An Analysis of Firm' Capacity in Mazda's Keiretsu

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Abstract: Capacity is defined as the power resulting from the specific position in network organizations in this paper. Thus, it becomes one of the important issues to measure firm's capacity. In this paper, we review the relevant studies of network organizations, and focus our study on Yokokai, the Mazda's Keiretsu. We propose a new approach to calculate firm's capacity. The capacity is divided into two categories, take-in capacity and take-out capacity in this paper. The relationship between the two capacities is called capacity difference. The relationship between capacity difference and corporate performance has been analyzed in order to discover the determinants of corporate performance in network organizations. Therefore, this paper provides a new perspective to find the determinants of the successful corporate management.

Keywords: capacity, capacity difference, corporate performance, Keiretsu

I. INTRODUCTION

As a special type of corporate group, Keiretsu is one of the well known organization forms widely today. It is an important factor for successful Japanese companies because Keiretsu is considered as the sources of the Kaizen and technical innovations. Many studies about the Keiretsu research have been published recently. In this paper, we propose a new structural index, capacity, in order to discover the rational relationship between capacity and corporate performance. The main contributions of this paper are: 1) the new quantitative concept of capacity is proposed; 2) the validity of capacity and corporate performance is analyzed. Therefore, this paper provides a new perspective to find the determinants of the corporate performance.

This paper is organized as follows. In Section 2, we briefly review some relevant researches of quantitative approaches of Keiretsu. Section 3 introduces the capacity model. Section 4 shows the results, and discusses the implications of the results. Finally in Section 5 we conclude by a summary of this paper.

II. BACKGROUND

Relationship is one of the important factors in structural analysis. Most researchers use strong tie and/or weak tie to describe the different strength of the relationship.

However, quantitative approaches are needed to discover the determinants of corporate performance. Dyer H. J. analyzed the relationship among firms based on distances between their locations and the frequency of face-to-face communication among engineers in the automobile industry [1].

High correlation relationship between degree and corporate performance has been found [2]. Interorganizational relationships in the Keiretsu have been analyzed with quantitative analysis tools such as CONCOR and other statistical methods [3]. Moreover, Fukuoka et al. reported a new finding in relationships between firms in the Keiretsu of Nissan from the viewpoints of transaction and cross shareholdings [4]. Recently T. Ito begins to apply graph theory to network organization analysis, and clarifies some characteristics such as centrality, size of network [5-7]. Like other indices, such as centrality and density, capacity is also one of the important indices of the analysis of the corporate performance. To the best of our knowledge and investigation, no study has examined capacity from an organizational network vantage point; therefore this study attempts to shed light on one of the most advanced quantitative analysis using data gathered from Mazda's Yokokai Keiretsu.

III. METHOD

Basically Capacity means power pertaining to, or resulting from, the possession of strength, wealth. It shows one kind of possible powers of being or of doing. In this paper, capacity is defined as the power resulting from the specific position in network organizations.

1. Outline of the capacity model

Generally a graph consists of a set of nodes and a set of arcs. Two nodes are connected if a path between these two nodes. Path is one of the important concepts in graph theory. According to graph theory, a path is a sequence of nodes such that the nodes and the arc are adjacent. A walk is a sequence of nodes and arcs such that the nodes and arcs are adjacent. The difference between path and walk is that a path is a walk that does not include any node twice, except that it its first node might be the same as its last. For digraphs, walks can travel arcs only in the direction of the arrows.

The length of walk is formed by a sequence of the number of arcs such that any two successive arcs in the sequence share a node. Basically the node's capacity is determined by the length of walk and the number of walks.

Suppose $S(r)_{ij}$ is the summation of the length of walks from node p_i to p_j when the length of the walk equals to r.

$$S(r)_{ii} = A + A^{2} + A^{3} + \dots + A^{r}$$
(1)

A is a normalized adjacent matrix. The reachable matrix, denoted by A^r , refers to the fact that node p_i can reach node p_j through the number of steps *r*. For instance, A^2 means that node p_i can reach node p_j through 2 steps. The element of matrix A is the number of the walks between node p_i and p_j .

The strength of the walk should be considered as the inverse of the length of the walk. In other words, the strength will be weaker if the length of walk is longer. Then the value of capacity of nodes can be expressed as follows.

$$C(r)_{ij} = \sum_{i=1}^{r} \left(\frac{A}{L}\right)^{i}$$
⁽²⁾

where

C capacity from node p_i to p_j

A the number of walks in a given graph

L parameter of the length from node p_i to p_j

r length of the walk from node $p_i \mbox{ to } p_j$

Then the terminal capacity of the row will be calculated as follows.

$$C(p_i, r) = C(r)_{i1} + C(r)_{i2} + C(r)_{i3} + \dots + C(r)_{in}$$
(3)

(4)

When the r equals to infinite, the total capacity of C is calculated as follows.

$$C = C(\infty) = (I - (\frac{A}{\eta}))^{-1} - I$$

 η The summation of row in matrix C means take-out capacity, and the summation of column means take-in capacity.

In real society, the node generally means the individual and/or firm, and the arc means the relationship. In transaction network, walk can be explained as one power to begin transaction with other companies. Therefore, the volume of walk could be explained as firm's capacity in network organization. In transaction matrix take-out capacity means the capacity of firm i that sell its parts to all other firms, and take-in capacity means the capacity of firm j that purchases parts from all other firms.

2. Data collection

In order to measure all firms' capacity in Yokokai, transaction data in the Yokokai keiretsu have been collected from our interviews and the publications of the Japan Auto Parts Industries Association and Automotive Parts Publishing Company [8].

In 2004, 177 parts suppliers are included in Yokokai. 72 parts suppliers and Mazda have reciprocal transactional relationships, and 105 parts suppliers are singletons. A singleton is an isolate company whose indegree and out-degree are both 0. In Yokokai's case, singleton means the firm which has no relationship with other firms.

The transactional relationships among the companies were identified through graph modeling. A tie shows the percentage of the transaction between each pair of firms. We collected directed and weighted data to measure the capacity of each firm.

IV. RESULTS AND DISCUSSIONS

We developed a computer program and calculated the capacity of each firm in Yokokai. The result of the capacity of transactions is shown in Fig. 1.



Fig. 1 Yokokai's capacity in 2004

As mentioned above, the capacity can be divided into two categories, take-in capacity and take-out capacity. The difference between those two capacities means the difference between the purchase capacity and sell capacity. It is called capacity difference. The firm has unbalanced issue if the absolute value of the capacity difference is high.

In order to discover the rational relationship between capacity and corporate performance, we collected the data of corporate performance including sales and profit from Mazda in fiscal years of 2004 and 2005, and calculated correlation coefficient between the capacity and corporate performance. Car maker Mazda is excluded because this paper focused on the study of parts suppliers. The result is shown as Table 1.

Table 1 shows us that a high correlation between capacity difference and corporate performance. Therefore, basically it is effective to improve corporate performance if the parts supplier to find the way to cut down the capacity difference.

In order to compare with Mazda's results, we collected transactional data from Nissan group. The correlation coefficient between capacity difference and sales and profit is 0.44 (p=0.01) and 0.39 (p=0.02)

respectively in 2004, and 0.52 (p=0.00) and 0.49 (p=0.02) respectively in 2005. Therefore, it is clear that certain correlation between capacity difference and corporate performance exits.

Table	1	Matrix	of c	correla	ation	coeff	ïcient	between
capa	ici	ty diffei	ence	e and	corp	orate	Perfo	rmance

		2004		2005			
	1			1			
Sales	-			-			
	33			37			
	0.64**	1		0.53**	1		
Profit	0	-		0.00	-		
	31	31		31	31		
a :	0.44**	0.88^{**}	1	0.69**	0.42*	1	
Difference	0.1	0	-	0	0.2	-	
Difference	33	31	42	37	31	53	

The scatter diagram between capacity difference and sales can be illustrated as Fig. 2.



Fig. 2 Scatter diagram of capacity difference and sales

The selling power is larger than its purchase power if its capacity difference is larger than zero. Therefore, these firms have good management skills if the value of sales of these firms is high; otherwise the management skills of these firms, such as No. 6; Sumino Kogyo Co. Ltd., and No. 4; Keylex, should be improved. No. 64 is Denso. Its capacity difference is -2.83, but its sales are high. It means Denso's selling power is less than its buying power because Denso is one of the main subsidiaries in Toyota's group. Denso purchases parts in Mazda's keiretsu and sells them in Toyota's group. This is the reason why Denso has negative value of capacity difference but high sales.

The scatter diagram of take-out and sales, take-in and sales can be drawn as Fig. 3 and 4 respectively.



Fig. 3 Scatter diagram of take-out capacity and sales



Fig. 4 Scatter diagram of take-in capacity and sales

In Fig. 3, No. 6 is Sumino Kogyo Co. Ltd., No.8 is Japan Climate Systems Corporation, and No. 4 is Keylex. They have high value of take-out capacity. It means that these firms have strong power to sell their parts in Mazda's keiretsu. But their sales are low. Therefore, the selling policy of these firms' should be adjusted.

In Fig. 4, No. 64 is Denso. Denso has an extremely high value of take-in capacity. It means that Denso purchases parts in this group, and maintains its good corporate performance because Denso has strong selling power in its own market.

V. CONCLUSION AND FUTURE WORKS

In this paper, the new approach of capacity analysis is proposed, and its validity is proved. We discovered the rational relationship between capacity and corporate performance using the example of Mazda's Keiretsu. However, much more works should be done to build up rational relationship with other parts suppliers. For instance, two indices are helpful to find the unbalance issue in corporate management. One is the difference between capacity difference and other corporate performance, such as capitals and stock prices, and other is the difference between capacity difference and centrality. Furthermore, the relationship between capacity and density should be done in the near future.

Acknowledgment: This research was partially supported by the Ministry of Education, Culture, Sports, Science, and Technology, Grant-in-Aid for Exploratory Research, 21510171, 2009.

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