal revenue curves MR_O and MR_S show a "turning point." In line with the condition of "absolute secrecy" in the nature of information, if venture business continues to deal only in "Software-intelligence service" requested by few restricted clients, social demands will soon cease to expand. Therefore, it ought to shift the former policy into the new stage where selling the "Excluded" information services (goods) is protected by program licences, etc. In this stage, the necessary condition is corporate-identity corresponding to the development of high-quality software, and it is a highly desirable requisite for information venture business just now, because the "Exclusivity" of information intelligence cannot yet be perfectly ensured.

V Consideration

Some problems of the above hypothesis exist in the logical basis pertaining to how to determine a demand curve $\overline{dd}$ which is confronted by venture business. Namely, is it possible to suppose the right-side declining individual demand curve à priori? How are we to determine the in-

dividual demand curve correlating with the closely related substitution goods as "software services," their prices, and business behaviors, etc.? Its determinant factors have not necessarily been clarified yet. They are the environmental factors fluctuating in accordance with conditional fluctuation of market. Then, they must be observed in the stage of individual research cases.

And if the expansion of needs (a sort of high quality software or information) takes place and raises external economy, $\overline{DD}$ curve has a possibility of shifting upwards to $\overline{DD}'$ (1969). Unlike ordinary consumer goods with elasticity of substitution in output, because of the nature of "Information" goods, especially with the changing character of business behavior which takes into account the secrecy in the nature of software intelligence, systematization tendency turns the tide of the industry, and we have to deal with this problem within the frame of oligopoly.

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Notes

(1) Criticism of Schumpeter's views on capitalism is in R.L. Heilbroner (1981).

(2) According to the research by Mansfield, where the central-institute of big business was examined, R & D risk is not so high and the deficit is limited within 25%. Also, Baumol-Williamson Model is suitable for inference.

(3) About the 'quality' problems of R & D, see, W. D. Nordhaus (1969).

(4) This research (1978) was intended to estimate the importance-level of 57 human factors (selected through preliminary search process), which are supposed to have an influence on researcher's will or productivity. For example, 30 higher ranking factors are as follows;

Influential Factors evaluated by researchers

1. Researcher's interest in the job
2. Researcher's ability
3. Sufficiency of equipment and establishment
4. Leadership by the superior officer
5. Researcher's potential talent
6. Exhausted atmosphere with regard to energy and resources
7. Research circumstance of rival firms
8. Personality of researchers
9. Evaluation of research theme in the firm
10. The amount of research funds
11. Sufficiency of physical service for research activity
12. Understanding of management about R&D
13. Interest in the job of the superior officer (of direct control)
14. Allocation and transfer of researchers
15. Treatment of researchers
16. Alteration or discontinuation of research themes
17. Determination of research themes
18. Atmosphere of R&D department
19. Ordinary working behavior of the superior officer (of direct control)
20. Sufficiency of manpower-service for research
21. Human relation within the research team or in the laboratory
22. Researchers' good relationship with each other in academic learning and job
23. Human relation with the superior officer
24. Ability of the superior officer
25. Internal position of R&D department
26. Allowance of discretional use about research expenses
27. Criterion and ability-estimation of researchers
28. Sufficiency of information service on research
29. Personality of the superior officer
30. Organization of R&D department

(5) See MITI: "The Survey of Special Designated Service-Business."

(6) Since IBM carried out the Unbundling in America, ADR (Applied Data Research), Cincom Systems, Informatics and such software firms have developed many original basic softwares (TOTAL, Librarian, etc.), achieved differentiation from Main-framers and then enjoyed splendid growth. The softwares for "Data-communication" are now increasing. See, for example, Saito (1983), Kikai Shinko Kai (1981).

(7) The difference may be not so great.

(8) G. Stigler verified by his demonstrative analysis of price leadership,

that the increase in the number of firms in one market enhances the elasticity of prices. [G. Stigler; "The Kinky Oligopoly Demand Curve and Rigid Prices," *Journal of Political Economy* (Oct. 1947).]

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情報産業ベンチャービジネスの研究開発行動と市場参入

〈要　約〉

町田忠治

情報産業は産業構造の知識集約化，高付加価値化の潮流を代表する先端産業の一角にあって脚光を浴びてきたが，広くは新聞，放送，出版，広告，そして情報処理，シンクタンクなど，情報収集・加工・提供にかかわる産業の総称である。

これら産業に共通する商品，「財」としての「情報」は，当然，特殊経済財としての制約を受ける。すなわち，公共財としての性質の他に排他性，不可逆性，秘匿性，不確実性，不分割性等々の性質にかかわる制約である。

問題を「インテリジェンス」としての情報に絞るとき，一つの「情報」の完全な代替財と呼ばれるべき情報は稀少であり，これが独占価値を形成する素因である。

従って，仮にベンチャービジネスが情報産業の独占的市場に参入し，橋頭堡を築くことが可能であるときは，既成大企業の未だ開発していないオリジナル情報システム・プログラムを開発し，排他的ノウハウとするか，日本に於ては未だ脆弱な保護能力に止まっているが，プログラム・ライセンスを取ってこれを守る以外にはない。

情報産業ベンチャービジネスの発展期に於て危険な時期は創成期ではなく，むしろ限られたクライアントを対象にSoftware-intelligenceサービスを細々と行なっていた時期から，クライアントを拡張してゆく過程で，プログラム・ライセンスを公表し，「情報の排他性」を犠牲にして「不

確実性」に挑戦する時である。

その時，市場はオリジナル情報システムの次元(ベース)では，独占下の制約的供給のステージから不完全競争のステージに移行する。広告や販売促進手段を持たない情報産業の場合，情報の「排他性」が不完全な保護下に於て，他と劃するものは，システム・プログラムの独自性であり，次いで汎用性でなければならない。

高度なシステム・プログラムがCIと結びつく時が企業を磐石にする機会である。