Influence Analysis in the Keiretsu of Mazda

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ABSTRACT

One of the most important issues in Customer Relationship Management (CRM) is how to measure the relationship with customers. More research into quantitative approaches to this measurement is needed. To help consider this issue, the reciprocal relationship between the automobile maker Mazda and its suppliers is analyzed and the results presented in this paper. This set of interlocking business relationships is known as a keiretsu. This paper uses the influence analysis tool DEMATEL (DEcision MAking Trial and Evaluation Laboratory), to measure one kind of reciprocal relationship, the influence, of each firm in the keiretsu of Mazda Yokokai. The results of this analysis are used to identify some characteristics of effective relationships between Mazda and its suppliers.

Keywords: influence, relationship, cross-shareholdings, transactions, DEMATEL

1. INTRODUCTION

A keiretsu is a set of companies with interlocking business relationships. In the Japanese automobile manufacturing industry, these relationships include cross-company transactions and cross-shareholdings between automobile manufacturers and companies supplying their parts. A keiretsu can be considered as a type of network organization. In the automobile manufacturing industry, the competition between manufacturers is substantially the competition between the keiretsu of manufacturers. Generally speaking, from 60 percent to 70 percent of the cost of each vehicle is derived from the cost of auto-parts. The remaining costs are labor, equipment costs, and various other costs such as advertising and distribution. For different automobile manufacturers, for each vehicle with the same displacement volume, the selling price, wages of employees, and the price of raw materials, are approximately the same. Consequently almost all of the profit is generated from the reduction in costs of the parts obtained from suppliers. Hence, one kind of reciprocal relationship, the influence between the manufacturer and its suppliers, is a key competitive factor in the industry. The aim of this paper is to use the influence analysis tool DEMATEL (DEcision MAking Trial and Evaluation Laboratory), to measure the influence of each firm in the keiretsu of Mazda Yokokai and hence uncover the effective structural relationships between suppliers and the automobile manufacturer.

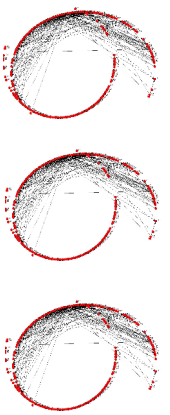
The structure of this paper is as follows: In Section 2 the authors briefly review some previous studies of relationships; Section 3 introduces and applies the DEMATEL measurement technique, showing the result of the influence of each firm in the keiretsu of Mazda; An analysis and discussion of the implications of the measurement results are presented in Section 4. The final section (Section 5) contains some concluding remarks.

2. BACKGROUND

There are many kinds of reciprocal relationships that can be considered. Dyer analyzed the relationship between firms based on distances between their locations and the frequency of face-to-face communication among engineers in the automobile industry (Dyer, 1994, 1996). Bensaou identified the successful portfolios of buyer-supplier relationships from the viewpoint of effective supply-chain management (Bensaou, 1999). Ito measured the firm's relationship in the keiretsu of Toyota from the viewpoint of centrality (Ito, 2004). Ito and Sakamoto developed a new method to calculate the importance of each individual firm in the keiretsu of Toyota and Nissan (Ito and Sakamoto, 2005). Recently, inter-organizational relationships in keiretsu have been analyzed with quantitative analysis tools such as CONCOR (Lincoln and Gerlach, 2004). Fukuoka et al reported a new trend in relationships between firms in the keiretsu of Nissan from the viewpoint of network organization (Fukuoka et al, 2006). All of these researchers focused on the relationship of each firm in the keiretsu. However, there are only a few empirical studies that analyze reciprocal relationships between the firms in the keiretsu (Nohria and Eccles, 1992; Hakansson and Waluszewski, 2002). One kind of reciprocal relationship is the level of influence between firms. Measuring this level of influence helps to identify effective relationships between firms.

