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DOES GROUP MEMBERSHIP MATTER? EVIDENCE FROM THE JAPANESE STEEL INDUSTRY

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In this study we address criticism that performance differences among strategic groups found in past research may be spurious and attributable to firm effects. The Japanese steel industry provides the setting for the study. Our analysis is based on data from the carbon steel sector of the Japanese steel industry for the periods 1980–87 and 1988–93. A one-way ANOVA indicated that the average performance of firms in the two technology-based groups in this industry—the integrated mills and the minimills—were significantly different during the two periods. Subsequently, we performed a regression analysis to examine the residual group effect after controlling for both environment and firm-specific effects. We found that even after controlling for both environment and firm-specific effects group membership was significantly associated with firm performance.

A strategic group comprises firms within an industry that have similar cost structures, degrees of product diversification, formal organization, or resource profiles (Bogner, Mahoney and Thomas, 1994; McGee and Thomas, 1986). Firms within a group are considered similar to each other compared to firms outside the group and within the same industry (Thomas and Venkatraman, 1988). Strategic groups within an industry are mutually exclusive and collectively exhaustive.

Starting with Hunt's (1972) identification of groups in the U.S. home appliance industry, research on strategic groups has grown substantially. This growth perhaps supports Thomas and Venkatraman's (1988) observation that strategic group research is a useful intermediate level of analysis between the firm and the industry. However, despite the growing body of work that has established the presence of groups in different industries, research on strategic groups has been the target of considerable criticism.

Several researchers (cf. Barney and Hoskisson, 1990; Cool, 1985; Cool and Schendel, 1988; Hatten and Hatten, 1987; Reger and Huff, 1993; Thomas and Venkatraman, 1988) have expressed concern over the different sets of variables and clustering algorithms used to identify groups. Barney and Hoskisson (1990), for example, argued that the identification of groups within an industry is a mere methodological artifact, dependent primarily on the particular clustering algorithm used to generate them.

Another widely shared concern in strategic group literature is the mixed support for the relationship between group membership and performance (Lawless and Tegarden, 1991). Although some studies have found performance difference among groups (e.g., Dess and Davis, 1984; Oster, 1982), others have found no significant differences in performance (cf. Cool and Schendel, 1987; Cool and Schendel, 1988; Frazier and Howell, 1983).

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Cool and Schendel (1988) suggested that the conflicting findings may be because of improper identification of mobility barriers. But Barney and Hoskisson (1990) demonstrated that the performance differences between groups exist even when different sets of variables, irrespective of mobility barriers, were used to identify groups within an industry. They concluded that performance differentials among groups may be the result of idiosyncratic firm attributes and may have little to do with group membership per se.

Such concerns about the existence of groups and their impact on firm performance are serious, because they undermine the very concept of strategic groups and its meaningfulness to strategy research. Perhaps it is such concerns that led Dranove, Peteraf and Shanley (1998) to go so far as to assert that a strategic group exists only if the performance of members is an outcome of group characteristics, after controlling for firm and industry characteristics.

This study is an attempt to contribute to group-level research by addressing some of the concerns raised above. It primarily focuses on the following question: Does membership in a group affect firm-level performance? Employing data from the carbon steel sector of the Japanese steel industry (JSI), this study attempts to isolate the direct effect of group affiliation on performance, after controlling for environment and firm-specific factors.

Two factors make the JSI an ideal setting in which to examine the direct effect of group membership on performance. First, this industry has two distinct groups—the integrated mills and the minimills—that produce ordinary or carbon steel.[1] The presence of two distinct groups in this industry (as explained in greater detail below) is due to the different technological processes that firms in this industry use to produce steel. Thus, it helps us identify groups without resorting to any clustering algorithms.

Second, the financial performance (measured as return on sales) of the two groups has changed over time (see Figure 1). The integrated mills outperformed the minimills during 1980–87. However, the minimills, as a group, outperformed their integrated counterparts during 1988–93. A priori knowledge that the two groups in the JSI differed in their mean performance levels provides a stylized setting to examine whether performances of firms in the industry were directly associated with group membership. Thus, this study explicitly addresses Barney and Hoskisson's (1990) concern about the lack of clear evidence of the 'group effect' in past studies that have examined performance difference among groups.

We organize this paper as follows. First, we provide a brief history of the JSI and describe the two groups in this industry. Next, we discuss the theory and hypothesis driving our study. Then we describe the sample, methodology, and analyses. Finally, we present the results of our analyses and discuss their implications for strategic-groups research.

INDUSTRY BACKGROUND AND PRESENCE OF GROUPS

Before World War II, Japan had 35 blast furnaces and 280 open-hearth furnaces (OHF) that produced approximately 7.65 million metric tons of steel. However, by the conclusion of World War II, only three blast furnaces and 22 OHFs were operating. Together these furnaces produced 557,000 metric tons of steel, less than 10 percent of the pre-World War II levels. In other words, by the end of World War II the production of steel in Japan collapsed.

