Pergamon

Technovation 22 (2002) 607–614

technovation

www.elsevier.com/locate/technovation

# Alliance strategy as a competitive strategy for successively creative new product development: the proof of the co-evolution of creativity and efficiency in the Japanese pharmaceutical industry

Makoto Takayama [a, b,*], Chihiro Watanabe [a], Charla Griffy-Brown [c]

[a] *Tokyo Institute of Technology, Department of Industrial Engineering and Management, 2-12-1 Ookayama, Meguro-ku, Tokyo 152 8552, Japan*
[b] *Yamanouchi Pharmaceutical Co. Ltd, Nihonbashi-Honcho 2-3-11, Chuo-ku, Tokyo 103-8411, Japan*
[c] *Pepperdine University, USA*

**Abstract**

Aimed at analyzing the continuity of core competence in a core field, the behavior of 11 Japanese pharmaceutical firms over the last two decades was analyzed. This study demonstrates that firms could maintain originality as a core competence in ongoing new product development (NPD) by utilizing a licensed alliance product as a tool for maintaining or injecting this originality. This finding was demonstrated by a comparative study of the core fields of each firm in the Japanese pharmaceutical industry. © 2002 Elsevier Science Ltd. All rights reserved.

*Keywords:* Alliance; Co-evolution of creativity and efficiency; Pharmaceutical competitive strategy; Core field

## 1. Introduction

The significance of enforcing core competence for creativity in new product development (NPD), while hedging against the risk of dynamic changes in customers' preference, has emerged as a key strategic consideration (Hamel and Prahalad, 1994a,b; Hamel, 2000). For continual growth, creative and original NPD is essential for the following reasons:

1. For ongoing economical growth, ongoing original NPDs are essential from the point of the continuity of the existing R&D core competence (Lester, 1998; Porter, 1998; Porter and Takeuchi, 2000).
2. For adapting R&D activities to rapid market changes by technological innovation and novel technologies, the importance of core competence for creative NPDs became seriously has been a consideration from the viewpoint of creative destruction (Schumpeter, 1935).

Creativity is of essence for original NPD for all industries. However, the process of successive or cumulative NPD is different between material-based industries and assembly-based industries. For material industries, creativity in original NPD is recognized as a critical component of core competence (Cockburn and Henderson, 1994). Thus, creative and original NPD is indispensable for material industries which inevitably stimulates high R&D intensity. Among material industries, an externally high level of creativity is the core particularly for the pharmaceutical industry. Thus, the pharmaceutical industry is compelled to maintain an extremely high level of R&D intensity level as illustrated in Fig. 1.

While ongoing and continuous R&D investment is indispensable for the pharmaceutical industry to maintain a high level of R&D intensity thereby enhancing its core competence, firms must also secure a risk hedge against unexpected dynamic changes in customer preference. These dual contradictory requirements compel the pharmaceutical industry to depend more on alliance strategies than other industries. This paper focuses on the role of these alliance strategies in the pharmaceutical industry in order to satisfy the dual and contradictory requirements of continuity and yet flexible and extreme changes in NPD.

Notwithstanding a number of studies on the significance and the role of creativity in NPD, the key factors

* Corresponding author. Tel.: +81-3-3244-3247; fax: +81-3-5203-7164.
*E-mail address:* takayama@yamanouchi.co.jp (M. Takayama).

0166-4972/02/$ - see front matter © 2002 Elsevier Science Ltd. All rights reserved.
PII: S0166-4972(01)00062-1

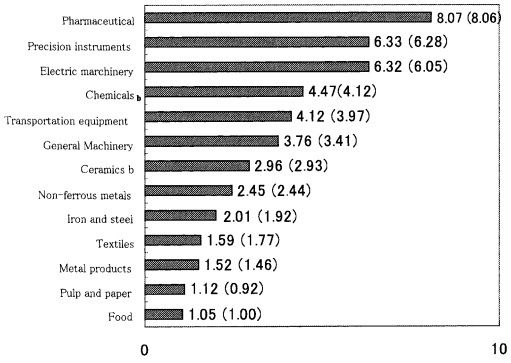


Fig. 1. R&D intensity in the Japanese Manufacturing Industry in 1998. R&D expenditure per sales (%). [a]Figures in parentheses indicate R&D intensity in 1997. [b]Not include pharmaceutical. [c]Average R&D intensity for whole manufacturing industry is 3.89% in 1998 (3.67 in 1997). [d]Sources: report on the Survey of Research and Development.

for ongoing and cumulative creativity in NPD has not yet been analyzed. Although the Japanese economic decline and the rise of American economical growth are often explained by fundamental differences in creative abilities and competitive structure (Lester, 1998; Porter, 1998; Porter and Takeuchi, 2000), these assertions still remain non-practical philosophical postulates.