3. MEASUREMENT

Influence is a term that refers to the power to indirectly control or affect the actions of other persons or things. In the social sciences, influence derives from an interpersonal relationship, and most research into influence is based on a psychological approach. Fontela and Gabus (1976) developed a tool for analyzing influence networks called DEMATEL, which is an abbreviation for DEcision MAking Trial and Evaluation Laboratory. DEMATEL is an approach for identifying the influence or the hidden or indirect power of a group of relationships, based on the principle "Friends of my friend are my friends". In this current research, DEMATEL is used as a new method to measure the influence of actors within the keiretsu of Mazda Yokokai.



3.1 Outline of DEMATEL

A brief overview of the mathematical basis of DEMATEL is as follows.

In a social network composed of n actors, the binary relation between each actor and the strength of this binary relation can be identified. Based upon the structure of this pattern of reciprocal relationships, an n×n adjacent matrix A^* can be obtained. The first step in the analysis is to normalize this matrix by multiplying each element of A^* by l , the largest row sum of A^*. The normalized matrix $A = l A^*$ is therefore obtained. The (i, j) element of a_{ij} of this matrix denotes the level of direct influence from actor i to actor j.

The reachable matrix, denoted by A^x, refers to the fact that actor i can reach actor j through the number of steps x. For instance, A^2 means that actor i can reach actor j through 2 steps. Therefore A^x measures the indirect influence from actor i to actor j. All of the levels of indirect influence can be summarized as follows, which the authors refer to as the indirect matrix.

$$A^f = A^2 + A^3 + \cdots + A^n = A^2(I - A)^{-1}$$

The total influence matrix, which includes both the direct and indirect influence matrix, can therefore be expressed as follows.

$$T = A + A^f = A + A^2 + A^3 + \cdots + A^n = A(I - A)^{-1}$$

3.2 Data Collection

In order to measure this pattern of influence, data showing the transactions and cross-shareholdings in the keiretsu of Mazda Yokokai were collected from the publications of the Japan Auto Parts Industries Association and Automotive Parts Publishing Company (JAPIA&ATJC, 2005). In 2004, the number of firms involved in transactions and cross-shareholdings was 181 and 223 respectively. This data set makes up about 42 percent of the complete set of transactions between Mazda and other firms.

The relationships between the firms in each category were identified through graph modeling. A tie shows the presence or absence of transactions or cross-shareholdings between each pair of firms. The authors collected directed 0-1

Figure 1. Relationship graph of transactions of Mazda Yokokai in 2004

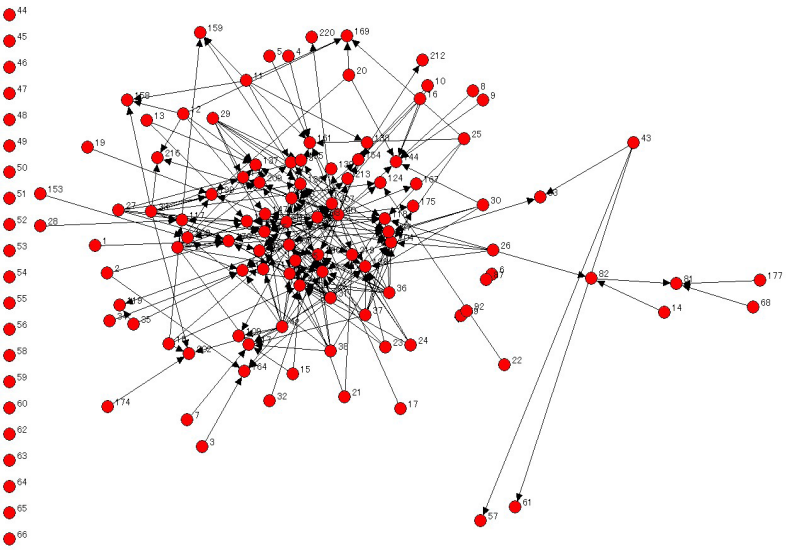
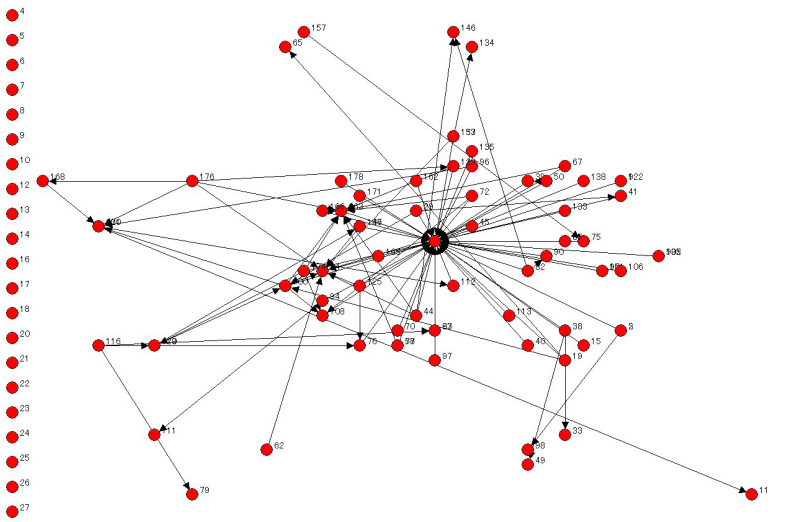


