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Performance and strategic changes of SMEs in the Korean electronic parts industry 1990- 2001: A dynamic strategic group approach

Youngbae Kim[1]

Seong-Wook Ha[2]

[1] Professor, KAIST Graduate School of Management, 207-43 Chungryangri-dong, Dongdaemun-gu, Seoul 130-012, Rep of Korea (+82-2-958-3608, ybkim@kgsm.kaist.ac.kr)

[2] Doctoral candidate, KAIST Graduate School of Management

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Abstract

This study empirically examined the patterns and performance consequences of strategic changes of SMEs in response to environmental changes, based on longitudinal data from 102 Korean electronic parts SMEs for the period from 1990 to 2001. Using the dynamic analysis of strategic groups in the Korean electronic parts SMEs, this study found that four to five different strategic patterns (subcontractor, production-focus, market-focus, innovator, and market-diversified groups) emerged depending on the periods, and there were significant performance differences among them. For instance, the innovator group outperformed other strategic groups, while the subcontractor group had the lowest performance level in terms of ROS. The production-focus group, which exhibited a relatively higher performance level in the early 1990s, gradually deteriorated in profitability in the late 1990s. As a result, a substantial number of SMEs (25% of sample firms on average) have attempted to shift their strategic configurations with different performance consequences. These results imply that given the rapid technological development in the industry and changes in the global production network with the emergence of Chinese competitors, Korean SMEs should focus on technological innovations for maintaining their competitive position by relentlessly enhancing their technological development capabilities rather than production capabilities. Based on these findings, policy and strategic implications for strengthening SMEs in the Korean electronic parts industry are proposed.

I. Introduction

Over the past decades, the Korean electronic parts industry has experienced significant changes in terms of both markets and technologies such as the emergence of the Chinese economy, shortened product life cycles, digitization in technology development, and the IT boom and bust. To cope with this environmental turbulence, it became a mandate for Korean SMEs (Small and Medium-sized Enterprises) to change their strategies for survival and growth, which have resulted in different performance consequences.

Many prior studies have explored the strategic changes of firms in conjunction with their performance implications in response to environmental changes from various perspectives with different theoretical backgrounds such as population ecology (Hannan and Freeman, 1984), institutionalism (Greenwood and Hinings, 1996), strategic choice (Child, 1972; Miles and Snow, 1978), and the organizational learning approach (March, 1991; Cohen and Levinthal, 1990). Recently, strategic group theory has received considerable attention as a useful systematic framework for analyzing competitive dynamics and strategic responses of firms to environmental changes in a particular industry (Zuniga-Vincent et al., 2004; Mascarenhas, 1989; Cool and Schendel, 1987; Figenbaum and Thomas, 1990; Bogner et al, 1996).

The concept of strategic group, first coined by Hunt (1972), can be defined as a group of firms within the same industry which deploys a similar strategy in terms of product/market scope and resource/capability commitment (Porter, 1980; McGee and Thomas, 1986; Cool and Schendel, 1987; McNamara et al, 2002). The basic premise of strategic group theory assumes that an industry is generally composed of a few heterogeneous groups of firms sharing common mobility barriers, which are defined as specialized assets and skills to deter movement between groups due to substantial cost, time lapse, or uncertainty regarding future outcomes (Mascarenhas and Aaker, 1989). In other words, the presence or formation of multiple strategic groups in the industry depends on the extent of product/market heterogeneity and resource inimitability within an industry (Mehra and Floyd, 1998). As a result, even the same environmental changes occurring within the same industry can have a different impact on different strategic groups with different product/market scopes and resource/capability profiles (Kim and Lee, 1998).

For instance, Zuniga-Vincent et al. (2004) analyzed strategic responses of Spanish banks using a dynamic strategic group approach in the face of turbulent environmental changes for the period 1983-1997. Cool and Schendel (1987) empirically showed different strategic shifts among different strategic groups with different performance consequences in the US pharmaceutical industry in response to environmental changes for the period 1963-1982. Kim and Lee (2002) also identified different evolution patterns of technological learning to cope with

environmental changes among different strategic groups in the Korean electronic parts industry for the period 1990 - 1995. The present study extends these works by expanding the time span to 2001 to analyze strategic group shifts of SMEs to cope with environmental changes occurring in the industry.