According to traditional knowledge creation theory, creative NPD is mainly focused on the assembly industry (for reviews, see Nonaka, 1991; Nonaka and Takeuchi, 1995; Von Krogh et al., 2000). Successive NPD is successfully performed by knowledge creation as a source of value (Von Krogh et al., 2000).

Contrary to this performance in the assembly industry, NPD in the material industry is performed not only by knowledge creation but also by the creation of discontinuous new products, or products outside the usual range. However, discontinuous NPD often obstructs business practice because of the high-risk and sometimes limited returns (Pfeffer and Sutton, 2000). In view of the process of NPD, NPD is made by a problem-solving process in the assembly industries (Allen, 1966; Clerk and Fujimoto, 1991). NPD in the assemble industries is characterized by a method or product platform, often represented by concurrent engineering system (Ohno, 1988; Clerk and Fujimoto, 1991; Fujimoto, 1993).

From the viewpoint of discontinuous NPD, the pharmaceutical industry is a typical industry in the material industries subset. However, the pharmaceutical industry has to maintain continuity for NPD (Pisano, 1997) because of the long duration of development period and the huge expense for NPD (Takayama and Watanabe, 2001). Accordingly, two contradictory factors are essential for NPD in the pharmaceutical industry (Henderson and Cockburn, 1994; Henderson et al., 1994; Pisano, 1997). Notwithstanding the above discussions, it has not yet proven whether there is a key strategy for creativity in the co-evolution of contradictory aspects as discontinuous and cumulative (ongoing) NPD.

This paper starts by defining these two contradictory aspects of creativity in NPD. According to the common treatment of creativity, a core competence of creative and original NPD is the opposite of a core competence of the continuity of the existing core competence.

This paper demonstrates the co-evolution of these two contradictory aspects of creativity in firms through the alliance strategy in the pharmaceutical industry. This paper also demonstrates the co-evolution of creativity and efficiency in pharmaceutical NPD by analyzing successive NPDs in the Japanese pharmaceutical industry. The significance of this alliance strategy for successive NPD is that firms can maintain originality as a core competence for ongoing NPD by utilizing the alliance product, or a product licensed from another firm, as a tool for maintaining or creating the originality. This alliance strategy serves as a competitive strategy for maintaining and creating core competence for NPD. This novel finding is demonstrated through a comparative analysis of the product area and product pipeline for each firm in the Japanese pharmaceutical industry.

Section 2 proposes a new classification for this kind of creativity in the continuum of the business practice by analyzing ongoing NPD in the Japanese pharmaceutical industry. Based on this classification of creativity, we conclude that the core competence for creativity in cumulative NPD is actually original or unique NPD by comparing the originality of NPD for each firm. Section 3 demonstrates the significance of this alliance strategy for successive NPD by proposing a product spiral model. Section 4 briefly summarizes the results of this analysis, presents conclusions and discusses implications.

## 2. Creativity in successive NPD

For the continuity of a firm as a going concern (Barnard, 1935), successive NPD is essential (Utterback, 1994; Bower and Christensen, 1995; Christensen, 1997). From a viewpoint of successive NPD, a new product is divided into two categories (Takayama and Watanabe, 2001). One is a new product with a superior point and another is a new product with a differentiated point. From the marketing point of view, NPD is categorized as a “market substitution type” and a “market creation type” (Table 1). According to Ansoff’s product-market matrix (Ansoff 1966, 1988; Ansoff et al., 1993), a superior product corresponds to a new product with the same mission. A differentiated product corresponds to a product with a new mission that develops or creates the new market. Our previous survey (Takayama and Watanabe, 2001) demonstrated that an existing product inhibits differentiated product development. This means that core competence for successive NPD works by enhancing or even inhibiting innovative NPD as summarized in Table 1.