Figure 2. Relationship graph of cross-shareholdings of Mazda Yokokai in 2004



relationships to model the influence of each firm. The network of transactions in the Mazda keiretsu is shown in Figure 1, and the network of cross-shareholdings in the Mazda keiretsu is shown in Figure 2. The numbers in both Figures 1 and 2 refer to various companies in the keiretsu. The list of company names is provided in Appendix I.

3.3 Influence Measurement

Using a computer program developed by the authors, the influence of each firm in the Mazda keiretsu was calculated. The result of the influence of transactions is shown in Figure 3.

Figure 3 shows that the influence from Mazda to other suppliers is zero, but the influence from other suppliers to Mazda is quite high. Figure 4 shows the influence from other suppliers to Mazda in more detail. The total influence from other suppliers reaches 5.46. This shows Mazda received many parts from suppliers. The influence of cross-shareholdings was calculated using the same method. The influence from Mazda to other suppliers is 0.50, but the influence from other suppliers to Mazda is zero.

The results of this analysis clearly show that Mazda has investments in many of the companies that supply its parts, and consequently receives many parts from these suppliers.

4. ANALYSIS AND IMPLICATIONS

The finding that the more investment that Mazda makes in its supplier firms the more transactions Mazda will have with them, is not an unexpected result. The question that can now be asked is: "How strong is this relationship between level of investment and number of transactions?" To answer this question, the correlation coefficients between transaction and cross-shareholdings were calculated. The results of this analysis are shown in Table 1.

This analysis shows that two correlations, that between influence B of transactions and influence A of cross-shareholdings, and that between influence A of