The research questions the present study addresses are: 1) are there any patterns of strategic changes Korean SMEs have attempted in response to environmental changes occurring in the electronic parts industry from 1990 to 2001?; and, 2) what are the performance consequences of these strategic change patterns? This study empirically examined the patterns and performance consequences of strategic changes of SMEs in response to environmental changes, based on longitudinal data from 102 Korean electronic parts SMEs for the period 1990 to 2001. Twelve years of time horizon in this study have been divided into four strategically stable time periods: t1 (1990-1992), t2 (1993-1995), t3 (1996-1998), and t4 (1999-2001).

This paper first describes the characteristics of environmental changes that occurred in the Korean electronic parts industry in the 1990s and explains research methods used in this study. Then, the results are presented in the following section. Finally, we discuss the main findings and delineate the managerial and policy implications based on these results.

II. The Korean electronic parts industry in 1990s

Korea has recently emerged as the third largest electronic parts producer in the world after the United States and Japan. However, the industry is largely made up of SMEs, which mainly produce general-purpose parts such as condensers, resistors, and switches, while there are only a few large conglomerate-affiliated firms, which usually supply single-purpose parts such as semiconductors, LCDs, and CRTs. In 1998, SMEs with less than 300 employees accounted for 94.3% of the total number of firms in this industry (Korea National Statistics Office, 1999).

Between 1990 and 2001, as shown in Table 1, the industry has grown by 13.7% per year in terms of production volume from 9,113 billion won in 1990 to 32,236 billion won in 2001, including semiconductors. During this period, the industry has witnessed a series of environmental changes that independently and jointly induced diverse strategic responses from Korean electronic parts makers. These environmental changes include a cyclic change of IT boom and bust, a wage hike, emergence of the Chinese economy, shift in market demand, and shortened product life cycle.

Table 1 here

First, there was an IT boom due to the launch of Windows in 1995, Y2K and emergence of e-business in 2000. The IT bust in subsequent years led to a fluctuation in market demand in the electronic parts industry, as shown in Table 1. The fluctuation of production volume mainly stemmed from the semiconductor sector, while other electronic parts maintained a sustainable growth rate until 1999. Since 2000, however, electronic parts other than semiconductors suffered from a significant decline of market demand and exhibited a negative growth rate of production volume.

Second, the annual wage increase in the small manufacturing sector was around 11.8% during the period 1985-2001, as shown in Table 2. The rapid increase in wages compared to other rival countries left both Korean set makers and parts producers vulnerable to cost competition in the export market. In addition, the rapid industrialization and new competition from China and other Asian countries eroded the competitive position of local firms in the low-end markets.

Table 2 here

Third, the emergence of the Chinese economy, however, also provided Korean electronic parts producers with a new market opportunity. The proportion of China in terms of the industry export amount has increased from 1.1% in 1991 to 8.9% in 2001. Korean manufacturing SMEs have also dramatically increased their foreign direct investment in China – from 1.7% of all such investment in 1989 to 45.4% in 2001.

Fourth, shifts in market demand for electronic sets and parts have occurred during this period. In the 1990s, the market for consumer electronics was already saturated, while IT (information and telecommunication) products such as PCs and cellular phones emerged to be the next dominant products. In response to these environmental changes, large set makers began to reduce their domestic production of mature products and to move their production lines overseas, especially to China. In turn, this movement reduced the demands for such traditional electronic parts used for the assembly of consumer electronics as transformers, resistors, and condensers, which were produced mainly by SMEs with a labor-intensive assembly process. On the other hand, by relentless enhancing of their technological development capabilities rather than production capabilities, the market growth of IT products increased the demand for more technology-intensive parts such as DRAMs, LCDs, Multi-layered PCBs, RF filters, antennas for wireless, modems, etc (Kim and Lee, 2002).

Finally, coinciding with demand shifts were the shortened product lifecycles. In the 1990s,

a series of new products was rushed into the market to digitalize and integrate the functions of the traditional products. The pressure for the digitalization and accelerated time-to-market of end products inevitably required technological innovations in electronic parts, which resulted in modularization and integration of several different parts into a smaller chip. The digitalized products replaced traditional electronic parts such as transistors, resistors, and condensers with ICs.

In response to such environmental changes, diverse patterns of strategic shifts by electronic parts producers were found. Many SMEs moved their production facilities to China as well as other South-East Asian countries to reduce labor cost, while other SMEs invested in the automation of production processes to lower cost and increase product quality. In addition, some SMEs also made an effort to develop more technology-intensive new products, based on both indigenous technological capability and collaboration with outside technical agencies (Kim and Lee, 2002). These different strategic responses of Korean SMEs to environmental changes may lead to diverse strategic group structures with different level of performance consequences in the industry.