Table 1
Two types of new product from viewpoint of advantage point

| Type of product | Superior point | Differentiated point |
|---|---|---|
| Competition with existing product | Direct competing | Indirect competition or neutral |
| Style of market penetration | Replace old product | Produce new market |
| Influence to product innovation | Enhancing | Inhibitory |

Among the material industry the pharmaceutical industry is characterized as being the most competitive as its R&D intensity is the highest and dynamic change in innovative product is often observed due to the continuing emergence of innovative technology. Under these dynamic circumstances, continuity of successive NPD is essential because of the huge amount of the investment and enormous duration for NPD (Takayama and Watanabe, 2001; JPMA, 2000). With the aim to identify the essential factors for successive NPD, NPD for leading Japanese firms has been analyzed.

The authors demonstrate this hypothetical view taking 30 leading R&D intensive Japanese pharmaceutical firms and examining their R&D over the last two decades (Watanabe et al., 2001). Many scholarly works have attempted to elucidate the sources of high R&D intensity in the pharmaceutical industry (Dimasi et al., 1991; Grabowski and Vernon 1990, 1994). However, none have looked at the relationship between R&D intensity, technology spillover and assimilation capacity.

To clarify the role of the assimilation capacity for successive NPD by alliances in the pharmaceutical industry, 11 firms from the 30 leading Japanese pharmaceutical companies are selected.

Fig. 2 demonstrates that each firm has one projected core field. This new finding is explained by the aforementioned competitive characteristics of cost and period for pharmaceutical NPD. Each firm has its original base field as its core competitive advantage to hedge against risk in the uncertainty of the market. Throughout the first two decades, a core field is not stable and changes in accordance with unexpected customers' preference as typically observed in Figs. 2b, c, d, g, h, j and k. Seven of the 11 firms shifted their core field during these two decades, although all firms changed the weight of their core field. Therefore, we conclude that each firm has "originality" as a base for both cumulative and discontinuous NPD.

Based on this finding, Table 2 proposes a new definition for creativity in this form of NPD. In the assembly industries, the integrity of the technology and market is the crucial factor for core competence in cumulative NPD. Throughout the entire process of R&D, the problem-finding system is a key for this ongoing and cumulative NPD (Fujimoto, 1993). In the material industry, the originality generated via a "one-spot" search is a crucial factor for core competence throughout successive NPD since carving out a unique advantage for each product is a key to NPD in this context. Based on this classification of creativity and by comparing the originality of NPD of each firm as shown in Fig. 2, we conclude that the core competence for creativity in successive NPD is actually the originality of NPD.

## 3. The significance of the alliance strategy for ongoing and discontinuous NPD

### *3.1. The alliance product as a tool for maintaining or creating originality*

We found the existence of a core field focused on maintaining originality as a core competence for successive NPD of each firm examined. Fig. 3 shows the mechanism of successive NPD in each core field for each firm. The alliance product is marked in bold in the figures. Surprisingly, the alliance product is utilized as a tool for maintaining the core field and very often is pulled out from the major product pipeline once each firm has its own original product. This finding is proven by the fact that the peak sales are smaller for these licensed products than in-house products as summarized in Table 3 and product lifetimes are shorter for these licensed products than in-house products.

In this strategy, alliance product is introduced in case firms' own big product is not marketed in about a 5-year time frame. After introducing this product from another company, the next in-house product is launched. Consequently, the accumulated sales amount of the in-house product is always larger than the alliance product as shown in Table 3. Looking at Fig. 3, the lifetime of an alliance product is shorter than an in-house product. Table 3 also summarizes the comparison of average peak sales between alliance products and in-house products. Average peak sales of alliance product are smaller than in-house product except two exceptions. Looking at Figs. 3g and h, sales of in-house products are larger than alliance products even in these two exceptions. In summary, alliance products are used as linkage for the maintenance of core field of a firm and completely unique product introduction.

Our findings are summarized as follows:

1. Each firm has a strategy for nourishing its original core field.
2. To complement this product pipeline in a core field, an alliance product (a licensed product) is strategically used.
3. The firms' own products have a longer product life

