Strategic group formation and inter-firm networks in the international information technology industry

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Summary

Strategic partnering and the analysis of strategic groups are two issues which enjoy a growing interest from industrial economists as well as from strategic management scholars. Although it appears neglected in the literature the possible linking of the analysis of strategic groups with corporate network studies could generate further understanding of the process of strategic group formation. The analysis of strategic groups so far has suffered a major drawback from the fact that the identification of strategic groups had little material basis in the actual coherence of groups and has ignored the degree of interaction within a particular group. If the cooperative efforts of companies, i.e. the interplay of strategic groups, would be included in the analysis, the concept of strategic groups would gain substantial improvement in demonstrating the value of strategic group analysis. The present contribution focuses on the relationship between strategic groups and networks of companies in the international information technology industry in order to study the possible symmetry of the structure of strategic group formation and parallel inter-firm networks of strategic partnering.

Introduction

The analysis of strategic groups plays an important role in studies on industry structures and corporate strategies inspired by both industrial organisation and theories of strategic management. In the traditional industrial organisation literature sectors of industry and firms were to a large degree theoretically understood in terms of homogeneity, in later contributions alternative conduct influences market performance of companies allowing for a larger degree of industry heterogeneity. The introduction of behavioural aspects brings contributions from industrial organisation or industrial economics and strategic management together as more attention is paid to heterogeneity and mobility barriers within industries. Although not without theoretical implications, in terms of the level of analysis, strategic group theory can be seen as a compromise between the traditional economics inspired literature and the more practically and behaviour oriented literature on corporate strategy (see Barney and Hoskisson, 1990).

Generally, this concept of strategic groups is defined in terms of clusters of companies which pursue similar strategies with identical resources (see e.g. Hatten and Hatten, 1987), but the concept often remains somewhat vague. In a number of contributions one finds rather different bases for group foundation. For instance in McGee and Thomas (1986) a review of the literature demonstrates that at least 15 different sets of indicators are applied in less than 20 relevant studies. From a survey of empirical research on strategic groups in Thomas and Venkatranan (1988) one can also deduct a large number of different indicators. These indicators range from straightforward size-classes and measures of the degree of vertical integration to multivariate indicators with different selections of a number of familiar company characteristics.

Our present contribution is primarily aiming at a moderate extension of the research agenda. We do not present an extensive review of the state-of-the-art but build our analysis upon established understanding of strategic groups as it is thoroughly discussed in the survey literature mentioned above. Apart from these reviews many other contributions present more or less extensive overviews of the pathbreaking pre-1990s contributions. This has a certain 'percolating' effect in the repeated discussion of the same body of established literature. The main objective of the present analysis is the critical assessment of the value of strategic group analysis for understanding the structure

of heterogeneity in industries. In short, one has to find both a theoretical rationale for strategic group formation as well as some evidence of their empirical relevance if one seeks to establish some understanding of corporate behaviour in between an industry equilibrium or idiosyncratic corporate behaviour that blinds our theoretical understanding of structures and processes.

In the following sections we will first discuss some of the main topics in the discussion on strategic groups and its analytical depth, as well as introduce research topics that we address in this paper. Major research questions we deal with in this paper are related to:

- the (empirical) understanding of strategic group formation in a multivariate setting including both structural and behavioural corporate characteristics, and
- an a priori more theoretically based understanding of strategic groups in terms of group cohesion established by inter-firm partnering within groups of companies.

After a brief discussion of strategic group analysis we continue with a short elaboration on the subject of the strategic space that defines the level of competitive positioning that one has to discern before strategic group analysis is further developed. Although not without theoretical implications our analysis is of an empirical nature as we study the possible strategic group formation processes and the cohesion of group formation for the international information technology industry. This industry is chosen for several reasons but its non-standard industry classification character, the wealth of statistical material and company information, and the 'tradition' of inter-firm cooperation are amongst the more important motives. Before we present the actual analysis of strategic groups and discuss the conclusions in the final section, we first give a brief description of the population, the relevant variables and the data that mark the general outline of our research strategy.

Understanding strategic group formation

In their critical assessment of recent research on strategic groups Thomas and Venkatraman (1988) discuss a relatively large list of suggested directions for improved theoretical and empirical explorations. These valuable recommendations are largely based on their criticism of the state-of-the-art in strategic group analysis through which they advocate amongst other things a broader conceptualisation of strategy in order to capture

the complexity of the strategy construct, stress the importance of cross national border competition and explain the necessity to analyse inter-firm competition from a perspective that surpasses the classical industry classifications. In terms of theory development we fully support these authors' statement that strategic group analysis only makes sense if this is theoretically anchored and leading to empirically observable, yet not trivial, 'clustering' of companies in particular product - market combinations. Such contributions to the debate provide a long 'shopping list' of items to be studied and addressed. In the present contribution we will attempt to cover a number of the most important subjects for this line of studies, admitting that a single contribution is limited in both scope and empirical investigation.

A particular interesting and necessary, but also demanding, task is the urgency to provide a richer operationalisation of corporate strategy than found in most research, going beyond one functional area, 'unfolding' the so called 'strategic space' into several dimensions of strategic groups, see also Fiegenbaum et al (1987). The complexity of such a strategic space in terms of levels of corporate control or company organisation, components of strategic decisions and the dynamic aspects of changes in both other dimensions is not only interesting but also theoretically a point well made. Unfortunately, the step from the present state of analysis to such a more perfected framework could also be too large to take at once, given the present state of theory and lack of detailed systematic empirical knowledge. However, in a less complicated and more straightforward interpretation of such a strategic space one can construct a continuum of strategic group dimensions that reaches from company structure variables to more strategic and behavioural variables that facilitate the understanding of possible industry heterogeneity.

Given the increased internationalisation of companies this line of research should also go beyond national borders and include international markets in order to address multi-point competition at a global scale. Previously much research on strategic groups was concentrated on the identification of these groups within one national context. Besides some possible methodological insights based on these studies their benefits in terms of empirical and/or theoretical results are increasingly becoming obsolete.

Apart from a broader international interpretation of markets it appears worthwhile to explore the phenomenon of strategic groups in relevant product markets replacing artificial or outdated product-based industry classifications. An important point

to be made in that the abundance of statistical artefacts in official statistics is hardly a guarantee for relevant findings if competition takes place in markets that are only partly covered by such industry classifications. Also, as many companies compete in different markets strategic group formation should not be identified in terms of companies' main economic activities but more in particular to their multi-market competitive positioning. All this is necessary not so much to correct statistical mismatches with otherwise observable 'facts' but much more to catch as much as possible of the relevant charateristics of competition and the strategic space in which companies operate.

Some contributions support a more inter-subjective approach of the selection of dimensions of strategic groups by including the perception of strategic groups by the management of relevant companies (Pehrsson, 1990; Thomas and Venkatraman, 1988). We, however, think it is sufficient to take a more 'objective' position linking structural aspects of strategic groups to behavioural aspects that together build the necessary information for understanding the configuration of companies in industries. Also a more 'popular' understanding of strategic groups itself does not necessarily generate additional objectifiable information that can contribute to the theoretical understanding of the subject.

This theoretical understanding or at least the attempt to improve theory building seems a necessary step because identifying several strategic groups within an industry, however broad, narrow or original the classification, has only very limited value. It only gives some empirical understanding of sectoral heterogeneity that underpins the intra-industry economic performance variance. Given the relatively large number of studies with empirically derived groupings a more a priori and theoretically supported approach, that also discussses an explicit rational for strategic groups, could be seen as a necessary step forward, see also Barney and Hoskisson (1990). In particular if it is combined with a more multidimensional understanding of strategic group formation, see Kumar et al (1990) and Thomas and Venkatraman (1987), perceiving the rational for strategic groups in terms of inter-firm cohesion can increase the comprehension of the relevance of heterogeneous goups of firms within markets.

Although still largely neglected in the literature, it appears worthwhile to link the analysis of strategic groups to the study of networks of companies. Much of the analysis so far has suffered a major drawback from the fact that the identification of strategic

groups has little material basis in the actual coherence and has ignored the degree of interaction within a particular group. Usually a strategic group is only identified because companies have analogous characteristics in terms of economic inputs and/or outputs, organizational structure, and market position. In other words, a group merely reflects the number of units that builds a collectivity sharing certain characteristics, which was previously discussed as the basic collectivity emphasizing the heterogeneity in a larger total of groups. If the actual cooperative efforts of companies, i.e. the interplay and interaction of companies, would be included in the analysis, the concept of strategic groups would gain substantial improvement in demonstrating the coherence of strategic groups. A somewhat similar approach, extending the existing research agenda, is advocated by Nohria and Garcia - Pont (1991). Their contribution not only stresses the role of strategic capabilities in defining strategic groups it also links the analysis of strategic groups to the structure of inter-firm networks found in so-called 'strategic blocks'. Following this line of research, strategic groups could be identified not only with regard to their general resemblance in economic, strategic, or organizational characteristics but also in their common cooperative efforts, the degree of interaction, and their similarity with respect to the choice of partners. This approach to a certain extent revives the original concept of strategic groups as expressed in the field of industrial organisation that addressed the cooperative character of group formation.

Such elaborations lead us to the following two major issues to be studied in the empirical sections of this contribution:

- First, we will analyse strategic group formation in a multidimensional strategic space within international markets with a set of variables that follows from the brief discussion of directions for research outlined in the above. In terms of strategic groups research classifications this first step in the present contribution is still to be seen as a multidimensional operationalisation of corporate strategy with a posteriori, only partially theoretically deduced, understanding of groupings.
- The second issue we will study, after we have been able to construct strategic groups in a research population, is the attempt to find a more a priori theoretically specified relation of strategic groups with inter-firm cooperation as indicated in the above. In essence this issue boils down to the much more interesting research question whether the structure of strategic group formation

is reflected in the structure of parallel inter-firm networks of strategic partnering.[1]

Operationalisation of strategic space

In this paper the industry in which companies operate is loosely defined in terms of a broad set of product-market combinations of relevant companies in an international context extending beyond traditional industry classifications. Also, the group of companies that build an industry are not restricted to those for which a particular activity is also a major or the only business. Consequently, companies can operate in different industries allowing for multi-point competition.

Within this general strategic space we can discern a number of dimensions of strategy. As mentioned above we understand these to lay on a continuum from structural variables to more strategic and behavioural variables. Also the national background of companies could be a relevant aspect of the strategic space.

Although competition is gradually becoming more international, the country of origin of companies could very well be an important characteristic of strategic groups because we can expect that regional distance plays at least some role in group formation. If this is not the case or if country-specificity plays only a limited role it stresses the point made previously that strategic group formation has to seen in a global perspective.

Structural company heterogeneity can be related to both size of companies and their degree of diversification. The former dimension refers to the inter-firm differences in capabilities to generate economies of scale, the latter indicates possible economies of scope for a multi-product firm or a more specialised status for non-diversified companies. The dimension of diversification or width of corporate activities already takes an intermediary position in between structural and behavioural aspects of strategic groups because diversification not only reflects size it also indicates a strategic intent to confront multi-market competiton. A more outspoken set of characteristics of corporate behaviour reflects the crucial range of alternative strategies that can discriminate between groups

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[1] Compared to Nohria and Garcia - Pont (1991) this question primarily addresses the possible 'association' of strategic groups with 'pooling blocks', i.e. the likely clustering of cooperating firms from the same strategic groups. However, in the further examination of the empirical material we can also pay some attention to possible 'complementary blocks' of companies from different strategic groups.

of companies. In terms of general strategies these differences reflect broad categories of alternative strategic positioning, e.g. corresponding with Porter's (1985) generic strategies. For sectors where differentiation or focus strategies are most appropriate for competitive positioning in high-tech activities technology strategies demonstrating different degrees of corporate commitment to innovation, coinciding with dissimilarities in technological capabilities, seem most appropriate to discriminate between companies.

Contrary to a substantial part of the literature to which we relate in our present contribution, we stress that strategic group formation is not only emerging from similar strategies, as e.g. clearly stated in Fiegenbaum et al (1987) and Phersson (1990). We contend that, apart from issues such as group cohesion and a theoretical rationale for 'clustering', corporate structure related characteristcs are important phenomena for understanding strategic group formation. If the firm structural dimension is not included the existing barriers that limit the range of behavioural autonomy are ignored. In that case a particular interpretation of strategic similarity of companies with different size-attributes, say a small niche-player and a large, diversified company that follows a focus strategy in only one of its many activities, would arbitrarily conclude a strategic resemblance that is nothing but a clear example of a crude statistical artefact.

Description of population, variables and data

For the empirical analysis of strategic groups we have chosen the international information technology industry with its three large sub-sectors, i.e. dataprocessing, telecommunications, and microelectronics. Basic arguments for choosing this industry are: the strong international character of competition, its multi-market competition between a large number of players, product-market combinations going beyond traditional sector classifications, and the relative abundunce of reliable corporate indicators. For each of these sectors we analyze economic and technological data on structural and behavioural apects of the major producers of which the vast majority comes from the Triad: Europe, i.e. EC and EFTA countries, the USA and Japan. The data we analyze refer either to the period of the nineteen eighties at large or to the second half of the eighties, partly depending on the availability of consistent statistical material.

For the international information technology industry we constructed the following

sub-sectors. Dataprocessing has a population of 25 leading companies, of which 12 are US companies, 4 companies are European and 9 companies are Japanese. The telecommunications industry comprises a population of 25 companies with 5 US companies, 12 European companies, 7 Japanese companies and 1 miscellaneous company. Finally, the microelectronics sector consists of 20 companies of which 6 are US companies, Europe has 3 and Japan has 10 companies in the sector, 1 company falls in the category of 'others', see also Appendix I.

The data for the analysis are based on the MERIT-CATI data bank that holds information on a large number of indicators of corporate behaviour and performance, see the Appendix II. As an indicator of size we have taken the average of corporate revenues that companies realized during the period 1986 - 1990. We chose revenues as an indicator instead of the more frequently applied employment indicator to account for organizational differences and effects of quasi-integration. It is well-known that Japanese companies have fewer employees than their US and European competitors due to the Japanese lean production practice and sophisticated customer - supplier networks. Therefore, their size in terms of revenues, which roughly equals turnover, is in our opinion a better indicator of their economic magnitude in comparison with companies from other regions. Differences in corporate size in each sub-field of information technology are analysed by means of two indicators. The first indicator (SIZE) is the average total revenues of companies for the yearly average of the period 1986 - 1990. The second indicator (DPSIZE, TELSIZE, SEMSIZE) is related to the dataprocessing, telecommunications, or microelectronics activities of these companies, i.e. their average revenues in each of these fields during the same period.

Other characteristics we include are related to corporate diversification and specialisation patterns. By looking at the pattern of diversification we can say something about the width of the activities of companies in terms of their operations and general technical capabilities that possibly generate economies of scope, or whether they follow a strategy that concentrates their activities mainly in particular sub-fields of dataprocessing, telecommunications or microelectronics building on specialized capabilities. Diversification is first measured as the average number of information technology segments from a total of twenty segments in which companies were engaged during 1989. The degree of specialization is a different measure indicating the share of

dataprocessing, telecommunications, or microelectronics sales in total corporate sales during the period 1986 - 1989. We apply principal component analysis to reduce our data set in order to arrive at one composite variable (DIV).

The technology strategy variable (TECH) is based on a number of innovation and technological strength related indicators. The absolute innovative strength of companies is indicated by their number of sector relevant US patents, granted in the period 1980 - 1988. We have taken US patents because we expect the US market to be the most advanced in terms of the combination of competition, openness and technological sophistication, in particular in information technology. The absolute number of patents granted was taken to have at least one indicator of absolute strength next to a number of more relative indicators. Also, we found that the correlation between R&D intensity, alliance related variables and patenting intensity is extremely weak, whereas the correlation with the absolute number of patents is significant.

An indicator of innovative capabilities and efforts from the innovation input perspective is the R&D intensity of firms, i.e. their total R&D expenditures as a percentage of total corporate sales during the period 1986 - 1990.

Apart from these two 'standard' innovation strategy indicators we will also include a measure that is related to the strategic technology partnering behaviour of firms in each sub-field during the eighties. In order to construct a combined indicator of strategic technology partnering behaviour of companies we apply principal component analysis once more, this time by combining two measures of technological strength as expressed in partnering behaviour. One of these measures indicates if the strategic technology alliances of companies in relevant sub-fields are primarily related to R&D or whether these alliances are more closely related to marketing and market entry activities. We include this indicator because Hagedoorn and Schakenraad (1991) found that, in particular in information technology, R&D inclined strategic linkages are associated with improved economic performance. The other partnering related measure indicates the degree to which the strategic partnerships of companies generate technology to their partners or absorb technology from them. We assume that the more a company generates technology to its partners the stronger the technological position of this company. The combined measure of these two ratios indicates the degree of technological strength of companies through strategic technology partnering, see

Appendix II for an additional explanation of these measures.

The relationships between dimensions, variables and indicators of strategic groups are summarized in Figure 1.

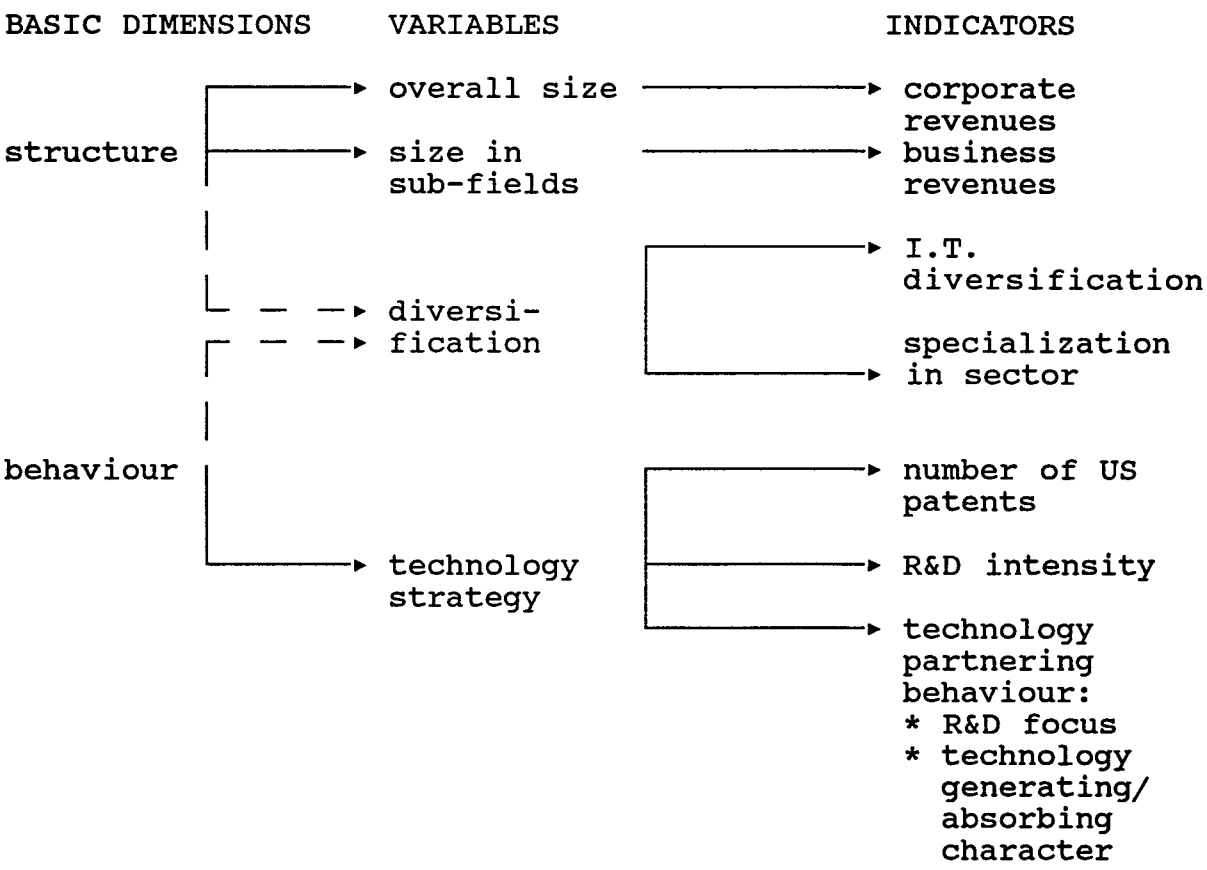

Figure 1 An overview of the applied strategic group indicators

For the second topic, assessing the possible association of strategic groups with networks of strategic technology partnering, we take the number of registrered inter-firm strategic technology alliances in the MERIT-CATI data bank as the unit of analysis, see also Appendix II. To reconstruct similarity of partnering behaviour and networks of firms in sub-fields of information technology we have taken all relevant inter-firm linkages established during the period 1985-1989 plus those made before 1985 that were not already discontinued in 1985.

The MDS technique that we apply for analysing both strategic groups and inter-firm strategic linkages will be briefly explained in the next section where the findings of our analysis are presented.

The analysis of strategic groups

In the present study we do not apply cluster analysis to detect strategic groups, as found in so many studies on strategic groups and strongly suggested by Harrigan (1985). A major reason for this is that to a large extent clusters, i.e. strategic groups, can always be generated for any larger population of companies, see Thomas and Venkatraman (1988). There are, of course, statistical procedures that can specify preferred cluster solutions in terms of 'tightness' of clusters and significance levels associated with variable differences between clusters, but in general also clusters of companies can largely exist only in the eyes of the beholder.[2] In the following we will apply a so-called multidimensional scaling (MDS) technique that enables us to identify groups of companies and interpret the 'rationale' of the formation for this grouping separately. MDS is a data reduction procedure comparable to principal component analysis and other factor analytical methods. One of the main advantages of MDS is that usually, but not necessarily, MDS can fit an appropriate model in fewer dimensions than can factor analytical methods. This increases the possibility of easy interpretable two-dimensional pictures. MDS offers scaling of similarity data into points lying in an X-dimensional space. The purpose of this method is to provide coordinates for these points in such a way that distances between pairs of points fit as closely as possible to the observed similarities.

In this section and the following one we analyze two different sets of data. For the analysis of strategic groups we measure the resemblence of companies on the four variables listed in Figure 1, i.e. overall size, size in relevant sub-fields, diversification, and technology strategy. For these four variables one would need a four dimensional space in order to represent the scores on the various variables. Using the formula given below we can aggregate the Euclidean distance between companies on each dimension and represent the data in a (dis)similarity matrix that can be scaled by an MDS program, as follows:

$$d_{ij}\,[\sum_{k=1}^{r}\,(X_{ik}-X_{jk})^{2}]^{1/2}$$

[2] An even stronger criticism of cluster analysis in this line of studies and an extensive discussion of the circular logic in cluster-analysis based contributions is found in Barney and Hoskisson (1990).

According to this procedure we first square the differences in coordinates dimension by dimension (k), add up the results, and take the square root of the total sum. Smaller distances between companies are then associated with more similar scores on the various characteristics. In order to facilitate interpretation the solution is given in two dimensions, provided that the fit of the model is acceptable. A stress-value indicates the goodness-of-fit of the configuration. For all MDS solutions presented in this paper the stress-values range from acceptable to very good.[3]

For the analysis of the structure of inter-firm strategic technology partnering the statistical procedure can be somewhat less complicated as the total number of alliances between companies are taken as a measure of similarity. A large similarity indicates intensive cooperation and/or a large similarity in terms of the partners of these companies.

With MDS-analyses there are in principle two complementary lines of interpretation, i.e. a dimensional as well as a neighbourhood interpretation. In the following only the latter interpretation, with small distance in the configuration indicating large similarity, is applied because the dimensional interpretation will generate hardly any results. To facilitate interpretation of the regional or national background of companies Japanese firms are put in rectangles, American firms in flat ellipses, European firms in spherical ellipses, and companies from outside the TRIAD in squares.

The first topic we address is the a posteriori, largely inductive, finding of strategic groups in the international dataprocessing, telecommunications and microelectronics industries, for which the interaction of companies as a measure of coherence is not taken into account. In Figure 2 we can identify four of these groups of companies for the **dataprocessing** industry:

- the first group contains large, diversified companies with only a modest interest in dataprocessing, i.e. the Japanese companies Matsushita, Toshiba, NTT,

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[3] Stress values of MDS solutions for the strategic group analysis and the analysis of strategic technology partnering are:

	strategic groups	alliances
dataprocessing	0.04	0.06
telecommunications	0.05	0.11
microelectronics	0.05	0.10

Mitsubishi, and Canon, the European electronic concerns Philips and Siemens, and two US companies, AT&T and Xerox,

- Wang, Compaq, Seagate and CDC, four relatively small and specialized US dataprocessing firms create a second strategic group,
- another regional 'cluster' is found for three technologically sophisticated large Japanese firms with a major interest in dataprocessing or closely related fields, i.e. Hitachi, NEC and Fujitsu,
- adjacent to both of these two regional groupings we find a group of US and European dataprocessing companies, H-P, DEC, Unisys, Olivetti, NCR, Bull, and Apple, that are somewhat 'found-in-the-middle', in the sense that their scores on size, diversification, and technology strategy are in between that of the other three groups, mentioned above,
- finally, we observe two outliers, Amdahl, a US company recently acquired by Fujitsu, and more interestingly, IBM the by far largest yet rather specialized and technologically well developed company that seems to build a group of its own.

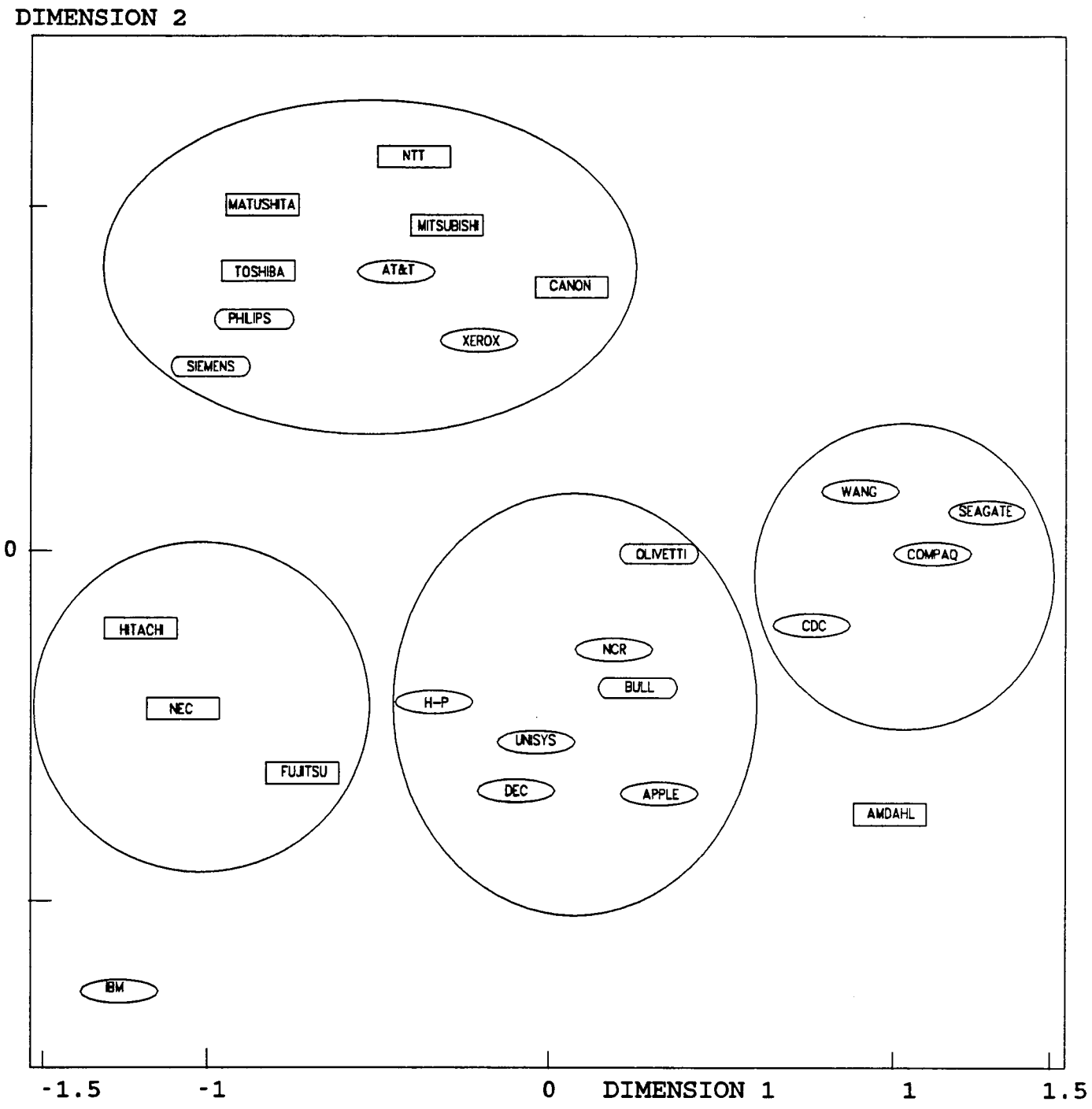
In the international **telecommunications** industry, see Figure 3, we also find a number of groups of companies with different structural and behavioural characteristics:

- the first strategic group one can identify consists of mostly diversified large companies with a minor interest in telecom; this cluster is of a 'Triadic' character with the Japanese corporations Matsushita, Toshiba, Hitachi, Fujitsu, and NEC, three European companies Philips, GEC, and Bosch, and GTE and Motorola as US representatives,
- Ericsson, Alcatel and Northern Telecom build a second group of specialized telecommunications firms with a rather strong position in the industry,
- a third group of small telecom specialists, with no apparent advanced technology strategy, is dominated by the European firms, STC, Nokia, Matra, Sagem, Racal, and Ascom; in this cluster we also find two Japanese firms, Ricoh and OKI, that are found to be very similar in their corporate charateristics,
- two leading IT firms, Siemens and IBM, form a different strategic group for which they share in particular their overall size and their level of technological sophistication,

- as with the dataprocessing industry we find one company to take a very special place in the industry, in this case AT&T stands out as a separate 'group' distinguishing itself from others in terms of its size in telecommunications and its technological strength.

Although the pattern of group formation in the **microelectronics** industry, see Figure 4, does not show either a particular 'outlier' nor a truly international group of firms, as is the case in the other two international sectors, the pattern of group differentiation is still somewhat similar in terms of combinations of size, diversification and technology strategies followed by companies operating in this field:

- at the bottom of Figure 4 we see an Asian cluster, including OKI, Sharp, Mitsubishi, Sony, and Sanyo from Japan and Samsung from South Korea, these companies can be characterized as diversified electronics companies with minor interests in microelectronics and no strong commitment to a state-of-the-art level of technological sophistication,
- AT&T and Philips form a separate pair of two large, technologically sophisticated, companies with a relatively small interest in microelectronics,
- in between these two groups we notice a group of five Japanese companies, i.e. NEC, Hitachi, Matsushita, Fujitsu, Toshiba, and Siemens from Germany; all these firms are large, diversified and innovative companies,
- a group of four small specialized microelectronics companies is formed by AMD, Intel and National Semiconductors from the USA and the European joint venture SGS/Thomson,
- two US companies are somewhat difficult to categorize: Motorola appears to share some chacteristics with the fourth strategic group we identified, TI comes somewhat closer to the cluster of specialized microelectronics companies; both companies are, however, still quite different from these groups in terms of the size of the former and the degree of diversification of the latter company.



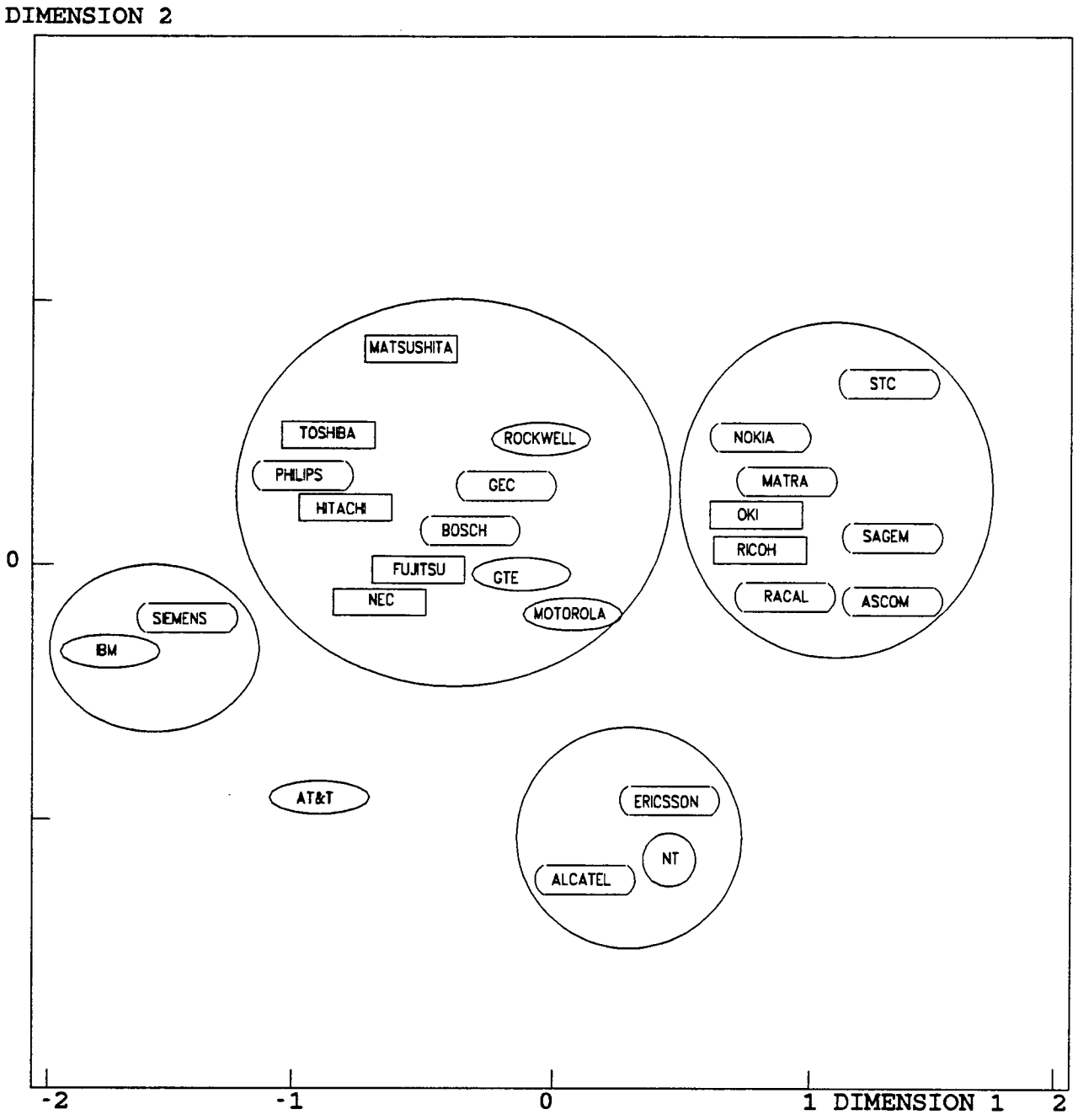
Legend:

Japanese companies

U.S. companies

European companies

Figure 2 Strategic groups in the international dataprocessing industry



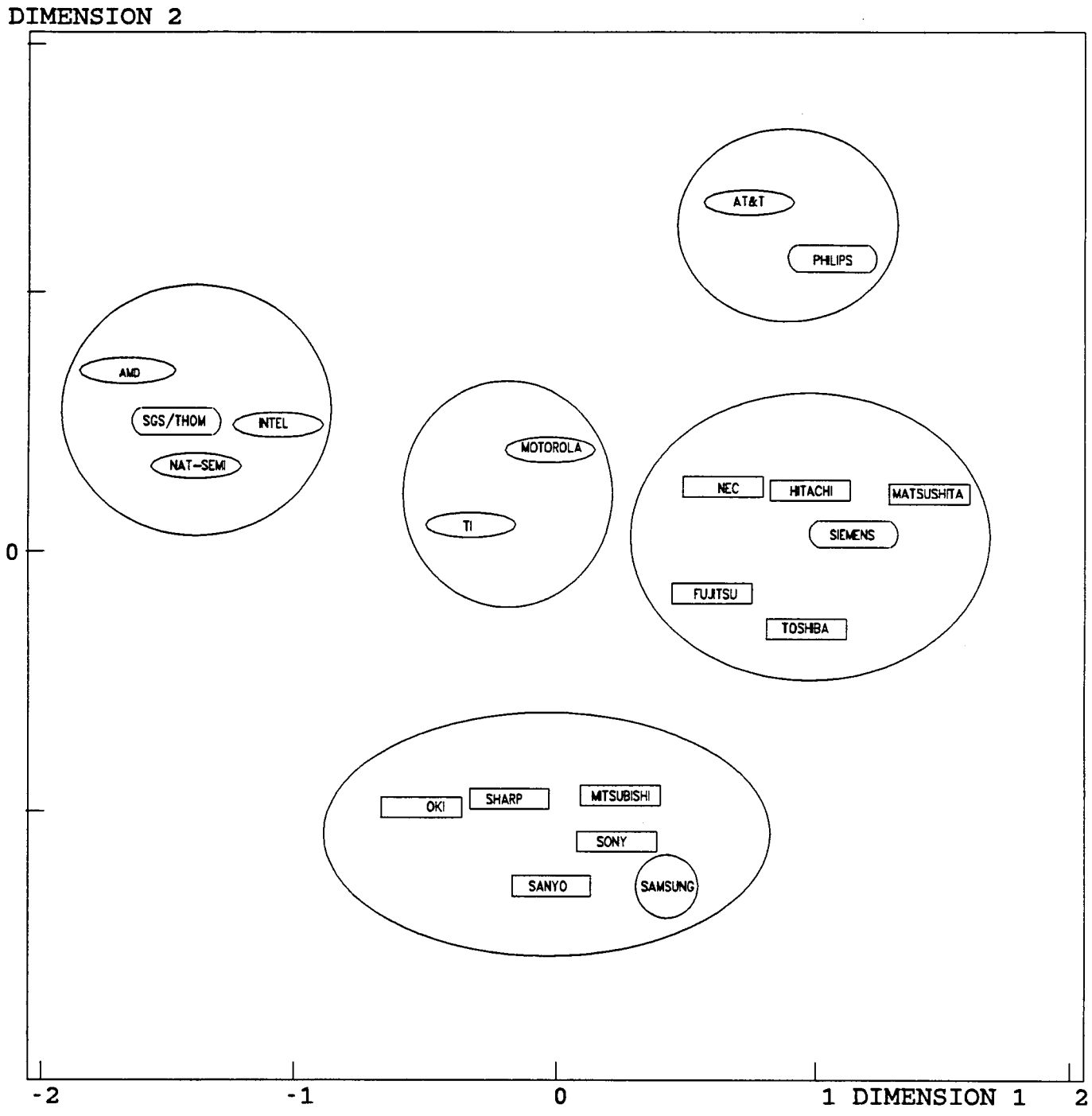
Legend:

Japanese companies

U.S. companies

European companies

Figure 3 Strategic groups in the international telecommunications industry



Legend:

Japanese companies

U.S. companies

European companies

Figure 4 Strategic groups in the international microelectronics industry

This analysis of different strategic spaces in the sub-fields of the international information technology industry demonstrates the possibility of grouping companies in a multidimensional setting of their structural and behavioural attributes. It pictures the heterogeneity of industry structures and the variance in competitive positioning by leading companies. For competitor analysis it can tell which firm belongs to which grouping and additional analysis can also reveal due to which scores it is found there. As already indicated above, it is, however, more appealing from an analytical perspective to study the possible association of these constructed strategic groups with inter-firm networks.

The analysis of networks of strategic technology partnering

In order to analyze the sectoral networks of cooperating companies and compare them with the groups of firms discussed above we apply MDS analysis in which, if possible, each company is positioned in the middle of its partners. These configurations of partnering firms include not only most of the companies represented in the strategic group analyses, it more generally pictures the 'networks' of a much larger group of the most cooperating companies. This enables us to analyze the relation between strategic group formation and technology partnering in a wider context without artificially limiting these configurations to the primary group of analysis. As we cannot picture all actors of each sectoral network, we restrict ourselves to the interrelations of about fourty five firms having the most ongoing strategic linkages in a given period. Also, in this case our analysis is at the parent company level, for which we assigned alliances of subsidiaries and divisions to the parent company. Alliances of companies taken over by others or partnerships made by merging companies are assigned to the acquiring company or the new corporation.

To improve interpretation of the pictures in terms of understanding the intensity of inter-firm partnering, it is useful to draw lines between companies. We drew lines between every pair of companies that have at least one joint strategic technology link. Fat solid lines indicate strong cooperation (four links or more), normal lines stand for moderate cooperation (two or three links), while dashed lines represent weak cooperation (one registered link). Furthermore, in Figures 5, 6, and 7 companies from the strategic group analyses are indicated with dark edges. For a more extensive analysis

of inter-firm networks in information technology see Hagedoorn and Schakenraad (1992) and Hagedoorn (1993).

Careful analysis of the inter-firm networks in the international **dataprocessing** industry, in Figure 5, reveals that there is certainly not a straightforward reflection of strategic groups in networks of partnering firms. By and large the strategic groups reconstructed in the above do not come close to identical 'clusters' in technology partnering as we found these companies scattered over Figure 5. Moreover, the second strategic group with the specialised US dataprocessing firms is, with the exception of CDC, not even represented in the group of most cooperating firms. Other companies that are not represented are NTT and NCR.

Many of the companies that were included in the analysis of strategic groups are found to play a somewhat nodal role in terms of their special links to other companies, but a substantial number of these other companies are not major players in the dataprocessing companies. Some companies from the group that we described as 'found-in-the-middle', in particular H-P and Unisys, have special ties to the group of large and diversified electronics companies, but we think it would go too far to suggest these ties play a role in the creation of complementary blocks.

Companies such as Mitsubishi, Xerox and Fuyo (Canon) do not play a nodal role in the sense that they have only a limited number of tie-ups to the other dataprocessing companies. Also IBM, previously disussed as a group of its own, does not take a very nodal position.

The first thing one notices while looking at the inter-firm networks in international **telecommunications** is the larger density in this field compared to dataprocessing.[4] The structure of strategic technology partnering during the second half of the eighties seems to suggest some clear patterns of regional clustering, in particular for Japanese companies at the left hand side of Figure 6 and a number of European firms in the second quadrant. This regional character that the industry still has does have its effects on a possible relation between strategic group formation and inter-firm partnering. One of the consequences is that also in telecommunications strategic groups do not seem to be unequivocally reflected in inter-firm partnerships. The Japanese pack, indicated above,

[4] In Figure 6 a relatively large number of network operating firms that are engaged in technology partnering with manufacturing firms are included.

does count a number of major Japanese companies, such as Hitachi, Toshiba, Fujitsu (DKB), NEC (Sumitomo), that are a part of the international group of large diversified companies, but with the exception of GTE the other companies from this strategic group are not connected to this block. The strategic group of eight smaller, largely European, telecom specialists is only represented by STC, Matra, Racal, and the Japanese company OKI (Fuyo). Siemens and IBM, which we described as a small group of two technologically well developed companies for which telecom is not their major business, have stong ties that link IBM to a wider network of European firms in the other strategic groups. AT&T takes a nodal position in the sense that it is connected to a large number of Japanese and European firms. The upshot of all this appears to be that strategic technology partnering in telecommunications is too a large degree reflecting the still existing national or regional context in which companies operate.

Strategic technology partnering in **microelectronics** during the second half of the eighties reveals a very dense network of cooperation amongst specialized microelectronics companies and also between these companies and other more diversified companies that have a number of interests in information technology at large. In Figure 7 we notice an interesting pattern of strong inter-firm linkages that causes a string of nodal firm that reaches from Matsushita to Sumitomo, DKB and IBM via Philips, Siemens, Toshiba, Thomson, Motorola, AMD, National Semiconductors, H-P, Intel. In particular worth mentioning are the nodal positions for Intel and Motorola and their history of competing networks of second-sourcing arrangements for RAM chips and microprocessors. Intel and Motorola produced highly competitive processors - Intel its 8086 and 80X86 series, Motorola its 68000 family - which were subject to many second-sourcing agreements which ultimately led to these clusters. In the second half of the eighties the Intel and Motorola clusters converged somewhat, although still no important ties between both firms were registered. After 1984 fewer second-sourcing links were established, instead a larger number of research links between dominant firms were forged during this period.

Interesting as all this might be, it does not demonstrate a strong association of the strategic group formation process with this pattern of technology partnering. Companies from the so-called Asian cluster of diversified companies, such as Sanyo, Mitsubishi, Samsung and Fuyo are somewhat similar in their ties to Intel. Furthermore, this group

of companies is not represented in the string of companies that we discussed above. The group of small specialized microelectronics companies can also be seen as a cluster with somewhat similar technology partnering behaviour but their internal linkages are rather weak. Also the position of Philips and AT&T is quite different in terms of their network positions.

For a somewhat more structural and non-graphical interpretation we can use a measure of intra-strategic group partnering, as presented in Table 1. This strategic group partnering (SGP) indicator is a simple measure of the share of the alliances made by companies within a constructed strategic group set against the total alliances in a sector made by these companies outside their strategic group.[5] In the following we will apply two indicators of strategic group partnering for each sector we study. The first indicator (SGP1) sets the intra-strategic group alliances against all the group members' alliances made in that sector, irrespective whether these alliances are made with companies that are included in the strategic group analysis or not. The second indicator (SGP2) is related to a much smaller total number of alliances as it reflects the share of intra-strategic group partnerships set against all the alliances made with the leading firms already included in the strategic group analysis.

In dataprocessing we found that only two of the actual four strategic groups have intra-group partnerships, see Table 1. For the first strategic group from Figure 2, that consists of Matsushita, Toshiba, NTT, Mitsubishi, Canon, Philips and Siemens, AT&T and Xerox, the SGP1 ratio is only 7.5%, the SGP2 ratio is 33%, which both indicate that the majority of the strategic alliances made by these companies is found outside their own strategic group. Although there are some links to other strategic groups, as mentioned above, these ties are not concentrated enough to suggest the existence of so-called 'complementary' blocks. For the other relevant strategic group, with H-P, DEC, Unisys, Olivetti, NCR, Bull, and Apple, there is some tendency towards a 'pooling' block as indicated by an SGP1 of 22% and, in particular an SGP2 of 57%.

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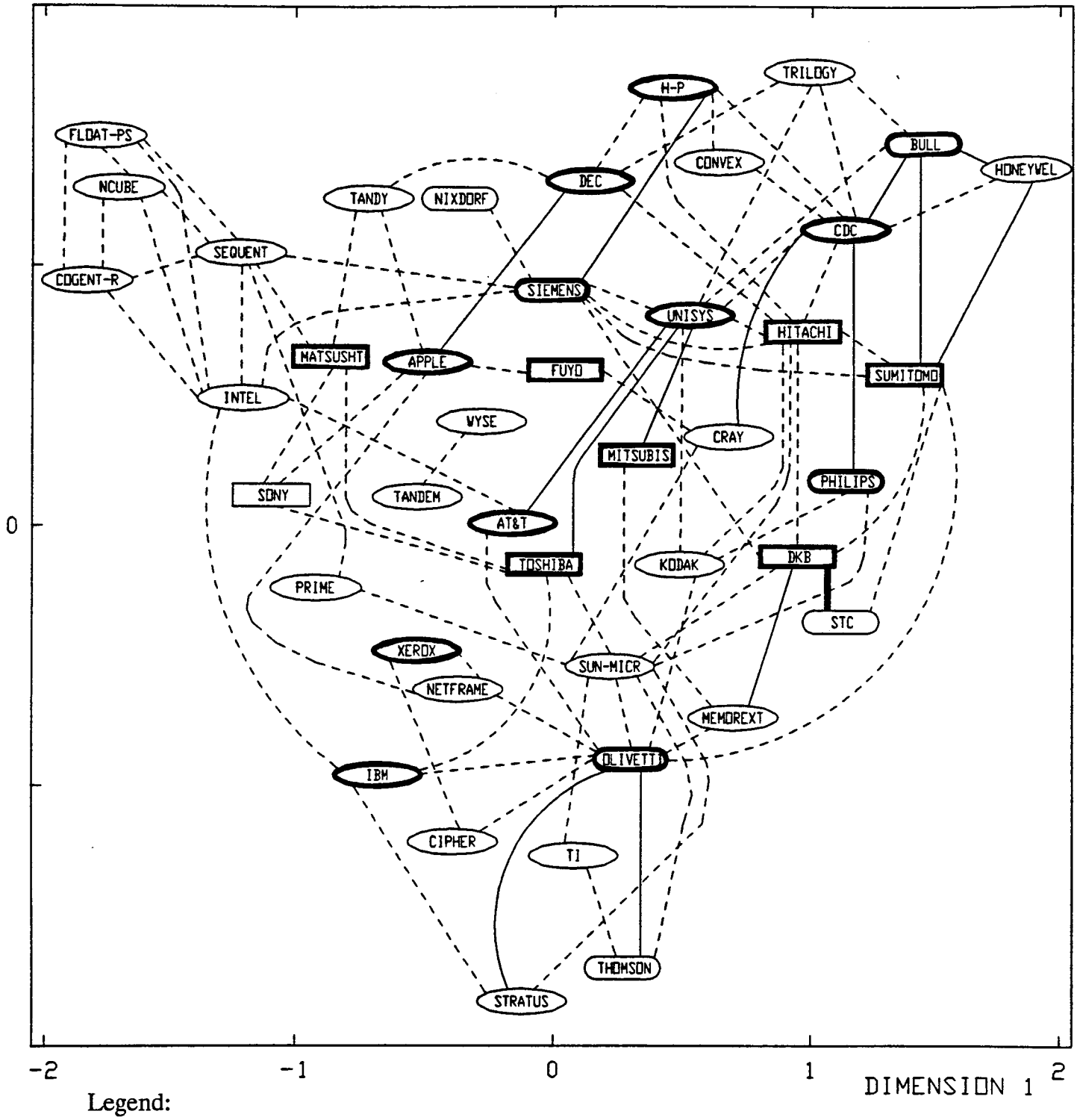
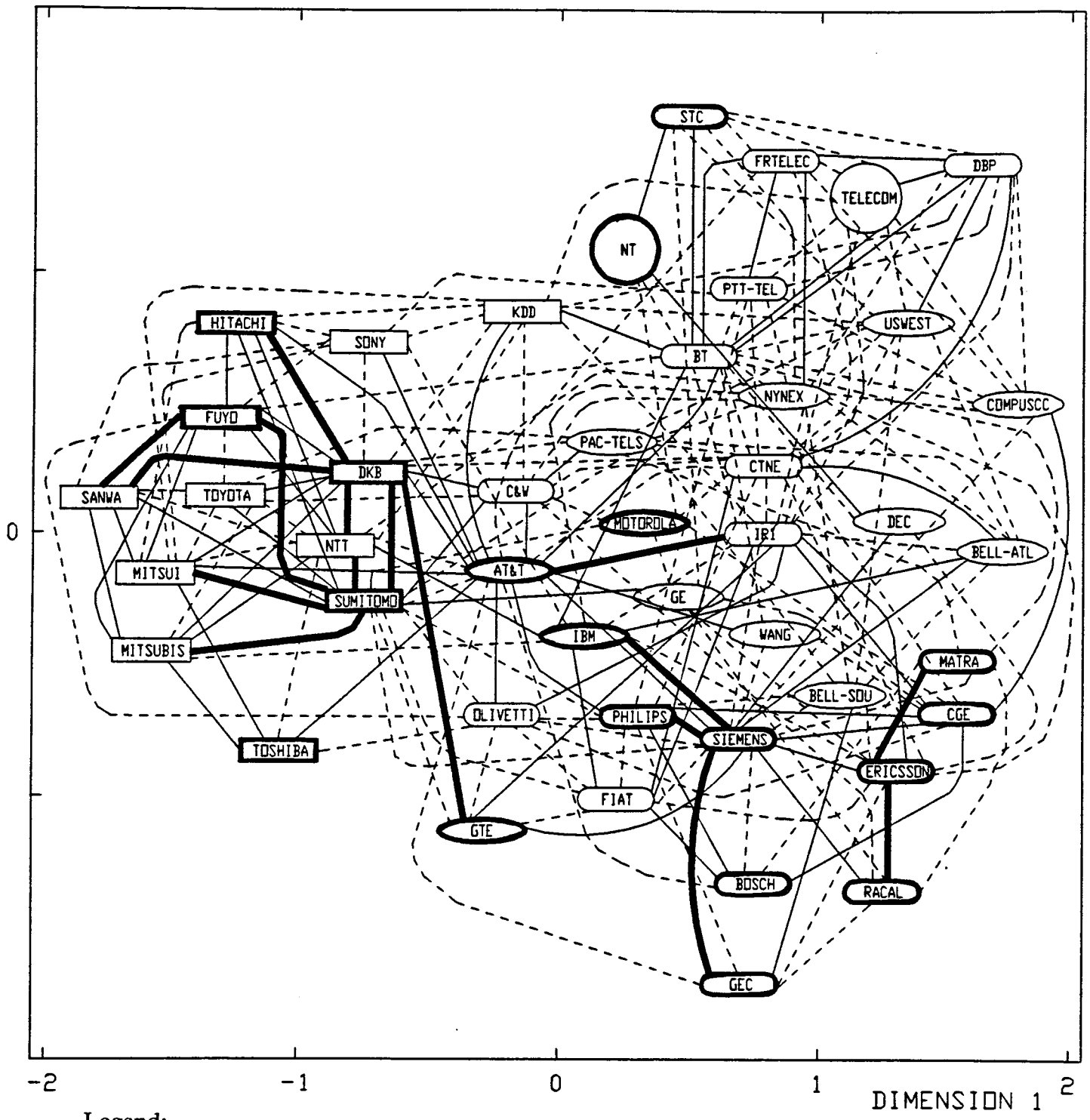
[5] We also undertook some regression analyses on strategic group formation and strategic partnering but the insignificance of results does not invite further elaboration.



Legend:

▭	Japanese companies	- - - - -	one link
⬭	U.S. companies	———	two or three links
⬭	European companies	▬▬▬	four links or more

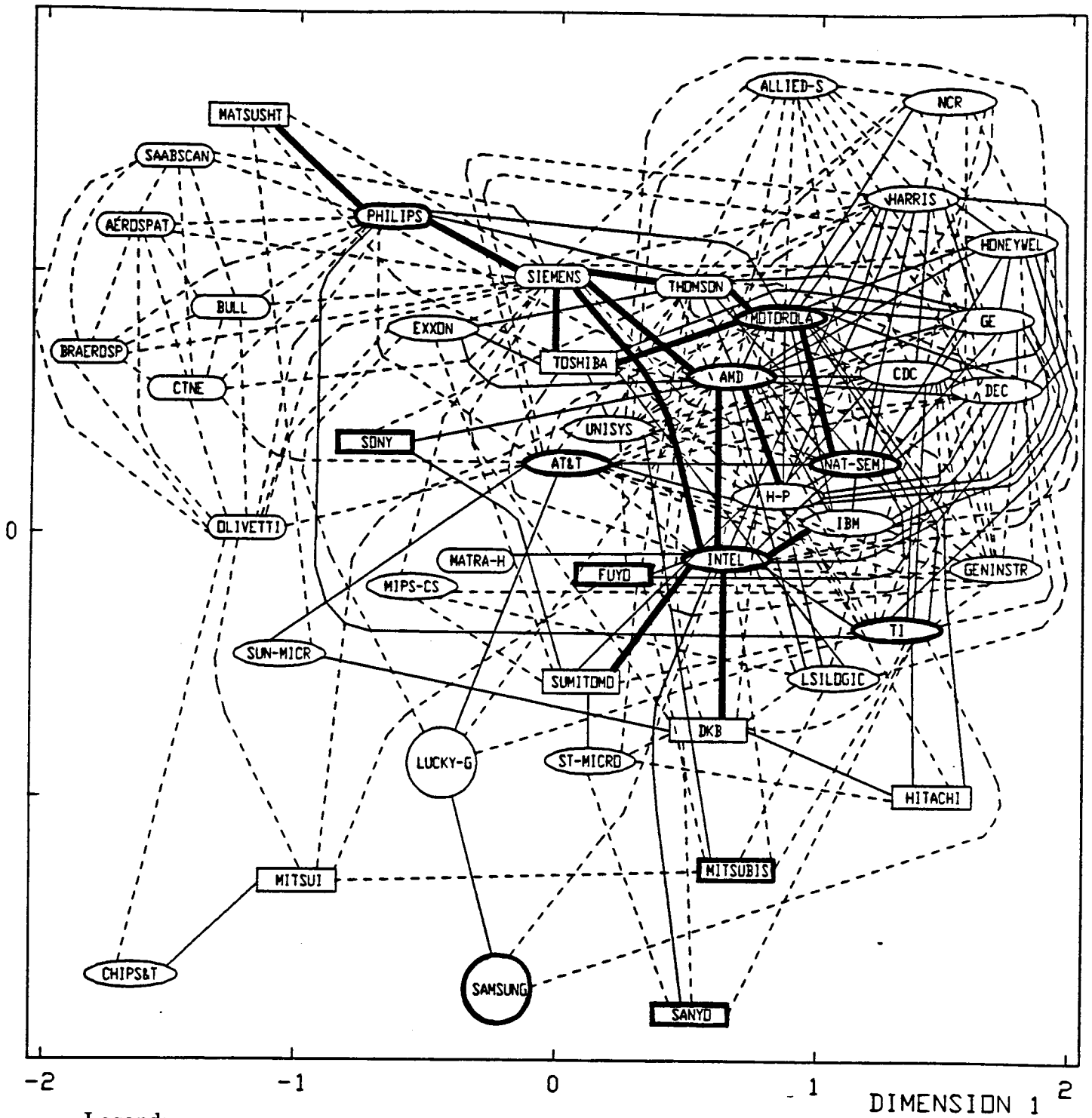
Figure 5 The strategic technology relations among the most intense cooperating firms in dataprocessing



Legend:

▭	Japanese companies	- - - - -	one link
⬭	U.S. companies	———	two or three links
⬭	European companies	▬▬▬	four links or more

Figure 6 The strategic technology relations among the most intense cooperating firms in telecommunications



Legend:

▭	Japanese companies	- - - - -	one link
⬭	U.S. companies	———	two or three links
⬭	European companies	———	four links or more

Figure 7 The strategic technology relations among the most intense cooperating firms in microelectronics

Table 1 Strategic group partnering indicators for dataprocessing, telecommunications and microelectronics, % of intra-group alliances

dataprocessing

group	SGP1	SGP2
1	7.5	33
2	0	0
3	0	0
4	22	57

telecommunications

group	SGP1	SGP2
1	17	75
2	0	0
3	12.5	33
4	15	53

microelectronics

group	SGP1	SGP2
1	0	0
2	5	13
3	18.5	47
4	16.5	48

Of the four strategic groups in telecommunications identified in Figure 3 one group with Ericsson, Alcatel (CGE) and Northern Telecom has no intra-group alliances at all, see Table 1. For the third group with STC, Nokia, Matra, Sagem, Racal, Ascom, Ricoh and OKI we found a low degree of intra group partnering, indicated by an SGP 1 of 12.5% and an SGP2 of 33% which means that the majority of the alliances of these firms are made with companies that are not in their own strategic group. The first strategic group that consists of companies such as Matsushita, Toshiba, Hitachi, Fujitsu, NEC, Philips, GEC, Bosch, GTE and Motorola on the other hand can be characterized as a relatively strong pooling block. Its SGP1 is still rather low with only 17%, but its SGP2, for which only the number of alliances with leading telecom companies are

included, indicates that 75% of the alliances of these 10 companies are made within their strategic group. The 'small' strategic group of two leading IT firms Siemens and IBM also has a high degree of internal group partnering as suggested by an SGP2 of 53%.

In microelectronics the strategic group of Philips and AT&T, and cluster of diversified companies, such as Sanyo, Mitsubishi, Samsung and Fuyo, we found non-existing or very low internal strategic group partnering indices, see Table 1. For the other two strategic groups in microelectronics, one group with NEC, Hitachi, Matsushita, Fujitsu, Toshiba, Siemens, and another group with four specialized companies AMD, Intel, National Semiconductors and SGS/Thomson, over 80% of all their alliances are made outside their strategic group. If we consider the more restricted indicator SGP2 it appears that for both these strategic groups nearly 50%, i.e. 47 and 48%, of their alliances with other microelectronics companies are made within their own strategic groups.

In other words, both the multidimensional analysis and the intra-group strategic partnering density analysis suggest that there is little evidence of a very straightforward relationship between strategic group formation and inter-firm partnering networks. Even if one takes the rather favourable SGP2 indicator only a few strategic groups are found to have a substantial degree of intra-group partnerships.

Conclusions

In the end the question we have to answer appears not to be whether strategic groups do exist, in the sense that they can be empirically reconstructed, but whether they add something to our understanding of firm behaviour, corporate strategy, and industry development. In the above we have seen that the a posteriori construction of strategic groups in a multivariate setting generates interesting empirical results. At the level of individual firms basic dimensions of structural and behavioural variables, a large number of indicators plus a location of relevant strategic spaces in terms of the international context of competition and relevant product - market combinations set the broader scene for understanding the heterogeneity within industries and the possible homogeneity within groups of companies. In that sense strategic group analysis in terms of categorization of companies enables us to present a 'mapping' of the heterogeneity in industries. Based on

such statistical exercises the analysis of strategic groups can reveal both group formation as well as the role played by companies that are 'the odd ones out' and that do not fit within any strategic group.

Further in-depth analysis of dimensional differentiation and the weighing of the importance of particular variables can contribute to our understanding of industry particularities. However, unless there is an a priori deduction of strategic group attributes and a specification of conditions for group formation, strategic group analysis can only have a limited value, e.g. for competitor anlysis and empirical studies of industry segmentation.

In the present contribution we have taken a small step in the sense that we did not specify the conditions under which strategic group formation would or would not take place, instead we redefined strategic groups by adding group cohesion or interaction as a necessary element of a theoretically relevant understanding of strategic groups. In other words, strategic groups are not interpreted as mere categorizations of a number of companies but as entities with a similarity in terms of mutual dependence and reciprocallity.

In the empirical analysis strategic group formation was expected to be reproduced in an analogous or largely similar configuration of partnering firms. The combined results of our analysis of strategic groups and strategic partnering behaviour of firms however indicate that only for very few strategic groups did we find that their internal coherence had any relevance if compared to their overall cooperation efforts. If the analysis is restricted to a smaller number of inter-firm cooperative efforts that only reflect the leading firms themselves, still less than half of the constructed strategic groups have a substantial share of their partnering efforts within their own strategic group. The results that the analysis generates for a sector where inter-firm cooperation is so abundant demonstrate that the intra strategic group coherence is so small that it casts serious doubts about the further theoretical usefulness of this concept. In addition to this we can state that our findings do also suggest little evidence of well developed patterns of collusive behaviour within strategic groups as frequently suggested by some of the industrial organisation inspired literature on strategic groups.

Apart from a practical use in the context of the application of grouping techniques, the concept of a strategic group of companies sui generis does not seem to

have a significant theoretical role to play. As for instance suggested by Barney and Hoskisson (1990) abandoning the group level of analysis or, in our opinion, making an attempt to expand the research agenda towards a mixture of understanding idiosyncratic characteristics of companies and homogeneity in industries or strategic groups appears worthwhile. At the firm level analysis strategic groups in the traditional sense, i.e. without coherence characteristics, can initiate the understanding of a selection capacity, isolating the idiosyncratic characteristics that create performance variance within larger groups of firms. Linking up to theories of Schumpeterian dynamics can provide the wider context for the further understanding of the process of competition and corporate strategy. Behaviour aimed at creating innovative rents and above average income by those companies that succesfully pursue a disequilibrating strategy searching for competitive advantages, could create more useful insights to the understanding of the process and structure of intra-industry competition. In that light it seems that the attention paid to the concept of strategic groups is somewhat superfluous. From a theoretical perspective the concept can not be seen a major building block, but only as additional to an attempt to further develop our theoretical understanding of homogeneity and heterogeneity in corporate strategies and company performance.

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Appendix I Companies in the population of dataprocessing, telecommunications, and microelectronics industries

	Dataprocessing	Telecommunication	Microelectronics
USA	Apple	AT&T	AMD
	AT&T	GTE	AT&T
	CDC	IBM	Intel
	Compaq	Motorola	Motorola
	DEC	Rockwell	Nat. Sem
	H-P		T.I.
	IBM		
	NCR		
	Seagate		
	Unisys		
	Wang		
	Xerox		
Europe	Bull	Alcatel	Philips
	Olivetti	Ascom	Siemens
	Philips	Bosch	SGS-Thomson
	Siemens	Ericsson	
		GEC	
		Matra	
		Nokia	
		Philips	
		Racal	
		Sagem	
		Siemens	
		STC	
Japan	Amdahl	Fujitsu	Fujitsu
	Canon	Hitachi	Hitachi
	Fujitsu	Matsushita	Matsushita
	Hitachi		Mitsubishi
	Matsushita	NEC	NEC
	Mitsubishi	OKI	OKI
	NEC	Ricoh	Sanyo
	NTT	Toshiba	Sharp
	Toshiba		Sony
			Toshiba
Others		Northern Telecom	Samsung

Appendix II The Cooperative Agreements and Technology Indicators (CATI) information system

The CATI data bank is a relational database which contains separate data files that can be linked to each other and provide (des)aggregate and combined information from several files. So far information on nearly 10,000 cooperative agreements involving some 3500 different parent companies has been collected. In this appendix we will elaborate on sources of information and limitations of data bank.

Systematic collection of interfirm alliances started in 1987. If available, many sources from earlier years were consulted enabling us to take a retrospective view. In order to collect interfirm alliances we consulted various sources, of which the most important are newspaper and journal articles, books dealing with the subject, and in particular specialized journals which report on business events. Company annual reports, the Financial Times Industrial Companies Yearbooks and Dun & Bradstreet's 'Who Owns Whom' provide information about dissolved equity ventures and investments, as well as ventures that we did not register when surveying alliances.

This method of information gathering which we might call 'literature-based alliance counting' has its drawbacks and limitations:

- In general we have only come to know those arrangements that are made public by the companies themselves.
- Newspaper and journals reports are likely to be incomplete, especially when they go back in history and/or regard firms from countries outside the scope of the journal. Furthermore, in earlier years some journals simply did not exist whereas existing periodicals might grasp the collaboration subject less thoroughly.
- A low profile of small firms without well-established names is likely to have their collaborative links excluded.
- Some journals emphasize fashionable items, such as superconductivity or HDTV, while interest for 'outdated' topics such as solar and wind energy seems to fade away.
- The fact that we read mainly articles written in English probably causes some bias and distortion, too.
- Another problem is that information about the dissolution of agreements is not systematically published. This is in particular true for licensing and customer-supplier relationships. On the other hand, research contracts and joint product developments have often disclosed time schedules. Equity joint venture and dissolutions of investments are published rather systematically in specialized journals.
- One final problem is that the number of customer-supplier relations and licensing agreements is subject to a fierce underestimation due to the fact that these more casual agreements are little reported publicly, even in the professional literature.

All together, these handicaps in the first place lead to a skewness in the distribution of modes of cooperation, followed by some geographic - i.e. Anglo-Saxon - bias. Next, we have to reckon with an underestimation of certain technological fields not belonging to modern core technologies and finally, there is some overrepresentation of large firms.

Despite these shortcomings, which are largely insoluble even in a situation of extensive and large-scale data-collection, we think we have been able to produce a clear picture of the joint efforts of many companies. This enables us to perform empirical research which goes beyond case studies or general statements. Some of the weaknesses of the database can easily be evaded by focusing on the more reliable parts, such as

strategic alliances.

The data bank contains information on each agreement and some information on companies participating in these agreements. The first entity is the inter-firm cooperative agreement. We define cooperative agreements as common interests between independent (industrial) partners which are not connected through (majority) ownership. In the CATI database only those inter-firm agreements are being collected, that contain some arrangements for transferring technology or joint research. Joint research pacts, second-sourcing and licensing agreements are clear-cut examples. We also collect information on joint ventures in which new technology is received from at least one of the partners, or joint ventures having some R&D program. Mere production or marketing joint ventures are excluded. In other words, our analysis is primarily related to technology cooperation. We are discussing those forms of cooperation and agreements for which a combined innovative activity or an exchange of technology is at least part of the agreement. Consequently, partnerships are omitted that regulate no more than the sharing of production facilities, the setting of standards, collusive behaviour in price-setting and raising entry barriers - although all of these may be side effects of inter-firm cooperation as we define it.

We regard as a relevant input of information for each alliance: the number of companies involved; names of companies (or important subsidiaries); year of establishment, time-horizon, duration and year of dissolution; capital investments and involvement of banks and research institutes or universities; field(s) of technology; modes of cooperation; and some comment or available information about progress. Depending on the very form of cooperation we collect information on the operational context; the name of the agreement or project; equity sharing; the direction of capital or technology flows; the degree of participation in case of minority holdings; some information about motives underlying the alliance; the character of cooperation, such as basic research, applied research, or product development possibly associated with production and/or marketing arrangements. In some cases we also indicate who has benefitted most.

The second major entity is the individual subsidiary or parent company involved in one (registered) alliance at least. In the first place we assess the company's cooperative strategy by adding its alliances and computing its network centrality. Second, we ascertain its nationality, its possible (majority) owner in case this is an industrial firm, too. Changes in (majority) ownership in the eighties were also registered. Next, we determine the main branch in which it is operating and classify its number of employees. In addition, for three separate subsets of firms time-series for employment, turnover, net income, R&D expenditures and numbers of assigned US patents have been stored. The first subset is based on the Business Week R&D scoreboard, the second on Fortune's International 500, and the third group was retrieved from the US Department of Commerce's patent tapes.

From the Business Week R&D Scoreboard we took R&D expenditure, net income, sales and number of employees. Companies included in the Business Week survey are limited to those US firms reporting sales of $35 million or more and R&D expenses of at least one million or at least one percent of sales. With the exception of companies in telecommunications no regulated utilities or transportation companies are included. In 1980 some 750 companies were filed; during the next years this number gradually increased upto 900 companies in 1988, which were spread among 40 industry groups. Some of these groups are hardly relevant since they lie largely outside the scope of our research on strategic partnering, which is concentrated on core technologies and

major sections of manufacturing rather than branches such as resources, leisure time industries, housing and construction, paper and forest products. Other listed firms were dropped because they are subsidiaries of foreign multinational enterprises.

The Fortune's International 500 of the largest corporations outside the US provides amongst others information about sales (upon which the rankings are based), net income and number of employees. R&D figures are completely missing and the sample is very divergent with respect to nationality of the firms.

Additional information on companies relevant for the present paper was gathered through a large number of sources such as annual reports, various data banks, and specialised reports.