III. Methodology

Data collection

Data for this study was collected from SMEs in the Korean electronic parts industry, since the industry has experienced relatively dynamic changes in terms of both market and technologies. To acquire reliable data, 139 firms were initially sampled and investigated based on the following three criteria: (1) the firm must have been founded prior to 1988, (2) revenues from electronic parts must have comprised more than 80% of its total sales volume in 1990, and (3) the number of employees must have exceeded 50 in 1990. Sixteen firms were excluded due to insufficient data of technological learning indicators.

The remaining 123 firms were included in the following analyses. The median number of employees of the sample firms was 146, and the median sales volume was 6.3 billion Korean won (equivalent to US$ 5.9 million) in 1990. The median age of the sample firms was 11 years in 1990. Moreover, we investigated the bankruptcy and cessation status of the remaining 123 firms from the database of a credit information provider and telephone inquiries at the end of 2002.

The time horizon in this study covers 12 years, which are divided into four periods: the t_1 period (1990-1992), the t_2 period (1993-1995), the t_3 period (1996-1998), and the t_4 period (1999-2001). An aggregate measure for each three-year period is developed by averaging the

measures for each year. The three-year periods are used to ensure sufficient time to smooth out time-related fluctuations (Bierly and Chakrabarti, 1996; He and Wong, 2004).

Measurement of variables

To classify strategic groups, prior studies recommend using strategy variables which are associated with product/market domain and resource/capability profiles (Mascarenhas and Aaker, 1989). Based on ex-ante industry analysis and interviews with industry experts, the product/market domain of SMEs in this study has been measured by the number of product lines, product diversity, export ratios, the ratio of sales through open markets, the number of customers, and customer diversity, as indicated in Table 3. The resource/capability variables are also measured by the size and ratio of technical manpower, R&D intensity, the ratio of new products, manufacturing intensity, production equipment per employee, and degree of automation, as shown in Table 3. Performance variables used in this study are sales growth rate, ROS (return on sales), and ROA (return on assets).

Table 3 here

A principal component analysis on the thirteen strategic variables was undertaken to delineate underlying dimensions of business strategy. It produced four distinctive factors with an eigenvalue greater than one, as shown in Table 2. Considering the factor loadings of each factor, this study interpreted these four factors as product line breadth, market breadth, innovation capability, and production capability, respectively. Using these factor scores, the cluster analysis with the Ward method for each period was performed to derive strategic groups. The results of a Pseudo T2 test to determine the appropriate number of clusters indicated four strategic groups for the t1 to t3 time periods, and five strategic groups for the t4 period.

IV. Results

ANOVA results as shown in Table 4 describe the distinctive characteristics of each strategic group.

Table 4 here

Subcontractor group: The firms in this strategic group exhibit the lowest scores in all four strategic dimensions: narrowest product lines and market breadths, and lowest scores in

production and innovation capabilities. Their size and age are relatively small and young. They were quite dependent on one or a couple of set makers for supplying a few labor intensive and low value-added electronic parts as an outsourcing partner. Because their competitive advantage vis-à-vis other strategic groups is weak, the IMF crisis, which occurred in 1997, had seriously reduced the number of members in this group, from 40 firms in the t2 period to 23 in the t3 period.

Innovator group: This group of firms displays strong innovation capability in diverse markets with an increasing production capability. Their product lines are relatively more focused on emerging IT sectors such as cellular phones and flat panel displays. Based on indigenously developed electronic parts in this sector, they could expand their markets abroad. However, it seemed to be a formidable task for these firms to continually explore new technologies and products to keep up with dynamic technological and market changes in the emerging sectors of the electronic parts industry. As a result, the number of firms in this group has been gradually decreasing during the 1990 to 2001 period.

Market focus group: These firms show the broadest product/market scope with the modest innovation and production capabilities. They could diversify their product lines and expand their markets in spite of modest technological capability, since they were more likely to resort to key components brought from foreign sources for final assembly of imitative electronic parts. Although they had a strong customer relationship management ability, the number of members by the t3 period (the period hit by IMF crisis) had been reduced by almost 50% due to the lack of strong technological capability.

Production focus group: These firms have a strong production capability in very focused product lines. They have invested in production facilities and maintained high product qualities, avoiding a mere assembly of products to take advantage of lower wages pursued by the subcontractor group. However, these firms did not have an indigenous technological capability to develop new products in response to shifts in market demands.