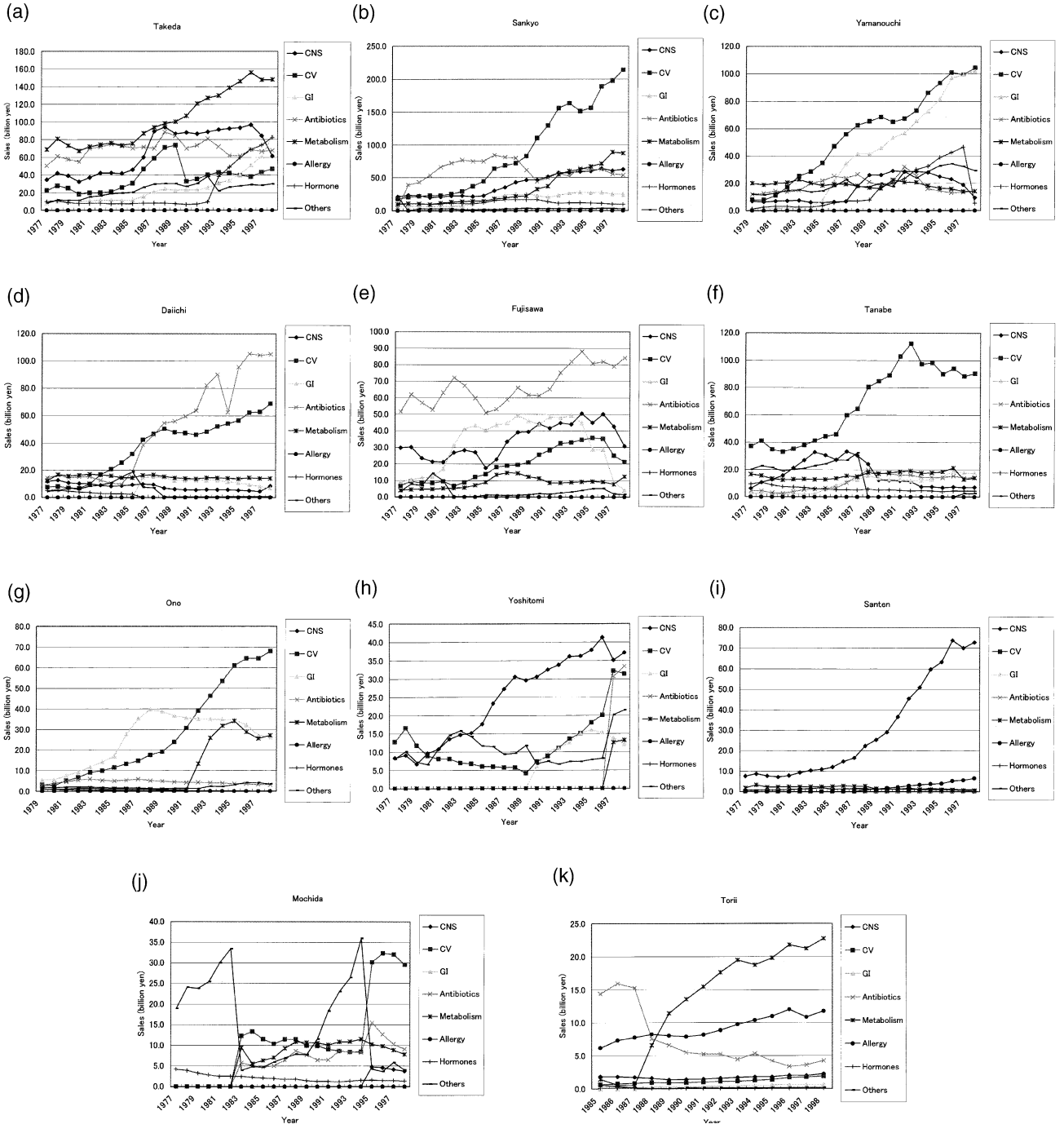


Fig. 2. Major therapeutic fields of each firm. (a) Takeda Pharmaceutical Co. Ltd. Note: sales represents an adjusted value by deflator of chemical industry compared to price level in 1990. Abbreviations: CNS, central nervous system; CV, cardiovascular; GI, gastro intestine. (b) Sankyo Co. Ltd. (c) Yamanouchi Pharmaceutical Co. Ltd. (d) Daiichi Pharmaceutical Co. Ltd. (e) Fujisawa Pharmaceutical Co. Ltd. (f) Tanabe Pharmaceutical Co. Ltd. (g) Ono Pharmaceutical Co. Ltd. (h) Yoshitomi Pharmaceutical Co. Ltd. (i) Santen Pharmaceutical Co. Ltd. (j) Mochida Pharmaceutical Co. Ltd. (k) Torii Pharmaceutical Co. Ltd.

cycle and reach a larger amount of sales than the alliance product.

4. The firms' own product ultimately replaces the alliance product creating a new core field for the firm.
5. The alliance product is pulled-out out once a firm launches its own product.

