Available online at www.sciencedirect.com
SCIENCE DIRECT®
Omega 34 (2006) 178–188
omega
The International Journal of Management Science
www.elsevier.com/locate/omega

Converging trend of innovation efforts in high technology firms under paradigm shift—a case of Japan's electrical machinery☆

Chihiro Watanabe*, Jae Yong Hur, Shanyu Lei

Department of Industrial Engineering and Management, Tokyo Institute of Technology, 2-12-10 Ookayama, Meguro-ku, Tokyo 152-8522, Japan

Received 13 June 2003; accepted 24 September 2004
Available online 8 December 2004

Abstract

Japan's electrical machinery firms are typical high technology firms and have been playing a leading role in Japan's economic development. This is primarily due to the large amount of R&D investment motivated by technoprenuership leading to high level of technology stock. However, such a high level of technology stock has dichotomized the firms resulting in the converging trend over the last two decades.

This converging trend can be attributed to the contrasting performance between gigantic and follower firms. While challenges to new functionality development in the gigantic firms were impeded by organizational inertia, the follower firms could overcome such impediments so as to lead to active development of new functionalities. Furthermore, higher functionality development of the follower firms guarantees them successfully securing their R&D funds by shifting from their operating income to market place; lower functionality development of the gigantic firms with strong organizational inertia impedes such a shift.

In order to demonstrate the foregoing hypothetical view and also to elucidate the structural sources compelling the firms to such contrasting performance, an empirical analysis is attempted taking Japan's leading electrical machinery firms by classifying into gigantic and follower groups. By means of a comparative analysis of development trajectories of these firms utilizing bi-logistic growth model, the sources of such convergence are identified leading to implications supportive to survival strategies of high technology firms amidst megacompetition.
© 2004 Elsevier Ltd. All rights reserved.

Keywords: Functionality development; Bi-logistic; Entropy; Organizational inertia; Development trajectory

1. Introduction

Under increasing global megacompetition, Japan's electrical machinery firms have expanded their investments in R&D not only to secure the predominated technological position but also to challenge new technological opportunities. These increased R&D investments have enabled the firms to maintain sustainable growth by increasing their technology stock[1] despite the rapid obsolescence of technology. However, looking at the behavior of each respective leading firm

☆ This article was processed by Associate Editor B Adenso-Diaz.

* Corresponding author. Tel.: +81 3 5734 2248; fax: +81 3 5734 2252.
E-mail address: chihiro@me.titech.ac.jp (C. Watanabe).

0305-0483/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.omega.2004.09.002

[1] Here technology stock implies technological knowledge stock generated by R&D investment and, in line with the previous approach [1,2], this stock can be measured by the following equation:

$$T_t = R_{t-m} + (1-\rho)T_{t-1},$$

where T_t is the technology stock at time t, R_t is the R&D investment at time t, m is the lead time between R&D and commercialization, and ρ is the rate of obsolescence of technology.

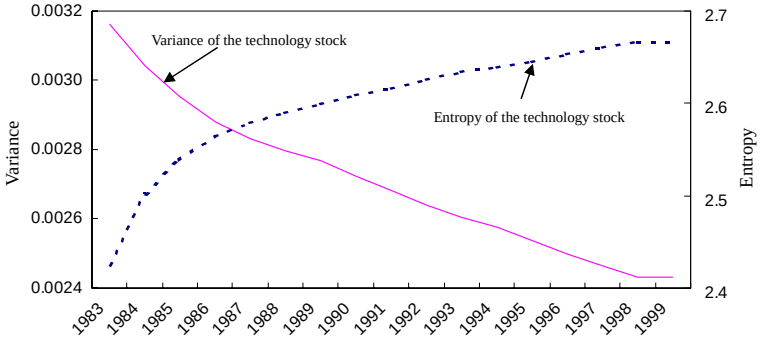

Fig. 1. Trend in the variance and the entropy of relative technology stock in 24 Japan's leading electrical machinery industry. The relative technology stock is the share of a firm's technology stock in the total technology stock of the industry.

carefully, we note that the growth rates of R&D investment of gigantic and follower firms differ significantly. Contrary to the remarkable growth rate of the R&D investment in the follower firms, that of the gigantic firms has been relatively low over the last two decades. These contrasting trends resulted in the convergence with respect to the technological level of the electrical machinery firms. Fig. 1 illustrates the trend in the variance of the relative technology stock of 24 Japan's leading electrical machinery firms.[2]

Looking at Fig. 1, we note that the variance of the relative technology stock has continued to decline during the period examined. Fig. 1 also illustrates that the trend in the entropy[3] of the same stock has increased. These trends, both of variance and entropy, imply that the technology stock of the 24 Japan's leading electrical machinery firms has converged over the last two decades.