Market diversified group: Firms in this newly emerged strategic group for the t4 period have the broadest market scope with the modest product diversity. These firms did not rely on a few big customers (set makers), rather they diversified their customers in both domestic and foreign markets. The firms in this strategic group did not intend to choose these strategic responses, but were forced to expand their customer base. Given their weak technological capabilities, their products were not technologically sophisticated and thus were under strong pressure of cost competition.

Table 5 shows ANCOVA results of the performance differences among four to five strategic groups for the t1 to t4 periods, controlling for the size and age of the firms. The results

revealed that the innovation group outperformed the other strategic groups in terms of ROS for all the periods, while the production focus group showed a higher performance level than the market focus and subcontractor groups only for the t1 and t2 time periods. The subcontractor group exhibited the lowest ROS level among different strategic groups during the whole period. The market diversified group also displayed a low ROS level for the t4 period. However, other performance variables such as sales growth rate and ROA were not significantly different among strategic groups for the whole period. In summary, both the production-focus and innovator strategic groups exhibited higher profitability (i.e., ROS) in the early 1990s, while only the innovator group maintained a higher performance level in the late 1990s.

Table 5 here

Not surprisingly, many SMEs (25% of sample firms on average) have changed their strategic group membership for each time period. As shown in Table 6, on average, 15.4% of the subcontractor group, 29% of the production focus group, 27.8% of the market focus group, and 33.2% of the innovator group have moved out to other strategic groups, respectively. On the contrary, 14.4% of the subcontractor group, 30.4% of the production focus group, 25% of the market focus group, and 16.2% of the innovator group have newly moved in from other strategic groups. Put differently, the mobility ratio of the subcontractor group is relatively low, while those of the production- and market-focus groups are comparatively high. Interestingly, the move-in ratio of the innovator group is significantly lower than the move-out ratio. Given the performance level of each strategic group, the results imply that strategic group changes of Korean electronic parts SMEs are not symmetrical. SMEs in the subcontractor group had a greater difficulty in moving out to other strategic groups due to their weak strategic capabilities and SMEs in other strategic groups were also reluctant to move in the subcontractor group because of the relative unattractiveness of this strategic group. SMEs were more likely to drop out of the innovator group than to newly enter this strategic group, because it was necessary for them to continually maintain innovation capability to remain as a member of this strategic group.

Table 6 also reveals the cessation rate of each strategic group. Thirty firms went bankrupt among 102 initial sample firms during the t3 and t4 periods. The cessation rates of the subcontractor, production-focus, market-focus, and innovator groups are 30%, 35%, 33%, and 13%, respectively. These results also indicate the relative competitiveness of the innovator group in the Korean electronic parts industry.

These patterns of strategic changes the Korean SMEs have exhibited from 1990 to 2001

were supported by the results of performance differences between SMEs which have moved to other strategic groups and those that remained in the same strategic groups. As Table 7 indicates, the ROS level of SMEs which have moved out of the subcontractor group was relatively higher than that of the remaining SMEs in this strategic group. On the contrary, SMEs which have stayed in the innovator group consistently outperformed in terms of ROS in comparison with those which have fallen out of this group. Table 8 also shows that SMEs which have changed their membership from the subcontractor group to other strategic groups exhibited higher performance level in the subsequent period than those stayed in this strategic group, while the performance level of SMEs which have moved from the innovator group to other strategic groups was worse than that of SMEs which have stayed in the innovator group.

Tables 7 & 8 here

The results can be interpreted that unless SMEs have invested continually in their innovation capabilities, they could keep neither their strategic group membership nor their performance level. In other words, when an SME in the innovator group could not successfully exploit the market performance from the past new product development efforts, this firm could not sustain their investment in upgrading technological capability. Given the decreasing membership in the innovator group from the t1 period to the t4 period, it seemed to be quite difficult for Korean SMEs to successfully balance the exploitation of existing products and the exploration of new innovations in the face of dynamic changes in terms of market demands and technologies in the Korean electronic parts industry.

V. Discussion and Conclusions

The results of dynamic strategic group analyses in the Korean electronic parts industry can be summarized as follows.

1) There are four to five different strategic patterns: the subcontractor, production-focus, market-focus, innovator, and market-diversified groups.

2) There are significant performance differences among strategic groups: the innovator group outperformed other strategic groups, while the subcontractor group had the lowest performance level in terms of ROS. The production-focus group, which exhibited a relatively higher performance level in the early 1990s, gradually deteriorated in profitability in the late 1990s.