This demonstrates not only the nature of the alliance product but also the assimilation capacity of the firms based on NPD from the licensed product. Furthermore, the knowledge spillover, including technology spillovers and marketing knowledge spillovers, are successfully managed in the well-known territory of the original core

Table 2
Crucial factor of core competence for successive NPD and essential factor for creativity

| | Creativity for NPD | Crucial factor of core competence for successive NPD | Essential factor for creativity |
|---|---|---|---|
| Assembly industry | Problem-finding | Integration of parts | Integrity |
| Material industry | Target-finding | One spot search | Originality |

field of each firm before the firm shifts these core fields. Based on this transition between an alliance product and the firms' own product, assimilation capacity is maintained in an original core field for each firm. Thus, to compete in this rapidly changing pharmaceutical market, both efficiency and creativity is maintained in NPD by using this alliance product strategy. In conclusion, the key for the co-evolution of creativity and efficiency is the constant injection of original products. Originality is nourished in a core field for each firm through this process, which enables the firm to have cumulative development along with unique product development along a new core competence path. The role of the alliance strategy is to work as a linkage for the continuous NPD and functioned as a tool for stimulating creativity while maintaining efficiency.

### *3.2. Product spiral model for creative NPD*

In Section 3.1, it is clearly demonstrated that firms could maintain originality as a core competence for successive NPD by utilizing alliance products as a tool for maintaining and injecting originality in this process. This novel finding was demonstrated by a comparative study of the core field for each firm in the Japanese pharmaceutical industry.

In order to explain the role of the alliance strategy for the NPD observed in Figs. 2 and 3, Table 4 proposes a spiral model for creative NPD. When a new field is created, it is a transition from another field. Once this new field is created, continuing to introduce new products also continuously enforces the new field.

In successful companies, unique NPD is sometimes inhibited even at the growth because firms focus on efficiency and become too specialized (Takayama and Watanabe, 2001). After reaching a stationary phase, the strategy is changed from creative to maintenance or protection. At this stage, the corporate strategy is concentrated on pursuing economies of scale giving rise to product inertia. Various factors work to inhibit unique NPD at the stationary phase and hence value-added is inhibited by the firms' own knowledge set.

The alliance product strategy is utilized as risk hedge against the uncertainty of competition in NPD to evade the interference and reduced efficiencies in a core field. One primary role of the alliance product is a tool for evading the trap of inertia created by the efficiencies, that firms have to put in their production process.

As shown in Fig. 2, core fields are very flexible and often changed by introducing the alliance products. In this case, a new core field is created by a transition from the stationary stage to the diversification stage. Hence, the alliance could stimulate original innovation for NPD.

## 4. Conclusion and implications

In spite of the general recognition of the significance of cumulative NPD, the mechanism and key factors for remaining competitive with this strategy alone have not been proven. Although most studies treat NPD as a process of innovation, this investigation demonstrates that the most crucial factor for success in cumulative NPD is the process for the co-evolution of creativity and efficiency.

In terms of NPD, each firm has a original core field. Originality in NPD was divided into two dimensions. One dimension was continuous NPD and the other was creative destruction in NPD. The alliance product served as a between these two dimensions. These dual contradictory requirements compel the pharmaceutical industry to depend more on alliance strategies than other industries.

This analysis demonstrates that firms could maintain originality as a core competence in ongoing NPD by utilizing a licensed alliance product as a tool for maintaining or injecting this originality. While consistent and continuous R&D investment is indispensable for the pharmaceutical industry to maintain a high level of R&D intensity thereby enhancing its core competence, firms must also secure a risk hedge against unexpected dynamic changes in customer preference. The role of these alliance strategies in the pharmaceutical industry in order to satisfy the dual contradictory requirements of continuity and yet flexible and extreme changes in NPD.

In view of the process of NPD, the problem-solving process in assembly industries primarily revolves around problem identification. Contrary to typical discussions, NPD in the material industries is primarily based on a target-search for new products. Typically the pharmaceutical industry differs from the assembly-type industries because R&D begins with the one spot search. This