Starting in 1946, the Economic Stabilization Board, a Japanese government agency, in consultation with the Supreme Commander of the Allied Powers, started programs to rebuild the core industries such as coal, electric power, and steel.

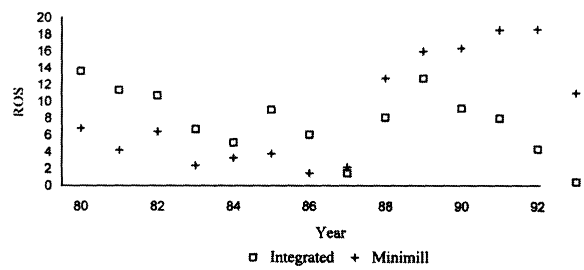

Figure 1. Performance changes over time in JSI

[1] Steel products come in many grades and are classified into two broad groups: ordinary steel and specialty steel. Ordinary, or carbon steel, contains less than 0.6 percent carbon by weight. In contrast, specialty steel, in addition to the carbon content, contains many alloying elements like molybdenum, tungsten, vanadium, chromium, nickel, and manganese that provide it with special mechanical, physical, and corrosion-resistant properties. In 1993, special steel comprised approximately 17.58% of total steel production. In the rest of our discussion, 'steel' refers to carbon steel.

In an effort to revive the steel industry, the Reconstruction Finance Bank of Japan provided financial funding for the acquisition of capital goods and working capital to firms in the industry (JISF, 1968). Additionally, many subsidies were extended to firms in the industry by other Japanese governmental agencies for the purchase of raw materials such as iron ore and coal, both of which were imported into Japan.

Despite these subsidies in 1950, the domestic prices of steel products in Japan were more than 50 percent higher than those in other industrialized nations. In order to make the JSI competitive, the Japanese government encouraged industry leaders to modernize equipment and improve their productivity. This modernization program lasted from 1951 until 1955. It resulted in higher steel-making capacity and improved productivity.

Following the success of the first program, the Japanese government initiated a second modernization program. This program, which lasted from 1956 until 1960, resulted in the setting up of several new steel plants. The number of blast furnaces increased from 21 to 34, the number of OHFs from 134 to 149, the number of basic-oxygen furnaces (BOFs) from zero to 13, and the number of electric-arc furnaces (EAFs) from 513 to 662. Due to such efforts and subsidies, the Japanese steel-makers became extremely competitive with the world's leading steel producers by the end of 1960.

Groups in the Japanese steel industry

The JSI has been dominated by the integrated mills. The integrated mills produce steel by first converting iron ore into pig iron in blast furnaces and subsequently reducing the pig iron into steel in BOFs. Japan also had a number of small steel producers starting as early as the 1920s. In contrast to the integrated producers, many of these small firms primarily used the EAFs for producing steel. The viability of small firms in competition with the well-financed larger firms was possible due to the availability of: (1) inexpensive ferrous scrap imported mainly from India and the United States; (2) cheap domestic labor; and (3) low-cost electric power during off-peak hours in Japan.[2]

After World War II, the main source of inputs for the small firms in the industry came from ferrous scrap left over from the war effort and imports from the United States. The war scrap was ultimately exhausted and, at the same time, imports became less dependable. As a result, the price of ferrous scrap in Japan became one of the highest in the world. This rise in ferrous scrap prices adversely affected the operating costs of small steel mills. However, the switch to BOF technology from OHF by the large integrated steel mills during the late 1950s and early 1960s considerably reduced their (integrated mills) dependency on ferrous scrap as an input to produce steel. The earlier OHF technology deployed by the integrated producers required a 1:1 ratio of ferrous scrap and pig iron to produce carbon steel. In contrast, the newly adopted BOF technology permitted the integrated mills to use a mere 1:9 ratio of ferrous scrap and pig iron to produce carbon steel.

By the late 1960s, as more and more integrated mills installed BOFs, the price of domestic ferrous scrap dropped considerably, and at the same time Japan's dependency on imported ferrous scrap was also reduced. Furthermore, improvements in EAF technology in terms of furnace lining, transformer capacity, and electrode design occurred during the same period, increasing the capacity and quality of steel produced by the EAFs. Thus, the switch to BOF by the large integrated mills and changes in EAF technology benefited the small steel mills, and it ensured their long-term survival and attractiveness within the JSI (JISF, 1995). These changes ensured the presence of two distinct groups within the steel industry: the integrated mills and the minimills.

The two groups differ in their use of technology, and critical inputs employed in the production of steel. The sunk costs and differences in technology create differences in resource endowments (Bogner et al., 1994), which in turn enable the existence of two separate groups. Additionally, the core-melting technology serves as a mobility barrier that prevents firms from switching groups.