3) In the face of environmental changes, a substantial number of SMEs (25% of sample firms on average) have attempted to shift their strategic configurations: the mobility ratio (both move-in and move-out ratio) of the subcontractor group appears to be lower than those of the other strategic groups, while the move-in ratio of the innovator group substantially lower than the move-out ratio due to high mobility barriers (i.e., innovation capability).

4) The prior ROS level of SMEs which have moved out of the subcontractor group tended to be higher than that of remaining SMEs. On the contrary, the prior ROS level of SMEs which have moved out of the innovator group was more likely to be lower than that of the remaining SMEs in this group.

5) SMEs which have moved out of the subcontractor group were more likely to maintain a higher level of ROS in the subsequent time periods than those that stayed in this strategic group. On the contrary, SMEs which have moved out of the innovator group underperformed in terms of ROS than those that remained in the group in the subsequent period.

The results found in this study imply that dynamic environmental changes in the industry lead to significant strategic group changes of SMEs in the industry. However, strategic group changes of Korean SMEs appear to be asymmetrical: SMEs in the subcontractor group with weak strategic capabilities are more likely to move out of their strategic group only when they have a relatively higher performance level, while SMEs in the innovator group with strong strategic capabilities are more likely to remain in their strategic configurations only when they maintain a sufficient level of performance to keep up their technological capability.

Given the changes in global production networks due to technological and market changes in the electronic parts industry and the emergence of Chinese competitors, the Korean SMEs should focus on technological innovations for maintaining their competitive position. In so doing, Korean SMEs first generate slack resources based on the current strategic configuration, then, invest these slack resources in upgrading their technological capabilities through both indigenous technological development and collaborative R&D with outside technical agencies such as customer firms, universities or government sponsored research institutes.

The results of this study clearly offer important implications for managers of Korean electronic parts SMEs and policy makers in the government. In the face of dynamic environmental changes in the Korean electronic parts industry, the best strategic response of SMEs appears to be to become more innovative by relentlessly enhancing their technological development capabilities rather than production capabilities. Given the changes in global production networks by the emergence of Chinese competitors, Korean SMEs should focus on technological innovations for maintaining their competitive position.

However, SMEs which want to move to and stay in the innovation group must have a certain level of financial performance, because developing and maintaining technological capabilities requires a lot of slack resources, given the inherent risk of failure and long-term payback period of technological innovation. The results in this study show both a virtuous cycle and a vicious cycle of strategic changes of Korean electronic parts SMEs: only high performing SMEs could move into and stay in the innovator group, which in turn tended to produce better performance. On the other hand, SMEs which failed to produce good e enough performance to enhance or maintain their technological capability were more likely to drop out of the innovator group and move into other inferior strategic groups.

Theoretically, SMEs in the Korean electronic parts industry can successfully evolve from inferior strategic groups to the more attractive innovator group by juggling both exploitation of existing strategic capabilities and exploration of new innovation capabilities simultaneously. However, this strategy is a formidable task for SMEs to successfully implement, given the paucity of slack resources and failure risk of technological innovations. So, the government should provide financial resources for SMEs, which run the risk of changing their strategic configuration by investing in technological innovation. Without slack resources from outside agencies, SMEs face a greater difficulty in jumping to the innovator group only by using their own resources and capabilities. In addition, strengthening the relationships among industry-university-research institutes can alleviate the risk of new technological development efforts of SMEs.

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<Table 1> Statistics of production amount in the Korean electronic components industry

Production Amount (Billion Won, %)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Average Growth Rate ('90-'01)
Semiconductor	3,220	3,615	4,689	6,054	7,432	11,891	19,122	16,038	18,923	24,129	26,069	31,652	19,391	
		12.3%	29.7%	29.1%	22.8%	60.0%	60.8%	-16.1%	18.0%	27.5%	8.0%	21.4%	-38.7%	19.6%
Other Electronic Components	5,027	5,498	6,266	6,154	6,718	7,868	9,261	10,603	12,162	13,880	16,741	14,248	12,845	
		9.4%	14.0%	-1.8%	9.2%	17.1%	17.7%	14.5%	14.7%	14.1%	20.6%	-14.9%	-9.8%	8.7%
Electronic Components Total	8,246	9,113	10,956	12,208	14,150	19,759	28,383	26,641	31,085	38,009	42,810	45,900	32,236	
		10.5%	20.2%	11.4%	15.9%	39.6%	43.6%	-6.1%	16.7%	22.3%	12.6%	7.2%	-29.8%	13.7%

Source: Korea Electronics Association (KEA), Statistics for Korea Electronic Industries, each year.