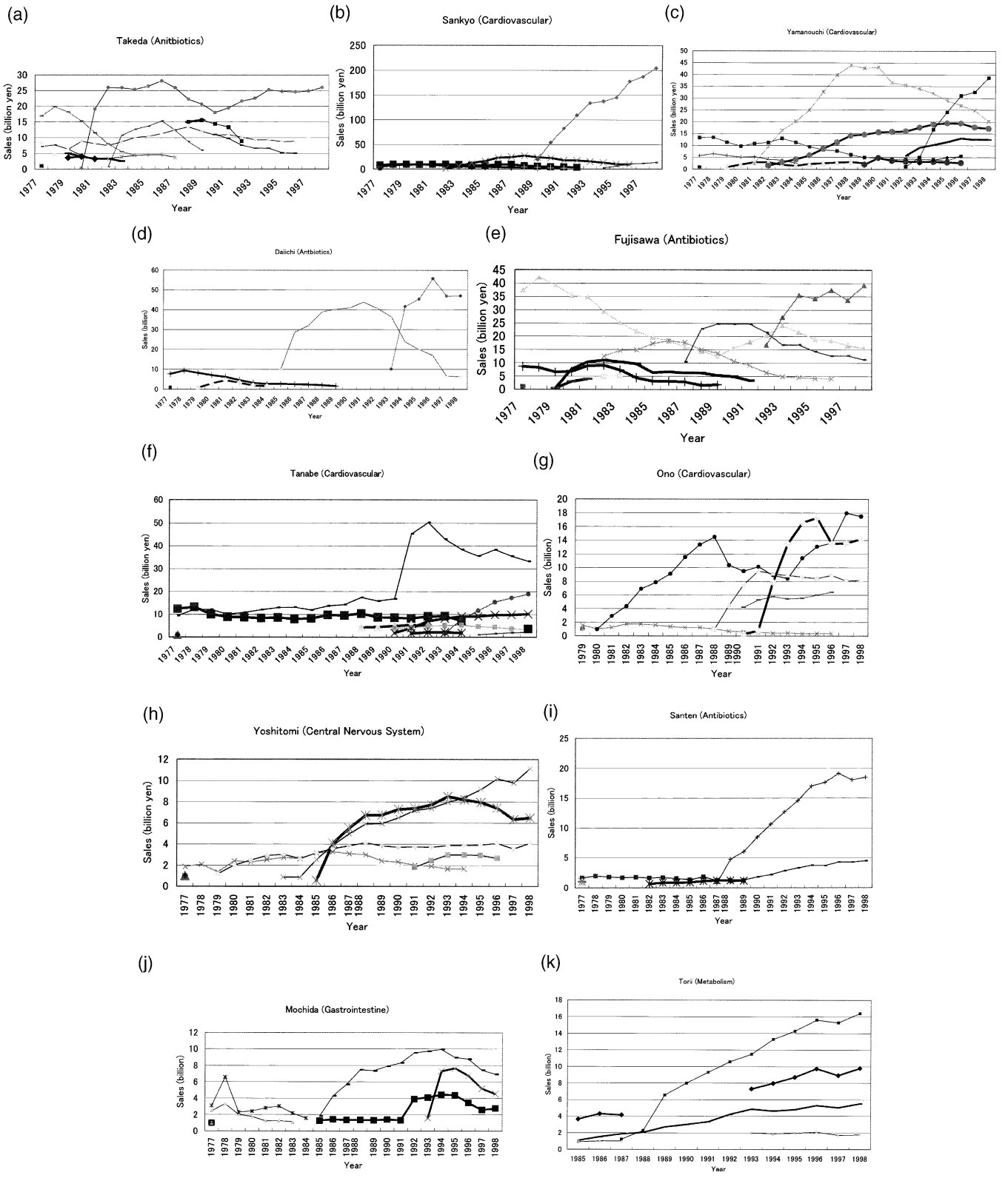


Fig. 3. Alliance products in a major therapeutic field of each firm. Note: sales represents an adjusted value by deflator of chemical industry compared to price level in 1990. (a) Takeda Pharmaceutical Co. Ltd. (b) Sankyo Co. Ltd. (c) Yamanouchi Pharmaceutical Co. Ltd. (d) Daiichi Pharmaceutical Co. Ltd. (e) Fujisawa Pharmaceutical Co. Ltd. (f) Tanabe Pharmaceutical Co. Ltd. (g) Ono Pharmaceutical Co. Ltd. (h) Yoshitomi Pharmaceutical Co. Ltd. (i) Santen Pharmaceutical Co. Ltd. Note: major product field of Santen became ophthalmology as one field of the nervous system. Antibiotics is a major product platform in Santen's ophthalmologic product field. (j) Mochida Pharmaceutical Co. Ltd. Note: special GI field for pancreatic or liver disease is a core of Mochida's major product field. (h) Torii Pharmaceutical Co. Ltd.