Existential basis of groups

Perhaps responding to Barney and Hoskisson's (1990) concerns about the tendency of clustering algorithms to generate frivolous groups, Peteraf

[2] In 1993, 31.2 percent of crude steel production in the JSI was done through the EAF process. This includes both carbon and special steel products.

and Shanley (1997) have suggested more robust criteria to establish the existence of groups. They argued that group members should have shared identities. Peteraf and Shanley (1997) assert that strategic group identities are shaped by similar and shared macro- and micro-level processes. According to them, macro-level processes comprise institutional, economic, and historical forces. Whereas historical forces create irrevocable structures that emerge out of path dependencies, economic forces create distinctions among firms based on characteristics such as scale, resource endowments, and technology (Peteraf and Shanley, 1997). Finally, institutional forces such as 'mimetic' and 'normative' pressures (DiMaggio and Powell, 1983) tend to produce convergence over time in firm behavior within a group.

In contrast to the above, micro-level processes that create homogeneity in behavior comprise the following: social identity, learning, and categoriza tion. Categorization processes result from managers' trying to make sense of a complex environment (Fombrun and Zajac, 1987; Lant and Baum, 1995; Porac, Thomas and Baden-Fuller, 1989; Reger and Huff, 1993). Vicarious learning processes, wherein firms use peers from their own groups as referent others, lead to convergence of member repertoire of strategies over time (Bandura, 1989). Finally, social identity processes reinforce the notion of membership in a group, and over time firm behavior tends to follow the group's norms. Thus, according to Peteraf and Shanley (1997) it is these macro- and micro-level forces that give rise to distinct group identities and form the existential basis of groups.

Groups in the JSI were subject to several of the macro processes discussed above. The two groups—integrated and minimills—were shaped by distinct historical forces. Integrated mills emerged out of institutionally coordinated efforts following World War II; the minimills, in contrast, have existed since the early 1920s, and have a shared history based on their dependence on common inputs comprising electric power and ferrous scrap.

The differences in the technology adopted by the two groups (i.e., EAF vs. BOF) meant that they were subject to different economic forces. For example, differences in steel-melting technology between the groups translate into differences in economies of scale—integrated mills need larger capacities to achieve scale economies compared to minimills. Finally, the two groups were also subject to different institutional pressures. As government agencies such as the Economic Stabilization Board, MITI, and the Reconstruction Finance Bank of Japan played a more critical role in the coordination and growth of the integrated mills, they were subject to different normative and coercive pressures than those belonging to the minimill group.

While we did not collect any direct evidence of micro-level processes, evidence of the outcome of both macro and micro processes are observed in the conduct of the two groups. For instance, according to O'Brien (1989), during the 1960s when the Ministry of International Trade and Industry's (MITI) power had declined, coordination among firms continued through Jishu Chosei (self-regulation). Under this system, managers from leading Japanese steel companies met regularly at the Japan Iron and Steel Federation to coordinate production, pricing, export, and investment plans. Also, when the integrated mills experienced a downturn in the mid-1980s, all but one of the firms started diversifying into the semiconductor business (*The Economist*, 1994). More recently, integrated mills have jointly attempted to develop the direct iron ore smelting reduction process (DIOS) (Iron Age New Steel, 1994). Thus, by virtue of their shared identities, the integrated and minimills constitute two distinct groups within the JSI.

The above use of core-melting technology to identify groups overcomes the problems associated with the use of clustering methods to classify firms into groups (Barney and Hoskisson, 1990; Wiggins and Ruefli, 1995).[3]

[3] The method we used here to identify the two groups may ignore the presence of finer groupings within the industry. An anonymous reviewer referred to this issue as the 'group within group within group' problem. To test if there were such finer groupings, we performed a cluster analysis of firms in JSI for the 1980–93 period using Ward's method. We followed decision rules developed by Fiegenbaum, Sudarshan, and Thomas (1990) to determine the number of groups. We performed the analysis using different sets of scope and resource commitment variables. The number of groups identified each year ranged from three to six. The shifts in the number of groups identified, the lack of any meaningful interpretability of the groups based on industry reports, and discussion with analysts cause us to be suspicious of these groupings. Moreover, we could not assess the extent to which these groups had experienced distinct shared identities. In addition, such an approach violates Cool and Schendel's (1988) suggestion that groups should be identified on the basis of mobility barriers, which in this industry is the tech-

THEORY AND HYPOTHESIS

The principal thrust of strategic groups research has been on examining the relationship between group membership and firm performance. This thrust reflects strategy researchers' orientation towards identifying factors that affect firm performance. As Thomas and Venkatraman (1988): 541) have aptly argued:

> ... strategic management is centrally concerned with issues of organizational performance ... and strategies are often evaluated in terms of performance implications ... Indeed, we go as far as to note that if strategic groups are to be truly useful for theory construction in strategic management, then there should be a relationship between strategic group membership and performance criteria.

Recently Dranove et al. (1998) went so far as to assert that a strategic group exists only if the performance of members is an outcome of group characteristics, after controlling for firm and environment characteristics.

Group membership and performance

Group membership may be associated with firm performance for the following reasons: (1) differences in intragroup competition; (2) asymmetrical impact of intergroup competition; (3) differences in the bargaining power of group members vis-à-vis customers and suppliers; and (4) the presence of mobility barriers.