Figure 3. Transactional relationships in the Keiretsu of Mazda Yokokai

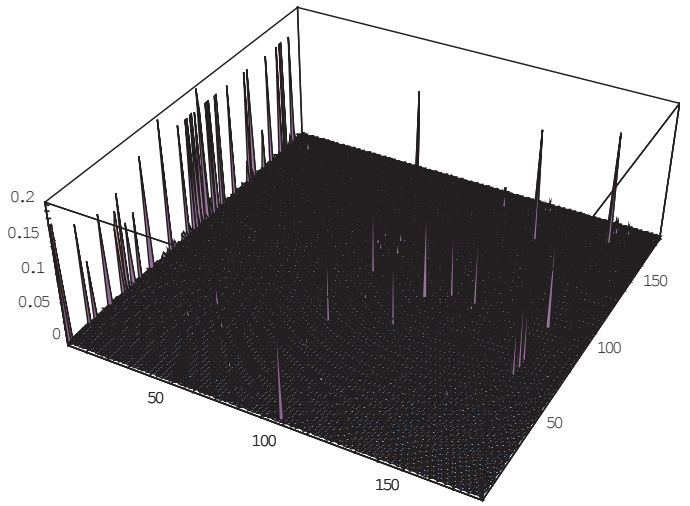


Figure 4. Influences from other suppliers to Mazda

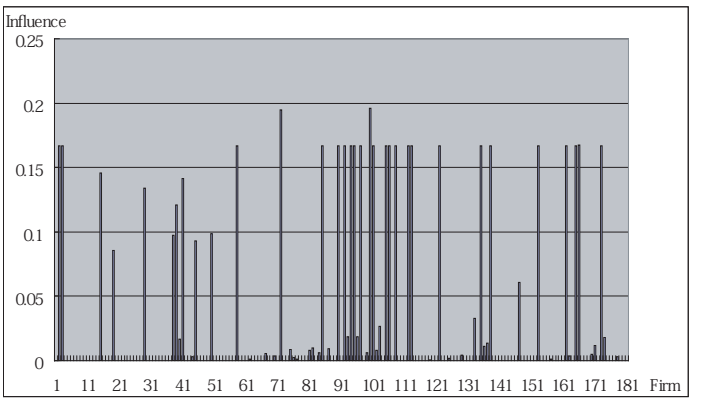


Table 1. Matrix of correlation coefficient between transaction and cross-shareholdings

		Cross-shareholdings		Transaction	
		Influence A	Influence B	Influence A	Influence B
Cross- shareholdings	Influence A	1	0.030	0.039	0.678**
		-	0.687	0.604	0.000
		181	181	181	181
	Influence B		1.000	0.399**	-0.033
			-	0.000	0.660
			181	181	181
Transaction	Influence A			1.000	-0.036
				-	0.633
				181	181
	Influence B				1.000
					-
					181

***p < 0.01*

Note: The first layer is the Pearson's correlation coefficient; the second layer is the probability (two-side test), and the third layer is the sample size. Influence A means actor i directly influences actor j; and Influence B means actor i is influenced from actor j.

transactions and influence B of cross-shareholdings, were significant ($p < 0.01$). The correlation values were 0.678 and 0.399 respectively, which shows that a strong relationship exists between the level of transactions and cross-shareholdings. In other words, the statement that "the more a firm invests in a supplier, the more the firm receives parts from that supplier" is valid. The reciprocal finding that "the higher level of investment that a firm accepts, the more parts that firm will supply" is also valid.

5. CONCLUSIONS

In this paper, the influence of each firm was measured in order to investigate the pattern of relationships in the keiretsu of Mazda. The study found that the influence of cross-shareholdings in other firms is closely related to the influence of the transactions between them. This means that the higher influence of cross-shareholdings has a strong impact on the influence of transactions. The implication of this finding for the automobile manufacturer Mazda is that an important strategy for them is to find those firms that have higher influence in the keiretsu and strengthen their reciprocal relationship with them.

One limitation of the paper is that the data of transactions and cross-shareholdings in this analysis are restricted to one fiscal year. Data from more years would be required in order to more completely study the trend of these identified influences through time series analysis. In addition, the form of influence investigated in this study is only one aspect of the reciprocal relationship between an automobile manufacturer and its supplies. Further quantitative research, such as the use of capacity analysis between two actors and clique analysis of the network structure, will be undertaken in the future, to attempt to capture the complexity of the relationships in the keiretsu of Mazda.

ACKNOWLEDGMENT

The authors would like to express their thanks to Nagaoka University of Technology for their financial support and the anonymous reviewers for their constructive comments of this research.