Table 3
Peak sales of major products in a core field of each firm

| Company | Origin of product | Accumulated peak sales (10 billion yen) | Number of products | Average peak sales (10 billion yen) |
|---|---|---|---|---|
| Takeda | Alliance | 24.6 | 3 | 8.2 |
| | In-house | 135.4 | 10 | 13.5 |
| Sankyo | Alliance | 51.6 | 4 | 12.9 |
| | In-house | 218.4 | 2 | 109.2 |
| Yamanouchi | Alliance | 40.4 | 4 | 10.1 |
| | In-house | 108.0 | 5 | 21.6 |
| Daiichi | Alliance | 13.9 | 2 | 7.0 |
| | In-house | 99.7 | 2 | 49.9 |
| Fujisawa | Alliance | 29.2 | 4 | 7.3 |
| | In-house | 122.7 | 4 | 30.7 |
| Tanabe | Alliance | 34.4 | 5 | 6.9 |
| | In-house | 76.6 | 4 | 19.1 |
| Ono | Alliance | 17.3 | 1 | 17.3 |
| | In-house | 35.7 | 4 | 8.9 |
| Yoshitomi | Alliance | 8.5 | 1 | 8.5 |
| | In-house | 21.5 | 4 | 5.4 |
| Santen | Alliance | 38.1 | 4 | 9.5 |
| | In-house | 121.9 | 9 | 13.5 |
| Total | Alliance | 258 | 28 | 9.2 |
| | In-house | 939.9 | 44 | 21.4 |

Table 4
Spiral transition of product in NPD

| Adaptation | Evolution of business | Strategy | Indispensable organizational factor | Type of innovation |
|---|---|---|---|---|
| New field | Latent | Diversification | Support by top management | Destructive of existing field |
| Concentration | Growth | Enforcement | Collaboration between business functions | Continuous |
| Maintenance /protection | Stationary | Scale of economy | Inertia | Process |
| Transition to new field | Transition | Transformation or isolation | Enforcement | Creation |

kind of R&D has been explained as a factor of something peculiar to this type of industry but that produces creativity and surprisingly enhances efficiency.

This paper elucidated the crucial factors for successive NPD and the significant role of the alliance product strategy to evade the typical inertia trap found in cumulative NPD. Future research should address the mechanism and factors governing the co-evolution of creativity and efficiency.

## Acknowledgements

The authors are grateful to Messrs Akira Nagamatsu and Takashi Tagami of Tokyo Institute of Technology for their support with the numerical analysis. The authors also gratefully acknowledge the contribution of a lot of senior management of many pharmaceutical companies in the USA, Europe and Japan to respond to our questions regarding the implications of alliance strategy for NPD. In particular, the authors are greatly indebted to Mr Mamoru Adachi, General Manager of Yamanouchi Pharmaceutical Co. for his invaluable advice based on his business on the concept making nature of corporate behavior.

## References

Allen, T.J., 1966. Studies of the problem-solving process in engineering design. IEEE Transactions on Engineering Management 13 (2), 72–83.

Ansoff, H.I., 1966. Corporate Strategy. McGraw–Hill, New York.

Ansoff, H.I., 1988. The New Corporate Strategy. Wiley, Chichester.

Ansoff, H.I., McDonnell, E., Lindsey, L., Beach, S., 1993. Implanting Strategic Management. Wiley, Chichester.

Barnard, C.I., 1935. The Functions of the Executives. Harvard Business Press, Boston.

Bower, J.L., Christensen, M.C., 1995. Disruptive technologies: catching the wave. Harvard Business Review Jan-Feb.