Intragroup competition

Firms within a strategic group may generate above-normal returns if the group characteristics prevent the emergence of perfect competition within it. In other words, some groups resemble oligopolies and are able to generate superior performance (Newman, 1978). Factors affecting oligopolistic coordination may include the number and size of firms within a group and their shared history (Porter, 1980). For example, a small number of firms in a group may recognize their mutual interdependence and be able to achieve tacit coordination and avoid excessive competition in product and factor markets, enabling members to generate above normal rents.

Intergroup competition

Intergroup competition in an industry depends upon the extent of market interdependence, number of groups, and industry growth, among other factors (Porter, 1980). Excessive intergroup competition can reduce any above-normal profits that a firm could generate because of its unique strategies or intragroup factors discussed above. Moreover, performance difference among groups might be caused if the effect of intergroup rivalry is asymmetrical. Asymmetries can exist when different groups possess different cost structures, diversification, or market power (Bogner et al., 1994; Nayyar, 1989). For example, in the brewing industry, excessive competition had differential effects on local, regional, and national brewers (Boeker, 1991).

Differences in bargaining power

Differences in bargaining power that the groups have vis-à-vis their suppliers and customers could also generate differences in profitability (Porter, 1980). This is especially true when factor or product markets are partitioned or do not completely overlap. Under such conditions, groups within an industry may face different sets of suppliers and customers. The size of suppliers or customers, concentration, availability of substitutes, differentiation, and switching costs would influence the bargaining power that group members may have in product or factor markets (Porter, 1980). Differences in bargaining power among groups can create differences in rents generated by members in different groups (Dranove, Peteraf and Shanley, 1993).

Mobility barriers

Performance differences that emerge because of asymmetries in intra- or intergroup competition, or bargaining power in factor and product markets, may disappear unless they are sustained by mobility barriers among groups. Mobility barriers are factors which deter or inhibit the movement of a firm from one strategic group to another (Caves and Porter, 1977; McGee and Thomas,

nology used to melt steel. Thus, we proceeded with the technology-based grouping. Results of cluster analysis available from authors on request.

1986; Porter, 1980). These barriers prevent firms from low-performing groups from moving into high-performing groups and sustains performance difference among groups. In the absence of mobility barriers, firms from low-performing groups could easily move into the high-performing groups, increase intragroup competition, and reduce the profitability of group members.

Performance in the JSI

In the JSI, several of the factors discussed above appear to be present. Mobility barriers are clearly high and asymmetrical in the JSI. Entry into the integrated group is extremely difficult because of the high investment costs—upwards of $5 billion. Entry barriers into the minimills group are relatively low at about $60 million.

In addition, the number and size of firms in the two groups differed considerably, creating differences in intragroup competition.[4] There were seven integrated mills and nineteen minimills that produced carbon steel. In 1993, integrated mills had on average 18,460 employees and ¥1.075 billion in sales. The minimills on average had 1307 employees and sales of ¥119 million. The smaller number of firms in the integrated group increases the likelihood of achieving greater oligopolistic coordination.

The two groups also differed considerably in their product markets and cost structures that may create asymmetries in impact of intergroup competition. The integrated mills produce steel plates and I-section beams, in addition to bars and rods; whereas the minimills are predominantly focused on the bar and rod segments of the product market. Because of the greater market overlap in the bar and rod segments, the minimill group members are more vulnerable to competition from the integrated mills in these segments. On the other hand, differences in scale and overhead cost structures make the integrated group members more vulnerable during periods of decline in steel demand.

Partitioned factor markets, where the integrated mills principally use iron ore and coke as the input raw materials, while the minimills use ferrous scrap, and the differences in the number and size of firms in the two groups (mentioned earlier) have resulted in differences in bargaining power that the two group members have with their suppliers. For example, the integrated mills were able to institute coordinated procurement of raw materials by acting as a single customer in international markets (Mohan and Berkowitz, 1988). In contrast, the market for ferrous scrap, the key input for the minimills, is highly volatile because of the large number of EAF furnaces (carbon and special steel), and fluctuations in supply.[5]

In sum, the two groups in the JSI differ in terms of the number and size of firms in their groups, face asymmetric intergroup competition, have different bargaining powers in factor markets, and are separated by substantial mobility barriers. Thus:

Principal Hypothesis: After controlling for firm- and environment-specific effects, group membership will be associated with firm-level performance.

METHODS

Sample and data

We collected data from publicly traded firms listed on the Tokyo, Osaka, and Nagoya Stock Exchanges. Our main source of data was the Analysts' Guide, one of the most respected and comprehensive sources of information on Japanese firms available today. This guide is published annually by Daiwa Securities, a leading financial services firm in Japan. Data from this guide have been used by other researchers (e.g., Lieberman, Lau and Williams, 1990; Kotha and Nair, 1995). This guide provides information on all the publicly traded companies on Japan's three most important stock exchanges: Tokyo, Osaka, and Nagoya.