Note: 1,000 Korean won is approximately 1 US dollar.

<Table 2 > The annual wages of small manufacturing firms

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Average Increase ('87-'01)
Korea annual wage (Million Won)	2.7	3.2	3.9	4.6	5.4	6.6	7.6	8.6	9.7	10.9	12.3	13.1	12.5	13.0	14.4	15.6	
		15.2%	24.7%	15.8%	19.0%	22.4%	14.4%	13.4%	12.8%	12.6%	12.7%	6.3%	-4.4%	4.3%	10.5%	8.4%	12.5%
China monthly wage (Yuan)	106.3	118.2	142.5	158.3	172.3	190.8	219.6	279.0	356.9	430.8	470.2	494.4	588.7	649.5	729.2	814.5 (1.2)	
		11.2%	20.6%	11.1%	8.8%	10.7%	15.1%	27.1%	27.9%	20.7%	9.2%	5.2%	19.1%	10.3%	12.3%	11.7%	14.7%
Taiwan monthly wage (new Taiwan dollar)	13,983	15,356	17,012	19,461	22,048	24,469	26,986	28,869	30,797	32,545	33,900	35,456	36,436	37,686	38,792	38,277 (13.8)	
		9.8%	10.8%	14.4%	13.3%	11.0%	10.3%	7.0%	6.7%	5.7%	4.2%	4.6%	2.8%	3.4%	2.9%	-1.3%	7.0%

Source: Korea Federation of Small and medium Business (KFSB), Statistics DB of Korean Small and Medium sized Enterprises (SMEs).

ILO (international labor organization), LABORSTA Internet (http://laborsta.ilo.org/)

Note: 1 Yuan is approximately 120 Korean won. 1 new Taiwan dollar is approximately 30 Korean won.

<Table 3> Operationalization of the strategic variables

Variables	Operational Definition	Means at T1 (s.d.)	Means at T2 (s.d)
i) number of product lines	Count of product with distinct functions and raw materials	2.66 (1.63)	3.20 (1.69)
ii) product diversity	$= \sum_{i=1}^{n} (p_i \ln(1/p_i))$, where p_i is the portion of i^{th} product type in total sales	0.352 (0.273)	0.432 (0.277)
iii) export ratio	= amount of export/total sales	0.23 (0.30)	0.25 (0.26)
iv) ratio of sales through market	= 1- (sales from long-term contract-based product/total sales)	0.20 (0.30)	0.19 (0.29)
v) number of customers	= ln (number of customers that have on-going demand)	3.12 (1.43)	3.39 (1.39)
vi) customer diversity	= 1 - (sales from the largest customer/total sales)	0.60 (0.28)	0.64 (0.23)
vii) ratio of technical manpower (%)	= (number of engineers and R&D specialists/ total employees) x 100	9.71 (7.27)	11.63 (7.89)
viii) size of technical manpower	= ln (amount of technical manpower)	2.67 (1.07)	2.92 (1.01)
ix) R&D intensity (%)	= R&D investment/ total sales x 100	2.83 (2.57)	3.71 (2.74)
x) ratio of new products	= number of new products/ln (total sales)	0.96 (1.76)	1.41 (2.72)
xi) manufacturing intensity	= net book value of machinery and equipment/total sales	4.46 (4.88)	4.44 (4.92)
xii) production equipment per worker	= net book value of machinery and equipment/total number of shop floor workers	45.14 (67.92)	60.10 (72.81)
xiii) degree of automation	= (number of semi-automated production processes + number of automated production processes x 2)/total number of production processes	1.57 (0.44)	1.82 (0.48)