Christensen, M.C., 1997. The Innovator's Dilemma. Harvard Business School Press, Boston.
Clerk, K.B., Fujimoto, T., 1991. Product Development Performance. Harvard Business School Press, Boston.
Cockburn, I., Henderson, R., 1994. Racing to invest? The dynamics of competition in ethical drug discovery. Journal of Economics and Management Strategy 3 (3), 481–519.
Dimasi, J.A., Hansen, R.W., Grabowski, H.G., Lasagna, L., 1991. Cost of innovation in the pharmaceutical industry. Journal of Health Economics 10, 107–142.
Fujimoto, T., 1993. Comparing performance and organization of product development across firms, regions and industry: the applicability of the automobile case. In: Ito, H. (Ed.), R&D Strategies in Japan. Elsevier, Amsterdam.
Grabowski, H.G., Vernon, J.M., 1990. A new look at the returns and risks to pharmaceutical R&D. Management Science 36 (7), 804–821.
Grabowski, H.G., Vernon, J.M., 1994. Returns to R&D on new drug introductions in the 1980s. Journal of Health Economics 13, 383–406.
Hamel, G., 2000. Leading the revolution. Harvard Business Review.
Hamel, G., Prahalad, C.K., 1994a. Competing for the future. Harvard Business Review Oct–Nov.
Hamel, G., Prahalad, C.K., 1994b. Competing for the Future. Harvard Business Press, Boston.
Henderson, R., Cockburn, I., 1994a. Measuring competence? Exploring firm effects in the pharmaceutical research. Strategic Management Journal 15, 63–84.
Henderson, R., Cockburn, I., 1994b. Scale, Scope and Spillovers: The Determinants of Research Productivity in the Pharmaceutical Industry, NBER Working Paper No. 4466.
JPMA (Japanese Pharmaceutical Manufacturers' Association). Data Book, 2000, Tokyo.
Lester, C.T., 1998. The Age of Economic Exploration; What Lies Beyond Capitalism? Tachibana Press, Tokyo.
Nonaka, I., 1991. The knowledge-creating company. Harvard Business Review Nov–Dec, 96–104.
Nonaka, I., Takeuchi, H., 1995. The Knowledge-creating Company: How Japanese Companies Create the Dynamics of Innovation. Oxford University Press, Oxford.
Ohno, T., 1988. The Toyota Production System. Productivity Press, Tokyo.
Pfeffer, J., Sutton, R.I., 2000. The Knowing-doing Gap: How Smart Companies Turn Knowledge into Action. Harvard Business School Press, Boston.
Pisano, G.P., 1997. The Development Factory. Harvard Business School Press, Boston.
Porter, M.E., Takeuchi, H., 2000. Can Japan Compete? Harvard Business School Press, Boston.
Porter, M.E., 1998. On Competition. Harvard Business School Press, Boston.
Schumpeter, J.A., 1935. The Theory of Economic Growth. Oxford University Press, Oxford.
Takayama, M., Watanabe, C., 2001. Myth of market needs and technology seeds as a source of product innovation — an analysis of pharmaceutical new product development in an anti-hypertensive product innovation. Techonovation (in press).
Utterback, J.M., 1994. Mastering the Dynamics of Innovation — How Companies Can Seize Opportunities in the Face of Technological Change. Harvard Business Press, Boston.
Von Krogh, G., Ichijo, K., Nonaka, I., 2000. Enabling Knowledge Creation: A Source of Value. Macmillan Press, London.
Watanabe, C., Takayama, M., Nagamatsu, A., Tagami, T., Griffin-Brown, C., 2001. Technology spillover as a complement for high-level R&D intensity in the pharmaceutical industry. Technovation (in press).

**Makoto Takayama** graduated from Kyoto University in Agricultural Chemistry in 1976 and received his degrees of Master of Science at Kyoto University and MBA in graduate school of business at Tsukuba University. He has visited Business School at University of Washington as Visiting Scholar, where he had conducted comparative survey on the product innovation between American firms and Japanese firms. Currently he is associated with product planning at Yamanouchi Pharmaceutical Co. and with the innovation studies at Tokyo Institute of Technology.

**Chihiro Watanabe** graduated from Tokyo University with a bachelor's degree in Engineering (urban planning) in 1968 and received his PhD (arts and sciences) in 1992, also from Tokyo University. He began his affiliation with the Ministry of International Trade and Industry (MITI) in 1968. He is a former Deputy Director-General of Technology Development at MITI. He is currently Professor at the Department of Industrial Engineering and Management, Tokyo Institute of Technology, and also Senior Advisor to the Director on Technology at International Institute for Applied Systems Analysis (IIASA).

**Charla Griffy-Brown** is currently an Associate Professor at Pepperdine University, a researcher at the Foundation for Advanced Studies in International Development, Tokyo and a Visiting Fellow at Tokyo Institute of Technology. A former Fulbright Scholar, she graduated from Harvard University and has a PhD in Technology Management from Griffith University in Queenslan, Australia. She has worked for NASA at the Kennedy Space Center and has also worked as a lecturer at the Centre for Technology Management, Griffith University teaching innovation management courses in Australia, Singapore, Indonesia, Malaysia and Japan.