To ensure the reliability of our data, we cross-checked the data obtained from this source with data available from the Japan Company Hand-

[4] Whereas there were 45 blast furnaces in December 1994 in Japan, the number of EAFs was 480 (JISF, 1995). Each firm usually operates more than one furnace, and many of the EAFs are exclusively used to manufacture special or alloy steels.

[5] The ferrous-scrap requirements of the JSI are now increasingly met from domestic sources. Fluctuations in scrap supply depend on the demand for steel. In periods of high steel demand, scrap supply falls and prices rise; in periods of low steel demand, scrap supply is high and prices fall.

book (JCH). JCH is another well-known source for data on Japanese firms. This guide is published quarterly by Toyo Keizai Inc. This investigation found no discrepancies between the two data sets.[6]

We focused on data for the period 1980–93. We chose 1980 as our starting year for the analyses because, by then, firms in the JSI had completely rebounded from the effects of the 1973 recession created by the global oil crisis caused by the Arab Oil Embargo. The oil embargo and the resultant increase in oil prices created tremendous hardships for Japanese firms because many of them were heavily dependent on imported oil as their primary energy source. Overall, the 12 firms in our sample together accounted for more than 90 percent of carbon steel sales in the JSI in 1993.

Group membership

We operationalized membership in a group using two dummy variables: 'Group 1' and 'Group 2.' The Group 1 variable was assigned a value of '1' if a firm belonged to the integrated group and '0' otherwise. Similarly, 'Group 2' was assigned a value of '1' if a firm belonged to the minimills group and '0' otherwise. In a sample where only two categories exist, as in this case, only one dummy variable is included in the regression analysis. The excluded group thus becomes a reference group, and the regression coefficient will express the difference between the two group means (Hardy, 1993).

Performance

The financial performance measures employed in this study are return on sales (ROS) and return on assets (ROA). We assessed ROS as the ratio of operating income to total sales, and ROA as the ratio of operating income to total assets.[7] Although these two measures may be distorted due to aggregations, it is generally acceptable when the firms in the sample are relatively undiversified (Venkatraman and Ramanujam, 1986). In 1993, the most recent year in our sample, the average level of diversification for firms in our sample was less than 16 percent.

Control variables

Earlier we noted that many studies examining performance differences among strategic groups have failed to control for environment- and firm-specific effects. Controlling for such effects is important because without such controls it is impossible to isolate the direct effect of group membership on performance. Thus, we introduced the following environment- and firm-specific control variables.

Environment variable

Environment-level changes have been shown to impact firm-level performance (Capon, Farley, and Hoenig, 1990). Additionally, such changes may have asymmetrical impact on the groups (and individual firms) within an industry. For instance, in periods when steel demand is high, scrap supply falls and prices rise; in periods of low steel demand, the availability of scrap supply is plentiful and hence prices tend to fall. As minimills are more dependent upon the price of ferrous scrap, the demand for steel has an asymmetric effect on the two groups.

We used 'environmental munificence' to control for any changes in environment that may be associated with firm performance. 'Environmental munificence' describes the capacity of an environment to support organizations in the market place (Yasai-Ardekani, 1989). We operationalized 'environmental munificence' as the change in gross domestic product (GDP) because GDP accounts for the magnitude of changes in resource availability between time periods.

Firm variables

To control for firm effects, we used firm-level realized strategy measures (Mintzberg, 1978), firm age, and firm size. We included firm size because this measure serves as a proxy for a variety of economic impediments related to mobility. We assessed size as the number of employees on the firm's payroll for each year. Firm age can help

[6] Although JCH is less comprehensive in its coverage of industry-level data than the *Analysts' Guide*, it is less expensive and widely available in most university libraries. We found no discrepancies between the two data sets. This was as expected since we were gathering financial and operating data on publicly traded companies.

[7] It must be noted that Japanese firms tend, in general, to understate their asset values (Ito and Pucik, 1993).

determine the efficiency of a firm's operations, equipment, and its access to and relationship with powerful networks that control distribution of steel products. Moreover, age serves as a proxy for tacit dimensions such as employee skills and organizational knowledge. We measured firm age as the chronological age of the firm since its founding.

In addition to age and size, we controlled for realized strategy measures such as employee productivity, capital expenditures, capital intensity, exports, and degree of diversification outside the steel industry (Hambrick, 1983). We operationalized 'employee productivity,' a measure of realized firm-level efficiency, as price-index adjusted sales per employee for each year for each firm. 'Capital expenditures' and 'capital intensity' provide a measure of a firm's asset parsimony dimension (Hambrick, 1983). These two variables indicate a firm's commitment to employ technology to improve productivity and quality dimensions. We assessed 'capital expenditures' as net expenditures for plant and equipment, and 'capital intensity' as the ratio of total assets to the number of employees. We operationalized a firm's 'exports' as the percentage of foreign sales to total sales, and 'diversification' as the percentage of total sales that it derived from businesses other than steel.

Each of these realized strategy variables was calculated for all firms in the sample for the period 1980–93.