<Table 4> Profiles of strategic groups for each time period

T1 (1990-1992)	Subcontractor (n=40)	Production focus (n=20)	Market focus (n=22)	Innovator (n=20)	ANOVA F-value
Innovation capability	-0.66 (d)	-0.26 (c)	0.26 (b)	1.30 (a)	37.8 ***
Production capability	-0.53 (c)	1.43 (a)	-0.10 (b)	-0.27 (bc)	36.7 ***
Production line breadth	-0.36 (b)	-0.45 (b)	1.44 (a)	-0.42 (b)	45.0 ***
Market breadth	-0.75 (c)	0.13 (b)	0.47 (ab)	0.85 (a)	23.4 ***
T2 (1993-1995)	Subcontractor (n=40)	Production focus (n=20)	Market focus (n=27)	Innovator (n=15)	ANOVA F-value
Innovation capability	-0.63 (c)	-0.32 (c)	0.25 (b)	1.65 (a)	48.8 ***
Production capability	-0.41 (b)	1.23 (a)	-0.24 (b)	-0.11 (b)	20.4 ***
Production line breadth	-0.31 (b)	-0.71 (b)	1.21 (a)	-0.40 (b)	41.0 ***
Market breadth	-0.88 (b)	0.40 (a)	0.71 (a)	0.52 (a)	34.3 ***
T3 (1996-1998)	Subcontractor (n=23)	Production focus (n=22)	Market focus (n=14)	Innovator (n=13)	ANOVA F-value
Innovation capability	-0.61 (c)	-0.27 (bc)	-0.09 (b)	1.65 (a)	39.6 ***
Production capability	-0.70 (b)	0.67 (a)	-0.29 (b)	0.41 (a)	11.9 ***
Production line breadth	-0.16 (b)	-0.69 (c)	1.27 (a)	0.08 (b)	20.5 ***
Market breadth	-1.04 (b)	0.36 (a)	0.50 (a)	0.69 (a)	25.5 ***

T4 (1999-2001)	Subcontractor (n=27)	Production focus (n=14)	Market focus (n=11)	Innovator (n=9)	New market focus (n=10)	ANOVA F-value
Innovation capability	-0.34 (b)	-0.37 (b)	-0.12 (b)	1.78 (a)	-0.21 (b)	17.0 ***
Production capability	-0.64 (c)	0.99 (a)	0.00 (b)	1.04 (a)	-0.56 (c)	18.8 ***
Production line breadth	-0.35 (c)	-0.92 (d)	1.41 (a)	0.24 (b)	0.15 (b)	27.1 ***
Market breadth	-0.87 (d)	0.40 (bc)	-0.08 (c)	0.57 (b)	1.22 (a)	23.4 ***

Note: +: p<0.1, *: p<0.05, **: p<0.01, ***: p<0.001; a, b, c, d, e : Duncan's Multiple-Range test results

An outlier group (single firm) is excluded in the t4 period.

<Table 5> Performance differences among strategic groups at each time period

ANCOVA T1 (1990-1992)	Subcontractor (n=40)	Production focus (n=20)	Market focus (n=22)	Innovator (n=20)	Mean	Univariate F-value
Sales growth rate	24.8	37.2	34.1	102.5	45.5	1.1
ROS	4.1 (b)	7.9 (a)	7.1 (ab)	7.9 (a)	6.3	2.8 *
ROA	6.8	8.4	7.2	9.1	7.6	1.0
Sales per employee	47.3	51.6	56.1	60.4	52.6	0.9
ANCOVA T2 (1993-1995)	Subcontractor (n=40)	Production focus (n=20)	Market focus (n=27)	Innovator (n=15)	Mean	Univariate F-value
Sales growth rate	24.6	18.7	22.2	28.9	23.4	0.9
ROS	4.9 (b)	8.0 (a)	4.0 (b)	9.6 (a)	6.0	6.5 ***
ROA	7.5 (b)	8.1 (ab)	5.1 (b)	12.1 (a)	7.7	2.7 +
Sales per employee	66.8 (b)	81.7 (ab)	84.9 (ab)	102.2 (a)	79.7	2.5 +
ANCOVA T3 (1996-1998)	Subcontractor (n=23)	Production focus (n=22)	Market focus (n=14)	Innovator (n=13)	Mean	Univariate F-value
Sales growth rate	19.8	13.5	11.8	15.8	15.7	0.6
ROS	5.8 (b)	5.8 (b)	7.3 (ab)	11.2 (a)	7.1	2.7 +
ROA	11.0	7.7	8.8	11.2	9.6	0.9
Sales per employee	124.1	122.6	137.3	149.3	130.9	0.3

ANCOVA T4 (1999-2001)	Subcontractor (n=27)	Production focus (n=14)	Market focus (n=11)	Innovator (n=9)	New market focus (n=10)	Mean	Univariate F-value
Sales growth rate	18.2	10.4	19.7	17.7	9.7	15.7	0.7
ROS	5.0 (b)	6.0 (ab)	8.1 (ab)	9.1 (a)	5.4 (ab)	6.3	2.7 *
ROA	8.4	7.2	11.3	8.5	6.2	8.3	1.2
Sales per employee	191.0	162.6	176.9	184.7	213.0	185.8	0.3

Note: +: p<0.1, *: p<0.05, **: p<0.01, ***: p<0.001; a, b, c, d, e : Duncan's Multiple-Range test results

Ratio of sales volume for IT is controlled as a covariate.