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APPENDIX I: KEIRETSU MEMBERS SHOWN IN FIGURES 1 AND 2

No.*	No.#	Company	No.*	No.#	Company
-	1	The Daishi Bank,Ltd.	71	113	N.E.CHEMCAT CORPORATION.
-	2	Mitsui Trust Holdings, Inc.	72	114	NOK CORPORATION
-	3	TAIYO LIFE INSURANCE COMPANY	73	115	ENKEI Corporation
-	4	The Ashikaga Bank,Ltd.	74	116	Autoliv, Inc.
-	5	SECOM General Insurance	75	117	KYB Co.,Ltd.
-	6	The Yamaguchi Bank, Ltd.	76	118	CALSONIC KANSEI CORPORATION
-	7	Nissei Dowa General Ins.	77	119	Kyosan Denki Co.,Ltd.
-	8	Saitama Resona Bank, Limited	78	120	Kyowa Leather Cloth Co.,Ltd.
-	9	Nisshin Fire & Marine Insurance Co.,Ltd.	79	121	Clarion Co.,Ltd.
-	10	ASAHI MUTUAL LIFE INSURANCE CO.	80	122	Continental Teves AG & Co.
-	11	The Bank of Yokohama, Ltd.	81	123	KOITO MANUFACTURING CO., LTD.
-	12	Mizuho Bank, Ltd.	82	124	Sanoh Industrial Co.,Ltd.
-	13	Fukoku Mutual Life Insurance Company	83	125	SANYO Automedia Co.,Ltd.
-	14	The Hiroshima Bank, Ltd.,	84	126	JATCO Ltd.
-	15	Tokio Marine & Fire Insurance Co., Ltd.	85	127	SHOWA Corporation.
-	16	Shinsei Bank, Limited.	86	128	Shin-Kobe Electric Machinery Co., Ltd.
-	17	Mizuho Trust & Banking Co.,Ltd.	87	129	STANLEY ELECTRIC CO., LTD.
-	18	Aioi Insurance Co., Ltd.	88	130	VALEO THERMAL SYSTEMS JAPAN
-	19	DAIDO LIFE INSURANCE COMPANY	89	131	CENTRAL GLASS co.,Ltd.
-	20	Nichido Fire & Marine Insurance Co., Ltd.	90	132	TAKATA Co.,Ltd.
-	21	Sumitomo Life Insurance Company.	91	133	T.RAD CORPORATION.
-	22	The Joyo Bank, Ltd.	92	134	TOKYO ROKI co.ltd.
-	23	Mitsui Sumitomo Insurance Company, Ltd	93	135	GKN Driveline Torque Technology KK
-	24	Resona Bank, Limited.	94	136	TOPY Industries Ltd.
-	25	Mitsubishi Trust and Banking Corporation	95	137	Nisshinbo Industries,Inc.
-	26	The Sumitomo Trust & Banking Co., Ltd.	96	138	Nittan Valve Co.,Ltd.
-	27	SOMPO JAPAN INSURANCE INC.	97	139	Nifco Inc.
-	28	Meiji Yasuda Life Insurance Company	98	140	Nippon Sheet Glass Co., Ltd.
-	29	Trust & Custody Services Bank, Ltd.	99	141	NIPPON THERMOSTAT CO.,LTD.
-	30	UFJ Trust and Banking Corporation	100	142	NSK Ltd.
-	31	Nippon Life Insurance Company	101	143	NHK SPRING CO.,Ltd.
-	32	Tokio Marine & Nichido Fire Insure Co. Ltd.	102	144	NIPPON PISTON RING CO.,LTD.
-	33	The Bank of UFJ	103	145	Japan Brake Industrial Co., Ltd.
-	34	The Nomura Trust and Banking Co., Ltd.	104	146	HARADA INDUSTRY CO.,LTD.
-	35	NIPPONKOA INSURANCE CO.,LTD.	105	147	Pioneer Corporation
-	36	The Dai-ichi Mutual Life Insurance Company	106	148	PIOLAX. Inc.
-	37	The Bank of Tokyo-Mitsubishi, Ltd.	107	149	Hitachi Metals, Ltd.
-	38	Meiji Yasuda Life Insurance Company	108	150	Hitachi, Ltd.
-	39	Mizuho Corporate Bank., Ltd.	109	151	Hitachi Cable, Ltd.
-	40	The Master Trust Bank of Japan, Ltd.	110	152	Fujikura Ltd.
-	41	Japan Trustee Services Bank, Ltd.	111	153	Bridgestone Corporation
-	42	SUMITOMO MITSUI BANKING CORP	112	154	THE FURUKAWA ELECTRIC CO.,LTD.
1	43	Mazda Motor Corporation	113	155	PRESS KOGYO Co.,LTD.
2	44	ASTEER co., Ltd.	114	156	Benteler Automotive K.K.
3	45	Ishizaki Honten Company, Limited	115	157	Bosch Corporation
4	46	UCHIYAMA MANUFACTURING CORP.	116	158	Marui Industrial Co., Ltd.
5	47	UBE INDUSTRIES, LTD.	117	159	Mikuni Corporation
6	48	OHMORI TECHNOS CO.,LTD	118	160	MITSUI MINING & SMELTING CO.,LTD.
7	49	OGINO INDUSTRY CO.,LTD	119	161	Mitsuba Corporation
8	50	ONDO CORPORATION	120	162	Mitsubishi Electric Corporation
9	51	Kautex Textron	121	163	Minebea Co.,Ltd.
10	52	KAINAN IRON WORKS CO.,LTD	122	164	Meiwa IndustryCo.,Ltd.
11	53	KATAYAMA KOGYO CO., LTD.	123	165	YAZAKI CORPORATION.
12	54	KAWAKAMI IRONWORKS.CO.LTD	124	166	U-SHIN LTD.
13	55	KAWADA Corporation	125	167	Unipres Corporation
14	56	KANDA CO.,LTD.	126	168	THE YOKOHAMA RUBBER CO.,LTD.
15	57	KEYLEX corporation.	127	169	YOROZU Corporation
16	58	Kitagawa Iron Works Co., Ltd.	128	170	RIKEN CORPORATION
17	59	KIYO INC	129	171	AISAN INDUSTRY CO LTD Hiroshima Sales
18	60	KUBOTA IRON WORKS CO.,LTD	130	172	Aisin AI CO.,LTD.
19	61	KURASHIKI KAKO CO., LTD.	131	173	Aisin AW CO.,LTD.
20	62	KUROISHI IRONWORKS.CO.LTD	132	174	AICHI STEEL CORP. Hiroshima Sales