Firm-specific effects

While this study intends to control for firm-level variables (such as 'employee productivity'), it can be argued that some part of these variables can be attributed to the firm's membership in a group.[8] Thus, to control for the true firm-level effects, the group effects have to be partialled out. Not doing so can result in double counting such effects in regression models that include both firm- and group-level variables. Further, there is also the possibility that having both sets of variables can induce collinearity problems in the analyses.[9]

To prevent such distortions, we first isolated the firm-specific effect by running a regression analysis with the firm-level variables (employee productivity, capital expenditures, exports, age, capital intensity, and diversification) as the dependent variables, and the group-level dummy variable (GR1) as the independent variable. The model specification was as follows:

$$Y_i = K + \beta X_i + \varepsilon \qquad (1)$$

Here Y_i is the ith strategy of a firm. X_i is the group dummy variable. The residuals in the above model constitute the firm-specific effect after the group effect has been filtered out. These residuals were used to perform the analysis in Equation 2, described below.

Analyses

Table 1 provides the descriptive statistics and zero-order correlations among the dependent and independent variables.

As illustrated in Figure 1, performance differences (ROS) between the integrated mills and minimills changed considerably over time; integrated mills as a group outperformed minimills during the 1980–87 time period, and minimills outperformed their integrated counterparts during the 1988–93 time period.[10] The results of the ANOVAs for the two time periods using ROS and ROA as the dependent variable and the membership in group as the categorical variable are presented in Table 2. These results are consistent with the representation in Figure 1.

Model

The relationship between firm performance and the environment, firm-specific variables, and group dummy variable were modeled as follows:

[8] We thank the reviewers for providing this insight.

[9] Even a variable such as age can have a group component, i.e., firms that are founded during the same time reflect the technology and strategies of the period, and thereby belong to a group (Stinchombe, 1965).

[10] We investigated whether the two time periods (1980–87 and 1988–93), identified based on performance difference, comprised distinct strategically stable time periods (SSTPs). Following Cool and Schendel (1988) and Fiegenbaum *et al.* (1990), we performed Bartlett's χ^2 test to examine the stability of the variance–covariance matrices of the strategy variables across the years (e.g., 1980–81; 1981–82; 1982–83, and so on until 1992–93). The stability of the variance–covariance matrix across each year pair indicates whether there is a relative shift in firm strategies that can alter the group composition. The test coefficients indicate that the groups were stable over the period under study. That is, the relative change

$$Y_{it} = \beta' X_{it} + \epsilon_{it} \ (i = 1, 2, ..., N; t = 1, 2, ..., T) \quad (2)$$

Y_{it} is defined as the return on sales (assets) for firm i in year t. X_{it} are the independent variables; that includes the environment variable, firm-specific variables (residuals from Equation 1), and the group dummy variable for firm i in the year t. We estimated separate models for both ROS and ROA. Efficient and unbiased regression estimation of such time series cross-sectional (TSCS) data may need correction for the following problems:

a) Error terms for cross-sectional observations may be heteroskedastic.
b) Cross-group correlation, that is, error term for firm i in time $t(\varepsilon_{it})$, is related to error term for firm j in time $t(\varepsilon_{jt})$.
c) Within-group autocorrelation, that is, error term for firm i in time $t(\varepsilon_{it})$, is related to error term for firm i in time $t - 1(\varepsilon_{it-1})$ (Greene, 1993; Pindyck and Rubinfeld, 1991).

Another potential estimation problem is multicollinearity. Multicollinearity exists when the independent variables in the model are highly correlated, thereby affecting the accuracy of the regression calculations. Under these conditions OLS estimates are inefficient (i.e., standard errors are inflated) but not biased (Netter, Wasserman and Kutner, 1989).

Because of the presence of highly correlated variables, multicollinearity was a concern. We checked for multicollinearity in the models by examining the variance inflation factors (VIF) for each independent variable. If these values were above the recommended values of 10 (Netter et al., 1989), we dropped the suspect variable and reestimated our regression models. We dropped the 'size' and 'capital intensity' variables from all our models to avoid concerns with multicollinearity.[11]

We then estimated regression models using LIMDEP software (Greene, 1992). Using LIMDEP, we estimated generalized least-squares (GLS) models using the TSCS estimator. The TSCS estimator provides consistent estimates in the presence of groupwise heteroskedasticity, cross- and within-group autocorrelation. The model and the procedures used are those described in Greene (1993): 444 and LIMDEP Version 6).

Given the changes in performance observed over time, we modeled the relationships between group membership and performance for the two time periods. We performed regression analyses using two sets of dependent variables: ROS and ROA. Table 3a and Table 3b show results of our analyses for the 1980–87 and 1988–93 period respectively.

Model 1 (Table 3a) estimates the relationship among environment- and firm-specific variables and ROS for the 1980–87 period. In Model 2, we include the group dummy variable. Model 3 examines the impact of environment- and firm-specific variables on ROA. In Model 4, we include the group dummy variable.

Model 5 (Table 3b), estimates the relationship among environment- and firm-specific variables and ROS for the 1988–93 period. In Model 6, we add the group dummy variable. Model 7 examines the impact of both environment- and firm-specific variables on ROA. In Model 8, we include the group dummy variable. Thus, we estimated eight different regression models.

RESULTS

ANOVA results

The ANOVA results indicate that the integrated mills had a significantly higher ROS during 1980–87, whereas the minimills had a significantly higher ROS between 1988 and 1993. ANOVA results for the ROA variable indicate that during the 1980–87 period there was no significant difference between the integrated mills and minimills. However, during the 1988–93 period the minimills had a significantly higher ROA than the integrated mills.

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in the strategies of firms was not significant. Results are available on request from the authors.

[11] We incorporated size into our base model; however, it was not significant. The two groups use different technologies to produce steel and therefore have different cost structures and economies of scale. While the minimum efficient plant size for the integrated mill is, on the average, 3 million tons per year, the minimum efficient size for minimills with one furnace could be as low as 500,000 tons (D'Costa, 1999: 146). The lack of significance of the size variable suggests that there was not much performance difference among firms attributable to scale, possibly because the firms in the sample had sizes beyond the minimum efficient scale.

Table 1. Means, standard deviations, correlation matrix, Japanese steel industry (1980–93)

	Variable	Mean	S.D	1	2	3	4	5	6	7	8	9	10	11	12
1	Age	51.8	14.2	1.00											
2	Capital expenditure	7.5	5.2	0.19	1.00										
3	Capital intensity	79	30.9	0.20	0.32*	1.00									
4	Diversification	14.5	15.2	0.57*	0.22*	−0.15	1.00								
5	Employee productivity	61.42	25.8	0.00	−0.06	0.69*	−0.39*	1.00							
6	Export	19.7	12.6	−0.20	0.00	−0.47*	0.24*	−0.52*	1.00						
7	GR 1	0.6	0.5	−0.10*	0.27*	−0.20	0.57*	−0.65*	0.47*	1.00					
8	GR 2	0.4	0.5	−0.25*	−0.27*	0.20	−0.57*	0.65*	−0.47*	−1.00*	1.00				
9	Munificence	3.4	1.7	−0.08	−0.38*	−0.29*	−0.06	−0.19	0.08	0.01	−0.01	1.00			
10	ROS	9	5.6	0.01	−0.01	0.55*	−0.15	0.35*	−0.38*	−0.10	0.10	0.02	1.00		
11	ROA	6.9	4.9	−0.09	−0.20*	0.35*	−0.23*	0.45*	−0.41*	−0.30*	0.30*	0.08	0.88*	1.00	
12	Size (log of employees)	8.7	1.5	0.06	0.21*	−0.25*	0.53*	−0.62*	0.70*	0.85*	−0.85*	0.02	−0.17*	−0.32*	1.00

*$p < 0.01$

Table 2. ANOVA—Differences between integrated and minimills in the Japanese Steel Industry

	1980–87[a]				1988–93[b]			
	Integrated mills	Minimills	F-statistic		Integrated-mills	Minimills	F-statistic	
ROS	8.09	4.16	17.06	$p < 0.001$	9.23	15.71	40.49	$p < 0.001$
	(4.31)	(4.27)			(3.63)	(5.02)		
ROA	5.66	5.21	1.39	n.s.	5.94	12.64	52.95	$p < 0.001$
	(3.22)	(4.15)			(2.55)	(5.16)		
Size/1000	28.33	1.35	59.61	$p < 0.001$	20.07	1.20	51.15	$p < 0.001$
	(19.7)	(0.66)			(14.9)	(0.48)		
Age	51.64	45.00	4.86	$p < 0.05$	58.60	49.70	7.89	$p < 0.001$
	(16.6)	(4.5)			(16.6)	(5.9)		
Cost efficiency	0.83	0.89	25.70	$p < 0.001$	0.79	0.72	34.30	$p < 0.001$
	(0.04)	(0.06)			(0.03)	(0.06)		
Employee productivity	40.99	67.89	126.13	$p < 0.001$	57.47	96.83	68.83	$p < 0.001$
	(6.12)	(16.05)			(9.61)	(28.63)		
Capital expenditures	8.01	2.99	83.03	$p < 0.001$	8.90	6.19	5.75	$p < 0.05$
	(2.83)	(1.71)			(4.1)	(5.6)		
Capital intensity	63.78	54.19	13.99	$p < 0.001$	87.90	119.46	31.13	$p < 0.001$
	(11.70)	(11.22)			(14.20)	(32.58)		
Diversification	20.00	3.53	33.56	$p < 0.001$	23.20	3.80	43.75	$p < 0.001$
	(15.70)	(4.38)			(15.70)	(3.60)		
Exports	28.86	19.77	14.15	$p < 0.001$	18.40	4.30	74.95	$p < 0.001$
	(11.42)	(9.91)			(8.10)	(4.40)		

[a]1980–87, $n = 88$; [b]1988–93, $n = 72$; standard deviations in parentheses.