An outlier group (single firm) is excluded in the t4 period.

<Table 6> Changes in strategic group membership at each time period

	Subcontractor	Production focus	Market focus	Innovator	T1 Total	
Subcontractor	33 (83%)	4 (10%)	2 (5%)	1 (3%)	40 (39.2%)	
Production focus	4 (20%)	13 (65%)	3 (15%)	0	20 (19.6%)	
Market focus	2 (9%)	1 (5%)	19 (86%)	0	22 (21.6%)	
Innovator	1 (5%)	2 (10%)	3 (15%)	14 (70%)	20 (19.6%)	
T2 Total	40 (39.2%)	20 (19.6%)	27 (26.5%)	15(14.7%)	102	
	Subcontractor	Production focus	Market focus	Innovator	T2 Total	
					Survivor	Cessation
Subcontractor	23 (82%)	4 (14%)	1 (4%)	0	28	12
Production focus	0	12 (92%)	0	1 (8%)	13	7
Market focus	0	2 (8%)	12 (78%)	4 (14%)	18	9
Innovator	0	4 (31%)	1 (7%)	8 (62%)	13	2
T3 Total	23 (31.9%)	22 (30.6%)	14 (19.4%)	13(18.1%)	72	30
	Subcontractor	Production focus	Market focus	Innovator	New Market focus	T3 Total
Subcontractor	21 (91%)		2 (9%)			23 (32.4%)
Production focus	5 (23%)	14 (64%)			3 (14%)	22 (31.0%)
Market focus			8 (62%)		5 (38%)	13 (18.3%)
Innovator	1 (8%)		1 (8%)	9 (69%)	2 (15%)	13 (18.3%)
T4 Total	27(38.0%)	14 (19.7%)	11 (15.5%)	9 (12.7%)	10(14.1%)	71

Note: An outlier group (single firm) is excluded in the t4 period.

<Table 7> Prior firm performance and strategic group membership change: 2-way ANOVA

Strategic group membership		Subcontractor (n=91)			Innovator (n=46)		
		Stay	Exit	Mean	Stay	Exit	Mean
Prior ROS	T1 => T2	3.4 (n=33)	8.4 (n=7)	4.1 (n=40)	8.7 (n=14)	6.2 (n=6)	8.0 (n=20)
	T2 => T3	4.4 (n=23)	7.1 (n=5)	4.9 (n=28)	11.9 (n=8)	6.0 (n=5)	9.6 (n=13)
	T3 => T4	5.8 (n=21)	5.8 (n=2)	5.8 (n=23)	12.0 (n=9)	7.7 (n=4)	10.7 (n=13)
	Mean	4.5 (n=77)	7.1 (n=14)		10.9 (n=31)	6.6 (n=15)	
F-value	Change effect	3.6 +			4.2 *		
	Time effect	0.0			0.5		
	Interaction	1.1			0.2		
	Total	2.4 *			1.1		

Note: +: p<0.1, *: p<0.05, **: p<0.01, ***: p<0.001

<Table 8> Strategic group membership change and posterior firm performance: 2-way ANOVA

Strategic group membership		Subcontractor (n=91)			Innovator (n=46)		
		Stay	Exit	Mean	Stay	Exit	Mean
Posterior ROS	T1 => T2	4.4 (n=33)	7.1 (n=7)	4.9 (n=40)	9.8 (n=14)	6.0 (n=6)	8.6 (n=20)
	T2 => T3	5.8 (n=23)	7.3 (n=5)	6.1 (n=28)	12.5 (n=8)	-3.9 (n=5)	6.2 (n=13)
	T3 => T4	5.0 (n=21)	8.1 (n=2)	5.3 (n=23)	8.0 (n=9)	4.9 (n=4)	7.1 (n=13)
	Mean	5.1 (n=77)	7.5 (n=14)		10.1 (n=31)	2.4 (n=15)	
F-value	Change effect	3.4 +			5.7 *		
	Time effect	0.2			0.4		
	Interaction	0.1			1.7		
	Total	1.1			1.9		

Note: +: p<0.1, *: p<0.05, **: p<0.01, ***: p<0.001