21	63	Kostal Japan Co.,Ltd.	133	175	Ashimori Industry;Co., Ltd.
22	64	Kolbenschmidt K.K.	134	176	ADVICS CO.,Ltd.
23	65	SANKEI INDUSTRY CO., LTD.	135	177	INOAC CORPORATION
24	66	SANWA INDUSTRY CO.,LTD.	136	178	Imasen Electric Industrial Co., Ltd.
25	67	Sigma.co.ltd.	137	179	EXEDY Corporation
26	68	GP Daikyo Corporation.	138	180	NTN Corp.
27	69	SUGIHARA CO.,LTD	139	181	Osaka Rashi Mfg. Co., Ltd.
28	70	Sumitomo Electric Sintered Alloy Ltd.	140	182	OKUMURA FORGE CO.,LTD.
29	71	SUMINO KOGYO CO., LTD	141	183	owari precise products co.,ltd.
30	72	Dairiki IronWorks Co., Ltd.	142	184	Kanemitsu Corporation
31	73	CHUO INDUSTRIES, LTD.	143	185	Kawashima Selkon Textile Co.,Ltd.
32	74	CHUO SPRING INDUSTRY	144	186	KYOWA INDUSTRIAL CO.,LTD.
33	75	DELTA Inc.	145	187	GATES UNITTA ASIA COMPANY.
34	76	Toyo Advanced Technologies Co.,Ltd.	146	188	JTEKT Corporation.
35	77	TOYO SEAT Co.,Ltd.	147	189	KOKUSAN PARTS INDUSTRY CO.,LTD.
36	78	NAGATO CORPORATION	148	190	Samtech Co.,Ltd.
37	79	NANJO SOBI KOGYO CO., LTD.	149	191	GS Yuasa Corporation
38	80	NIITECH CO., LTD.	150	192	ShinMaywa Industries, Ltd.
39	81	Nishikawa Kasei Co.,Ltd.	151	193	STARLITE Co.,Ltd.
40	82	Nishikawa Rubber Co., Ltd.	152	194	Sumitomo Metal Industries, Ltd.
41	83	Japan Climate Systems Corporation	153	195	Sumitomo Electric Industries, Ltd.
42	84	HAMADA CORPORATION.	154	196	SUMINOE Co.,Ltd.
43	85	Visteon Asia Pasific	155	197	SEIREN Co.,Ltd
44	86	HIRUTA KOGYO CO., LTD	156	198	Daido Steel Co.,Ltd.
45	87	HIROSHIMA ALUMINUM CO., LTD	157	199	DAIDO METAL Corporation.
46	88	HIROSHIMA SEIKEN KOGYO CO.,LTD	158	200	Taihei Koki MGF Co.,Ltd.
47	89	HIROSHIMA SEIMITSUKOGYO CORP	159	201	Goodyear Japan Ltd.
48	90	HIROTANI Co.,Ltd.	160	202	Chuo Spring Co.,Ltd.
49	91	HIROTEC.Co,.Ltd.	161	203	TSUBAKIMOTO CHAIN CO.
50	92	FUTABA KOGYO CO., LTD.	162	204	TRW Automotive Japan.
51	93	Webasto Japan Co. Ltd.	163	205	DENSO CORPORATION
52	94	MICROTECHNO CORPORATION	164	206	TOKAI Corp.
53	95	Mazda Engineering & Technology Co.,Ltd.	165	207	Tokai Rubber Industries, Ltd.
54	96	MAPS CO.,LTD	166	208	TOKAI RIKA CO.,LTD.
55	97	MALOX Co.,Ltd.	167	209	TOYO TIRE & RUBBER CO.,LTD.
56	98	Matsumoto Heavy Industry Co.,Ltd.	168	210	TOYOTA MACHINE WORKS.LTD.
57	99	Minoru Kasei Co.,Ltd.	169	211	TOYOTA GOSEI CO.,LTD.
58	100	Molten Corporation.	170	212	Nikkei Kakoh Co., Ltd.
59	101	Yumex Corporation,	171	213	Nihon Cable System Co.,Ltd.
60	102	YOSHIWA INDUSTRY CO.,LTD	172	214	JAPAN DROP FORGE CO.,LTD.
61	103	LEAR CORPORATION JAPAN	173	215	NGK SPARK PLUG CO.,LTD.
62	104	Ryobi Limited.	174	216	Hanshin Electric Co.,Ltd.
63	105	Ring Techs Hiroshima Co.,Ltd.	175	217	BANDO CHEMICAL INDUSTRIES, LTD.
64	106	YNS INC.	176	218	HIKARI SEIKO CO.,LTD.
65	107	Y-TEC CORPORATION	177	219	Matsushita Electric Industrial Co., Ltd.
66	108	Akebono Brake Industry Co., Ltd.	178	220	MARUYASU INDUSTRIES CO.,LTD.
67	109	ASMO CO.,LTD.	179	221	MITSUBOSHI BELTING LTD.
68	110	Ishikawajima-Harima Heavy Industries Co.	180	222	MIYAGAWA KASEI INDUSTRY CO.,LTD.
69	111	ICHIKOH INDUSTRIES,LTD.	181	223	METALART CORPORATION
70	112	Usui Kokusai Sangyo Kaisha, Ltd.			

Note: No. is the sequential number in the transaction network, and No.# is the sequential number in the cross-shareholdings network.*