In addition, trends in technology stock of the 24 firms illustrated in Fig. 2 demonstrate that there are distinctive technology gap among firms in Japan's electrical machinery industry.

Based on the foregoing observation of the converging trend,[4] it is postulated that this converging trend of the technology stock in Japan's leading electrical machinery firms can be attributed to the contrasting performance between gigantic and follower firms.[5] While challenges to new functionality development in the gigantic firms were impeded by organizational inertia, the follower firms could overcome such impediments so as to lead to active development of new functionalities.

In case of high technology firms like electrical machinery, their sales are primarily governed by their technology stock [4]. Assuming that the sales of a technology intensive firm is a function of technology stock that has been accumulated by its R&D activities, it approaches its maximal level, so-called carrying capacity, without new functionality development[6] as the technology stock increases. In other words, the stagnation of sales growth can be regarded as an inevitable conclusion of the firm locked in the single development trajectory.[7] Therefore, it is difficult for such firms to maintain high level of R&D investment. Furthermore, it is quite difficult for the gigantic firms which once

[2] (1) Matsushita, (2) NEC, (3) Hitachi, (4) Toshiba, (5) Fujitsu, (6) Melco (Mitsubishi Electric Corporation), (7) Sony, (8) Canon, (9) Sharp, (10) Sanyo, (11) Matsushita Electric Works, Ltd. (MEW), (12) Victor, (13) Fuji Electric, (14) Kyosera, (15) Oki, (16) Pioneer, (17) Alps, (18) Casio, (19) Rohm, (20) Aiwa, (21) Yokogawa, (22) Japan Radio Co., Ltd. (JRC), (23) Meiden, and (24) Kokusai Electric.

[3] Entropy of technology stock (H) is computed by the following equation postulated by Jaquemin and Berry [3]: $H = 1 - \ln a$, where a is the coefficient representing technological structure.

[4] From the observation of Figs. 1 and 2, variance of technology stock is decreasing and its entropy is increasing over time, it can be realized that technology stock of Japan's electric machinery firms decrease their dispersion during their development. The process of this technology stock in Japan's leading electric machinery firms' decreasing dispersion is identified as converging trend.

[5] Since sales, R&D investment and R&D intensity in Japan's electric machinery industry has been closely interacting and the sales take the governing role in this interaction, separation of the leading eight firms (nos. 1–8 as identified in Section 3.1) between gigantic groups and follower groups is identified by average sales volume over the period 1991–1998. Leading eight firms can be classified into the top four (nos. 1–4) and the following four firms (nos. 5–8) as identified by the Chow test on pp. 13–14. The former four firms consisting of Matsushita, NEC, Hitachi and Toshiba are identified as "gigantic groups," and the latter four firms consisting of Fujitsu, Melco, Sony and Canon are identified as "follower groups."

[6] The functionality development is generally defined as the ability to dramatically improve the performance of production processes, goods and services by means of innovation. In the process of diffusion of hi-technology products, the ratio of carrying capacity to the level of diffusion represents the extent of functionality development [4,5].

[7] Technological development trajectory namely directions of technological development that are cumulative and self-generating without repeated reference to the economic environment external to the firm [6]. Here development trajectory implies the path of Japan's leading electric machinery firms' technological development.

دریافت فوری ← متن کامل مقاله

ISIArticles
مرجع مقالات تخصصی ایران

✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
✓ امکان دانلود نسخه ترجمه شده مقالات
✓ پذیرش سفارش ترجمه تخصصی
✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
✓ دانلود فوری مقاله پس از پرداخت آنلاین
✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات