

A STRUCTURAL ANALYSIS ON FIRM-MARKET AFFILIATION NETWORKS IN THE KOREAN SYSTEM INTEGRATION INDUSTRY*

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This paper examines the market topology of the Korean System Integration (SI) industry and its diversified strategic groups using firm-market affiliation networks. The Korean SI market is fragmented into core, semi-core, and peripheral industries corresponding to the firm-market affiliation patterns. Given the fragmented market structure, the SI firms can be classified broadly into four types, according to their market strategies. Based on empirical research, this paper explores Korea's SI structure and the underlying relationships between Large Business Groups (LBGs) and Small and Medium Firms (SMFs), revealing the LBG-centered industrial organization of Korea's SI industry.

INTRODUCTION

In exploring the structure of and strategic market groups in the Korean System Integration (SI) industry, this paper utilizes the affiliation network analysis approach as the starting point. In short, this study reveals that Korea's SI market is fragmented into three sectors and that SI firms are clustered into four strategic groups exhibiting different patterns of market participation.

The information industry is composed of various types of firms dealing with hardware, software, data processing, and system integration. Regarding the approaches to industrial organization in the information industry, two contrasting arguments have been presented: one spotlighting the roles of small and medium firms (SMFs) and the other emphasizing the domination of large business groups (LBGs). For the former argument, SMFs are believed to lead the information industry with specialized technology and flexible production systems. Advantages of SMFs do not lie with their individual organizational attributes, but with SMF networks and their connection to the society. On the other hand, the latter argument emphasizes the powerful capacity of large corporations in mobilizing resources and information. Thus, some contend that while a number of SMFs tend to flourish in the beginning, LBGs will eventually dominate the

*This is based on my M. A. thesis.

core industrial areas. Moreover, the proponents of large businesses argue that market expansion and standardization tend to empower LBGs, resulting in the formation of a stable market structure.

These arguments contrasting the advantages and disadvantages of SMFs versus LBGs, however, need to be re-examined considering the following two points. First, they assume that two types of firms compete in the same market niches. This is not always the case, however, given that SMFs can survive in different niches from those occupied by LBGs. Additionally, the relationship between LBGs and SMFs changes depending upon their respective market niches. Second, the roles of firms are determined solely by their individual attributes such as capital size and technical resources. However, the roles of LBGs and SMFs must be explored according to their respective positions in the market as well.

The following questions can be raised regarding the roles of SMFs and LBGs in the SI market. How did the LBGs' entrance into the SI business in the 1990s affect the SMFs' ability to carve out a marketable niche? Some contend that SMFs should take appropriate roles in the SI industry, leaving the larger business enterprises to fill leadership roles. Even if this should be the case, it is not clear how the relationship between LBGs and SMFs can be established. In this context, is it possible to construct organizational networks of SMFs as an alternative SI industrial configuration in Korea? Although these questions are too broad to be given their due attention in this paper, I will provide a basic framework to explain these issues by examining Korea's SI market structure and the positions of SI firms therein. The more specific research questions pertaining directly to this paper are as follows: One, is the SI market homogeneous or fragmented by the pattern of firms' participation? If fragmented, how are the market sectors divided? Two, do SI firms exhibit similar patterns of market participation? If different, how can we classify the diverse SI firms?

THEORETICAL ARGUMENTS

Organization as the Open System

Organization has been defined in terms of rational natural and open systems (R. Scott 1992). Whereas the first two types of system view the organization as closed from its environment, the 'open' system considers the environment to be fluid in terms of personnel, resources and information. Organizations are viewed as 'systems of interdependent activities linking shifting coalitions of participants,' and the systems are considered to be

‘embedded in — dependent on continuing exchanges with and constituted by — the environments in which they operate (R. Scott 1992:25)’. Diverse research efforts have been made in different analytical levels to explore the relationship of organizations to environments. Organization set theory, resource dependence theory, population ecology, and the institutional approach to the organizational field are among them (R. Scott 1992; J. Pfeffer 1982).

One of the critical issues, therefore, is how to conceptualize the environment, and which methodology should be used to analyze it. The network approach provides solid ground for the empirical analysis of inter-organizational relationships. Rather than conceptualizing the environment in such holistic contexts as uncertainty or complexity, the network approach defines it as a collection of interacting organizations. Surrounded by the other organizations, all acting organizations are assumed to be embedded in the network structure.

Structural Analysis of the Market

Like the open system approach in organization studies, the structural analysis of the market comes from the tradition of economic sociology, an alternative to the neo-classical economics. Whereas economists assume free and open competition, sociologists treat the market as a complicated phenomenon requiring empirical analysis. Structural analysis has been useful in visualizing the market, i. e., the concrete terrain of competition and cooperation among firms with in supply-demand network data. Moreover, structural analysis has been also applied to diverse research areas: a structural autonomy model analyzing nation-wide industry contingency tables (R. Burt 1980; 1988); a producer’s behavior model using the concept of market schedule (H. White 1981); and, an analysis of the stock price stability observing interaction within the market crowd (W. Baker 1984). Although these researches do not employ the same analytic model, they do share the perspective that stable structures are formed in the market.

The determination of market fragmentation into several sectors can be accomplished through the analysis of a nexus of suppliers and demanders. As in the labor market, both the product and capital markets are fragmented into core and periphery. To demonstrate this, however, requires empirical research.

Affiliation Network Analysis

In terms of organizational characteristics, the three level approach has

been popularly used (Kim 1996). The lowest level addresses individual attributes of the organization, such as employee size, capital size, and advanced engineer ratio. The second level consists of relational properties among organizations, such as transactions, competition, and cooperation. The third level is network configuration, which shows characteristics of an entire network system, such as market fragmentation and segmentation of firm population. Affiliation network analysis provides a way of revealing the interconnectedness among these three dimensions of organizational characteristics.

Assume a bi-modal social network representing the affiliation of a set of actors with a set of social occasions (S. Wasserman 1994). We can then apply this network approach to Korea's SI industrial structure within which there are firms as suppliers and the private/public sectors as demanders. Assuming an $m \times n$ matrix (matrix A), where m firms participate in n market sectors, if firm i participates in a market sector j , the matrix entry (a_{ij}) is equal to one. Otherwise, it would be zero. The fact that firm i participates in market sector j reveals each firm's attributes. Using individual characteristics of firms, then, we can draw a relational property using the following algebraic equation.

$$F=(A \times A'), M=(A' \times A)$$

A: $m \times n$ matrix indicating the affiliation of m firms and n market sectors

A': transpose of A

Matrix F indicates the affiliated relation among firms, where the matrix entry (f_{ij}) signifies the number of market sectors in which both firm i and firm j participate. The relational distance between two firms is calculated from the number of market sectors in which both of them participate. The extent to which the market sectors overlap reflects their utilization of similar market strategies. Therefore, two firms showing similar market participation patterns are likely to be in the same strategic business group. Likewise, Matrix M indicates the overlapping relation of market sectors, where the entry (m_{ij}) indicates the number of firms which participate in both sector i and sector j . The relational distance between two market sectors corresponds to the number of firms that they share in common. As they share more firms, market sectors will have more synergy effects for each other. Consequently, two markets with similar firm participants are likely to be located in the same niche. We can draw the relational property among firms or among market sectors from the firm-market affiliation. From this we can also derive the configurations of the firm network and the market network.

If some market sectors overlap with firm participants and while others do not, we can conclude the market is fragmented into heterogeneous sectors.

We can find here two kinds of network dualities (R. Breiger 1993). One is the duality of firm-to-firm relation and market-to-market relation. These relations are two aspects of the firm-market affiliation. At the same time, when firms' market strategies form the relationships among market sectors, the sectoral characteristics of the market will affect the firms' strategies. A second duality is between actor and structure. It is argued that firms' behaviors determine the configuration of firms or market networks. Additionally, the firms' behaviors occur within and are constrained by the given configurations of the networks in which there are embedded. Such association is not a cause and effect relationship, but reflects the structuration process.

DATA AND METHOD

This paper uses data from *Handbook of Korean System Integrators 1997*, which contains data for 132 firms. The handbook includes individual firms' attributes and client relations.

Size, age, and capital are used as individual characteristics of each SI firm. Firm size is measured by the number of SI employees. Firm age is calculated from the starting year of firm's SI services. Firms' capital is measured by the amount of capital based on 1997 figure. A dummy variable is used to indicate whether a firm belongs to business group or independent firm.

Market participation patterns of a firm are measured from transaction lists containing the names of clients and the amounts of projects during 1995-1997. I first classified the clients into 12 sectors on the basis of demand characteristics: government, government-invested corporation, Korea Telecom, defense, manufacturing, finance, telecommunications, circulation, education, medical service, media, and none of the above.

Based on the market sector classification, I then measured the number of transactions with each sector during the period of 1995-1997. Using binomial numbers, firms with more than one transaction with a market sector are encoded with the numeric value of one and the value of zero is used for firms with no transaction record. Based on this method, I constructed an affiliation matrix of 124 firms by 12 sectors. Then, I calculated the sector-by-sector matrix and the firm-by-firm matrix from the following equation:

$$S = (A' \times A), F = (A \times A')$$

A: firm-by-sector affiliation matrix, S: sector-by-sector matrix, F: firm-by-firm matrix

I will use the sector-by-sector matrix to visualize the SI market structure. The sector-by-sector matrix indicates how many system integrators transact with both row sector and column sector. The larger the entry of matrix *S* is, the more firms participate both in the row sector and in the column sector. Using multi-dimensional scaling (MDS) and hierarchical clustering analysis, I mapped-out the social topology of SI market sectors.

The firm-by-firm matrix will be used to classify SI firms into several strategic groups. This matrix illustrates the number of firms that participate in a common market sector. As such, the size of matrix *F* corresponds to the number of incidences where two firms share in their market participation. Based on each firm's age, size and capital, a regression equation was employed to assess firms' levels of market diversification. A dummy variable was employed to determine whether or not a firm belongs to a business group. Four strategic groups were identified from the information on market diversification and industrial firm attributes.

UCINET IV and STATA 4.0 are used for the statistical analysis (Borgatti, Everett and Freeman. 1992).

SYSTEM INTEGRATION INDUSTRY OF KOREA

As a critical component of the information industry, the SI industry has been developing since the 1980's. The SI industry supposedly provides the private and public organizations with total solutions to information systems, which include system design, hardware and network equipment coordination, operations maintenance, and application software optimization according to the specific demands of users. By combining the information technology of hardware and software in a digitized fashion, SI increases organizational efficiency in business and public services.

SI, then, is a process whereby computers, supplementary devices, communication networks, and application software are integrated into one. Since SI deals with multi-fields of component technology, it is impossible to perform on a single firm basis. Rather, it requires collaboration among a range of firms, performing SI functions on a clientele basis. As a consequence, the appropriate SI solution differs according to the client's business field, size, or purpose.

The SI industry has grown rapidly in Korea since the beginning of the 1990's, due to increasing system developments in both public services and private businesses. As the demand for SI continued to increase, many business conglomerates and independent firms have recently entered the SI

market. The number of registered SI establishments was 93 in 1993, the year of registration start-up. By 1996, however, the number increased to 132, and SI sales exploded by more than 3 times during the same period, constituting more than 40% of total sales in the information industry.

Existing SI firms are classified into two groups based on their membership in a business group. SI firms belonging to business groups are those whose group companies perform businesses in areas other than SI. These include such electronic and engineering firms as Hyundai Electronics, Samsung Electronics, and Daewoo Engineering, and such SI specialist firms as Samsung SDS, LG-EDS, and Taepyungyang Information Technology. SI firms performing their own SI services without the support of group companies are regarded as independent firms, including such traditional computer/data processing firms as Kumhyang Information Communication, Junnung Computer, and Korea Company Computerization Agency, as well as such recently established firms as Handsoft, Sam Tech, and Samdo Data System. SI firms belonging to business groups generally exceed the independent firms in both capital size and technical manpower.

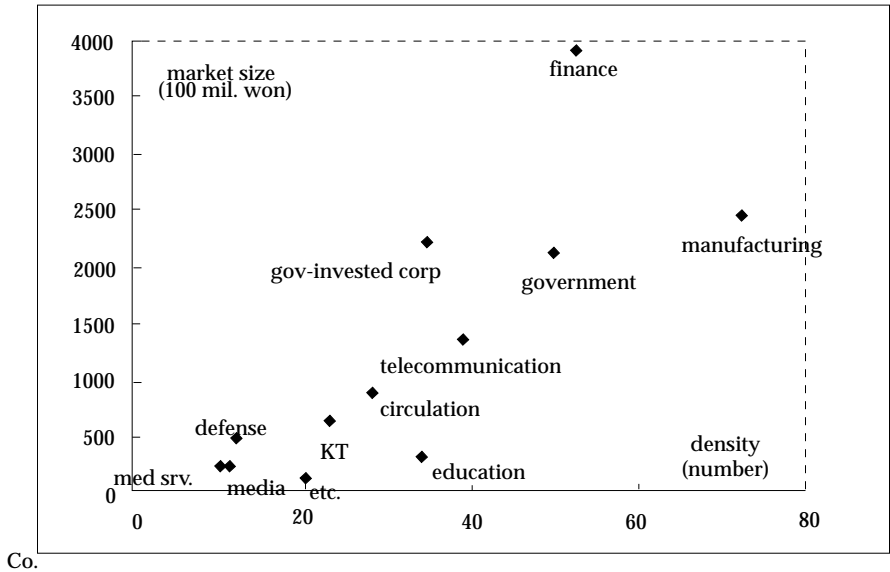
The SI market in Korea is composed of public and private sectors. Public sectors consist of government, government-invested corporations, and education sectors, while private sectors include manufacturing/construction, finance, circulation, and telecommunication. The finance sector recorded the largest SI demand in the last three years, followed by manufacturing/construction and government-invested corporations.

FINDINGS

Market Structure of the SI Industry

Based on the characteristics of SI demand, the SI market is classified into 12 sectors. The distribution of these sectors by market size and population density is shown in Figure 1. Market size signifies the 'carrying capacity' of the market sector as measured by total amount of SI sales in the sector. Market density refers to the degree of competition among SI firms participating in the market sector, coded as the number of participating SI firms in the sector.

We can examine distinctive features of SI market sectors by comparing size and density. In general, the SI sales rate corresponds to the level of SI firm participation in that sector. That is, the larger sector tends to have higher density levels. Some market sectors, however, show peculiar combinations of size and density. The finance sector, for instance, has the greatest



market size = the amount of sales in a market sector
 density = the number of firms participating in a market sector
FIGURE 1. MARKET SIZE AND DENSITY OF 12 SI MARKET SECTORS

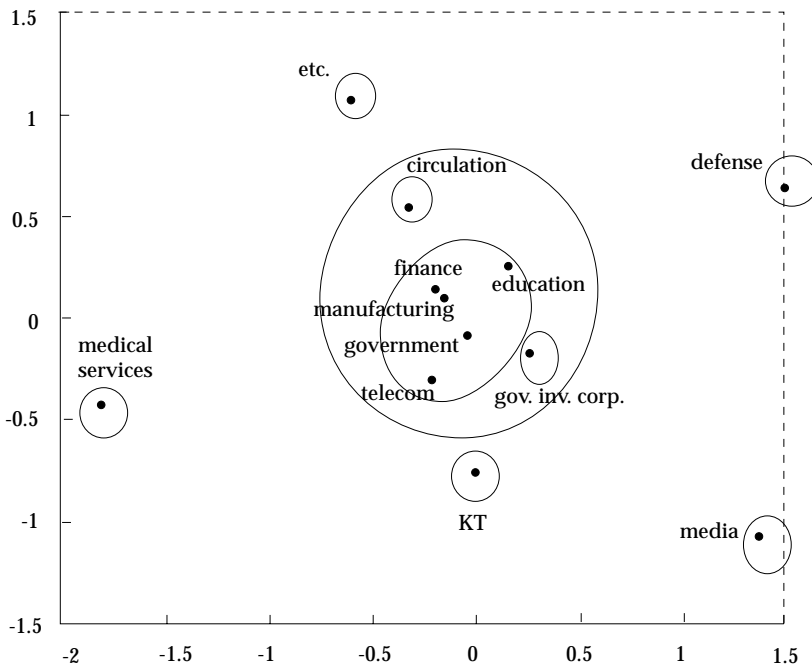
sales ratio but the number of its participants in the sector is smaller than the manufacturing sector. A similar pattern is shown between the government and the government-invested corporations. The finance sector has larger SI sales per transaction than the manufacturing sector, as do government-invested corporations in comparison to the government sector. By contrast, the education sector has more SI participants relative to other sectors that are similar in size. This is because entering the education sector has the effect of improving firms' social image.

Using MDS and clustering analysis in sector-by-sector matrix(matrix S), I mapped out the topology of 12 SI market sectors in figure 2. The closer the sectors, the more firms overlap in the two sector participation. For example, many SI firms participate in both the manufacturing and finance sectors, but only a small number of such firms participates in the medical sector. Using hierarchical clustering techniques, I grouped twelve sectors into 3 clusters, naming them core, semi-core, and periphery sectors based on firm-market affiliation.

The core cluster is characterized by the multiple and overlapping participation of SI firms. It includes manufacturing, finance, government, education, and telecommunication. Compared to other groups, industries in the

core have the greatest portion of the SI market share. Also, there is a significant number of cases where SI firms participate in two or more industries within the core group. Many system integrators, in particular, have offered services to several industries simultaneously in the core group within the last two years. For instance, the manufacturing sector covers a large portion of the SI market share, and a large number of SI firms participating in this sector overlap with other sectors. This is largely due to the fact that industries in the core consist of clients that have strong SI demands in such fields as the Management Information Systems (MIS), Electrical Commerce (EC), and Computer Integrated Manufacturing (CIM). The finance sector is the largest in terms of market size, though less firms participate here than in the manufacturing sector. Very small in market size, the education sector is relatively crowded with firm participants. This seems to be due to the legitimation effect of education sector. Entering education sector enables the SI firm to improve its corporate image as a contributor to society.

The semi-core group includes some sectors where overlapping participa-



The sectors are closer together to the extent that they share the same firm participants. The circle means the sectors therein belong to the same cluster by the hierarchical clustering analysis.

FIGURE 2. SOCIAL TOPOLOGY OF THE SI MARKET DURING 1995-7

tion occurs, but its extent is low relative to the core sector. Circulation and government-invested corporations are good examples of semi-core sectors lying on the fringe of the core. Despite such differentiation, many SI firms conduct business transactions with industries in both the semi-core and core sectors. Additionally, specialist SI firms participating in two or three market sectors tend to carve out circulation or government-invested corporation sector. Compared to the core industries, semi-core sectors such as circulation and government-invested corporation show relatively small market size and low population density.

Finally, the industries plotted on the outskirts of the graph are grouped as the peripheral cluster. These include defense, medical services, and media. A salient feature of the periphery is its small market size and low population density. This is because most firms doing business with this group offer specialized technology catering to the particular needs of these industries. As such, only a small number of SI firms are currently involved in the periphery, and they usually concentrate on a single market sector whether it be Korea Telecom, media, medical services, or defense.

Degree of Market Diversification

Given the fragmented market structure of SI industry, it is important to examine how the SI firms engage in a diversified market place. To do so, the following section will address the varied strategies employed by SI firms.

In determining the association between a firm's characteristics and its market participation pattern, the degree of market diversification (DMD) is used to measure the extent to which a firm participates in the SI market. Along the continuum of firm behavior, DMD can verify where the strategies used by firms fall between the specialist on one extreme and the generalist on the other as measured by the number of sectors in which firm participates. If, for instance, a firm uses a specialist strategy, it is likely to concentrate on a few, select industries and its DMD level will be relatively low. On the other hand, the DMD level will be higher for firms participating in multiple sectors and using a generalist strategy. Since SI firms offering services to large business groups (LBG) tend to have greater access to internal and external resources, they are more likely to participate in more market sectors than the small and medium firms (SMF). At this point, it can be generally predicted that LBG will use a generalist strategy while its counterpart, the SMF, will use a specialist strategy.

The following regression model is used to determine the relationship between DMD and firm characteristics.

DMD = f (age, manpower size, capital size, group dummy)

DMD: the number of market sectors in which an SI firm participate during 1995-1997

age: 97 - the year when a firm launched the SI business.

manpower size: the number of employees in the SI business as of 1997.

capital size: the amount of a firm's capital as of 1997.

group dummy: the variable indicating whether a firm belongs to business groups or not.

belonging to LBG=1. Otherwise=0.

TABLE 1. REGRESSION ESTIMATES OF CORPORATE ATTRIBUTES ON THE DEGREE OF MARKET DIVERSIFICATION

Independent Variables	Dependent Variable: DMD	
	β	<i>t</i>
Age	.055	.483
Manpower Size	.307	2.149*
Capital Size	-.336	-2.359*
Dummy	.187	1.366
R ²	.11	
N	86	

*p < .05

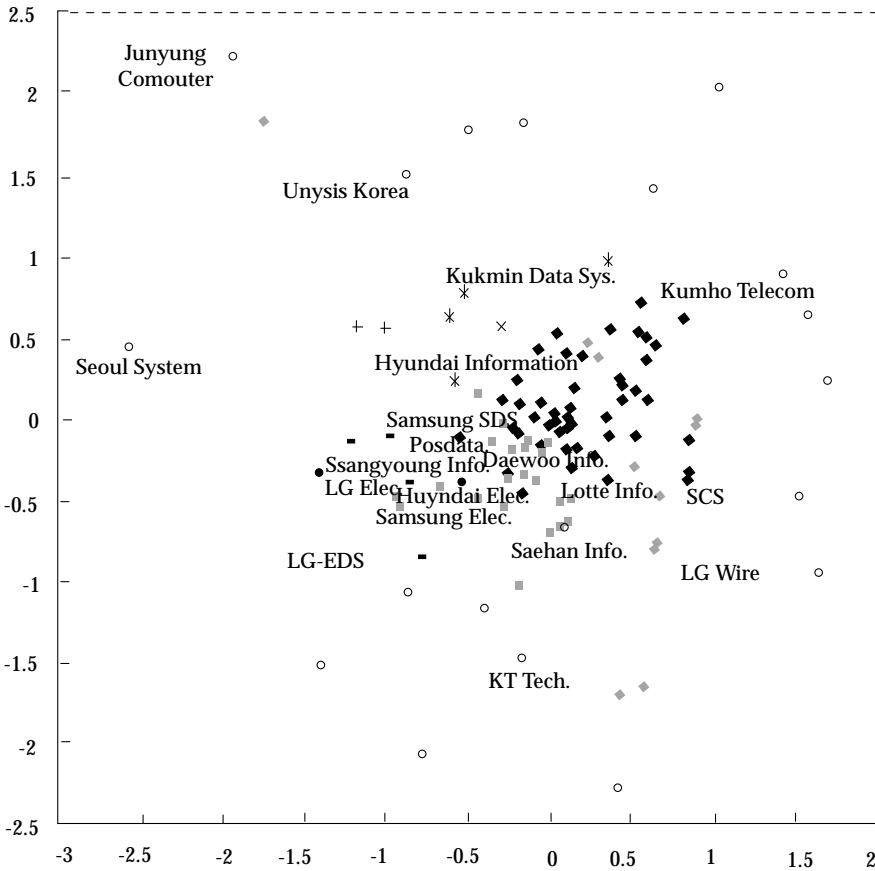
As shown in Table 1, a firm's manpower size and capital capacity have a significant association with the degree of market diversification, whereas a firm's age and group dummy have not. A firm's manpower size has a positive effect on diversification. That is, firms with a large number of employees tend to participate in a greater number of market sectors. However, a firm's capital size has a negative effect on diversification: the larger the firm's capital amount, the less diversified in its number of participating market sectors. This result shows an inconsistent trend when the level of diversification is compared to manpower size and capital amount. This inconsistency can be explained at least in two ways. First SI specialist firms may already exist which have grown in capital size while maintaining low numbers of employees. Second, there may be little correlation between SI firms market diversification strategy and corporate resources.

The fact that LBGs are not significantly different in their market diversification from SMFs is noteworthy. LBGs were expected to use a generalist

strategy entering more market sectors as compared to SMFs specialist strategy. This empirical study, however, shows that the Korean SI industry is not so simply organized as such a conventional expectation would dictate. It appears that both small and large business firms use a combination of generalist and specialist tactics, irrespective of their ability to muster corporate resources.

Social topology of SI firms

The following section explores the market positions of SI firms using the



The Same dot shape means the same cluster.

Only several firms selected was identified because of small space.

FIGURE 3. SOCIAL TOPOLOGY OF 124 SI FIRMS BY PARTICIPATION PATTERN TO 12 MARKET SECTORS

TABLE 2. FOUR TYPES OF SI FIRMS

	Generalist	Specialist
LBG	A	B
SMF	C	D

firm-market affiliation matrix method. I mapped-out the topology of 124 SI firms (Figure 3) applying MDS analysis to firm-by-firm matrix. The distance on the coordinate of Figure 3 indicates the degree of structural equivalence or variance among firms. The shorter the distance between firms, the more they share market sectors. Firms with similar market participation patterns are considered structurally equivalent and can be interpreted as belonging to the same strategic group.

Drawing from the information presented above, Korea's SI firms can be broadly divided into four strategic groups. The following table shows the four categories based on corporate characteristics and market strategies.

1) Group A: Generalist to Multiple Sectors (GMS)

The SI firms belonging to the GMS group conduct business with multiple sectors of core, semi-core, and periphery. This group includes large engineering and electronic firms such as Hyundai, Samsung, Daewoo, Lucky-Goldstar (LG) and the system integrators like Samsung SDS, LG-EDS, POS-DATA, and Ssangyong. According to the transaction data of the last two years, the following observations can be made. First, GMS participate in one or several periphery sectors, transacting with a number of core or semi-core clients. For example, LG and Daewoo provide SI services not only to core industries, but also to the defense sector in the periphery. Ssangyong provides SI technology to the medical service and media sectors as well as some industries in the core sector. Second, GMS firms are members of *chaebol* corporations. Rather than catering to the needs of their own subsidiaries, *chaebol* groups choose to branch out to other business groups. Although most GMS firms provide SI functions among its own subsidiary companies in the early stages, they eventually increase their markets to other private and/or public sectors.

2) Group B: Specialist to one or two Core Sectors (SCS)

Group B includes LBGs which have found a marketable niche in one or two core and/or semi-core industries. SCS consists of several strategic groups: finance specialists such as Kukmin Data, Korean Investment System, and Dongboo Information; specialists of manufacturing and circulation such as Nongshim Data; specialists of government and government-

invested corporations such as Dohwa Technology. The salient features of group B firms are three fold. First, some SCS concentrate on specialized niches of finance, circulation or communication, whereas other SCS tend to participate in two sectors as in manufacturing and circulation. Second, some firms in group B were initially created to meet the needs of expanding *chaebol* groups. As such, being *chaebol* subsidiaries themselves, they only work with *chaebol* groups to which they belong. Third, firms that participate in multiple market sectors and that have specialized component technology are also classified into SCS group. These include LG-Honiwell, a specialist of Intelligent Building System (IBS), and Intergraph Korea and Cadland, specialists of Geographic Information System (GIS).

3) Group C: SMFs as Subcontractors to LBGs (SSL)

Group C includes most SMFs that work for LBGs as subcontractors of SI projects. Since many SMFs do not have sufficient capital resource and necessary technology, LBGs often contract-out software development and network construction projects to SMFs. The alliance between small and large businesses in SI field is generally divided into independent and cooperative one on one hand, and dependent and unstable one on the other. In the former case, small firms with specialized component technology offer services to multiple LBGs. The venture business firms, like Future System, Handy Soft, Nanum Technology, and Koguryo Multimedia, are success cases of the 1990s. On the other hand, there are many small firms that suffer from a lack of specialized technology. Consequently, they are generally dependent on LBGs for capital and technology, and they provide repetitive programming and simple information processing services, contributing to an unstable future business outlook.

4) Group D: Specialist to Periphery Sectors (SPS)

Though small in number, some specialist firms have successfully carved out a marketable niche within SI industry. Small firms like Jungneung Com, specializing in medical service, and Seoul System, focusing on media, can be classified into this category.

SUMMARY AND DISCUSSION

Based on the firm-market affiliation data, this empirical study addressed important questions regarding the organization of Korea's SI industry. With the affiliation network analysis, Korea's SI market is shown to be fragmented into core, semi-core, and peripheral industries, organized by four main strategic groups.

The principal criteria on which industries were divided into three groups were based on industries size and their need for either specialized or generalized SI technology. Defined as the core industries, they are characterized by their overlapping nature of SI market participation. Unlike the core sectors, the peripheral industries like defense, media and medical service require much more specialized SI technology.

The SI service providers, in turn, can be divided into four groups. Large business groups that employ a generalist market strategy tend to diversify into multiple market sectors, while the specialist firms among the large businesses play a much limited role of catering to SI needs within business groups. As for the smaller companies that are more generalist in their tactics, they usually work with LBGs as their subcontractors. Specialist firms among SMFs were found to have a small SI niche, providing specialized technology and information to peripheral sectors.

Each of the four types of SI firms fulfils specific roles in Korea's SI industrial structure. These roles are better understood by examining the relationship between them. As it turns out, the SI structure is vertically organized with the large business groups at the top and the smaller firms at the bottom. The subcontracting system within the SI industry seems to exacerbate the unevenness of SI production in Korea.

The relationship between small and large SI firms is characterized by dependence and instability. The persistence of this relationship can be explained by LBGs' strategy of reducing production cost and of coping with temporary demand. At the same time, SMFs inability to invest in R&D and marketing contributes to their dependence on large businesses for technology and continued development. Such conditions pose increasing obstacles to the ability of SMFs to break out of the cycle of dependence. There are, however, some small firms that are quite independent and leaders in the industry. They often have technical licensing agreements with LBGs, providing SI components to a number of large businesses through sales agents and/or site licensing contracts. Despite these advantages, even the more independent and innovative small SI firms are confronting difficulties as foreign SI companies with advanced techniques and know-how are displacing the Korean service providers.

Although the idea of cooperative SMF networks is being suggested to remedy the situation, this notion is not without problems. Many optimists are hopeful that the flowering venture firms will successfully adapt to the changes in SI environments. They expect these small firms to form networks through which they can exchange resources and information, but this optimism has not been realized in Korea's SI industry. Currently, small firms

with generalist tactics (group C in table 2) are in an unstable position as sub-contractors to large businesses. At the same time, the specialist SMFs (group D) are having difficulty competing with diversified LBGs. Rather than mutual cooperation, many SMFs are in competition and conflict with one another to survive in their existing niches. The new relationships of SMFs would be possible if SMFs specialize in component technology and construct independent relationship with LBGs. Under this condition, SMFs can develop a pool of technical manpower, shared information, and joint R&Ds. In the long run, the social basis of local community could be an important resource base from which SMFs can take advantage of the institutional ties among schools, institutes, governments and firms.

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