Table 3a. GLS regression results (dependent variable—ROS and ROA) for 1980–87

	1980–87 time period			
	Model 1 (ROS)	Model 2 (ROS)	Model 3 (ROA)	Model 4 (ROA)
Firm-specific variables				
Firm age	–0.2735	–0.2288[+]	–0.2621*	–0.2035[+]
	(0.1826)	(0.1173)	(0.1220)	(0.1110)
Employee productivity	0.0535	–0.1573**	–0.1889*	–0.1718*
	(0.1130)	(0.0556)	(0.0859)	(0.0774)
Exports	–0.1764	–0.1398*	–0.1860*	–0.0902
	(0.1168)	(0.0602)	(0.0815)	(0.0827)
Diversification	0.10804	–0.0196	0.1245	0.0487
	(0.1310)	(0.0802)	(0.0937)	(0.0886)
Capital expenditures	–0.1492*	–0.2434***	–0.2755**	–0.3159***
	(0.0723)	(0.0585)	(0.0707)	(0.0653)
Industry-specific variable				
Munificence	–0.0636	–0.1384*	–0.1454*	–0.1722**
	(0.0608)	(0.0558)	(0.0593)	(0.0577)
Group membership				
Group 1		0.5186***		0.2347*
		(0.0723)		(0.0917)
R^2	0.6910	0.7678	0.7307	0.7328
Log-likelihood	–126.49	–125.70	–127.09	–127.73

***$p<.005$; **$p<.01$; *$p<0.05$; [+]$p<0.1$; 1980–1987, n=88; Standard Errors in parentheses

Table 3b. GLS regression results (dependent variable—ROS and ROA) for 1988–93

	1988–93 time period			
	Model 5 (ROS)	Model 6 (ROS)	Model 7 (ROA)	Model 8 (ROA)
Firm-specific variables				
Firm age	−0.1473	−0.0167	−0.2474+	−0.0480
	(0.1375)	(0.0874)	(0.1288)	(0.0461)
Employee productivity	0.0457	0.3467***	0.4194***	0.5063***
	(0.0730)	(0.0760)	(0.0758)	(0.0864)
Exports	−0.2134*	−0.1514+	−0.1702	−0.0746
	(0.1071)	(0.0774)	(0.1048)	(0.0463)
Diversification	0.0043	−0.0971	0.2246*	−0.0457
	(0.1215)	(0.0791)	(0.1098)	(0.4852)
Capital expenditures	0.0591	0.1956*	−0.1069	−0.0156
	(0.0817)	(0.0818)	(0.0721)	(0.0593)
Industry-specific variable				
Munificence	0.0956	0.3961***	0.1018	0.3099***
	(0.0810)	(0.0790)	(0.0716)	(0.0522)
Group membership				
Group 1		−0.6183***		−0.7388***
		(0.0785)		(0.0605)
R^2	0.8320	0.9248	0.7707	0.9143
Log-likelihood	−106.41	−103.38	−108.47	−104.01

***$p < 0.005$; **$p < 0.01$; *$p < 0.05$; +$p < 0.1$; 1988–93, $n = 72$; standard errors in parentheses.

While the ANOVA results indicate that performance differences existed between the two groups during the two time periods, they (the results) do little to inform us whether such differences were due to environment, firm-specific, or group-level effects (Barney and Hoskisson, 1990). In order to isolate the group-level effects, we examine the regression results that control for firm-specific and environment effects.

Regression results

Our principal hypothesis stated that group membership will have a direct effect on performance, after controlling for firm- and environment-level effects. For the 1980–87 period, in Model 2, the 'Group 1' variable is positively related to performance (ROS) and significant at $p < 0.005$. In Model 4, the 'Group 1' variable is positively related to performance (ROA) and significant at $p < 0.05$ (see Table 3a). For the 1988–93 period, in Model 6, the 'Group 1' variable is negatively associated with ROS and significant at $p < 0.005$. During the same period, in Model 8, the 'Group 1' variable is negatively associated with ROA and significant at $p < 0.005$ (see Table 3b). Thus, we found strong support for the principal hypothesis.

As expected, many of the variables introduced to control for environment- and firm-specific effects are related to ROA and ROS, and are statistically significant. This suggests that both environment and firm-specific factors were associated with firm-level performance, a finding that is consistent with the extant strategy literature (cf. Capon et al., 1990).

DISCUSSION AND CONCLUSION

We noted earlier that Barney and Hoskisson (1990) have argued that prior research had yet to establish that performance differences among strategic groups are due to group-, and not firm-specific factors. This paper set out to examine whether membership in a group has a direct effect on firm performance, after controlling for environment and firm-specific factors. We used firms from the Japanese Steel Industry (JSI) to perform our analyses. The presence of two distinct groups that use different technologies to produce carbon steel provided an ideal setting to examine this issue. It allowed us to avoid the criticism leveled at past studies on groups—that the groups identified in such studies were mere methodological artifacts.

Results indicate that after controlling for environment- and firm-specific effects, group membership was associated with firm-level performance. Interestingly, we found that, while membership in the integrated group was positively associated with firm performance during the 1980–87 period, membership in the group was negatively associated with performance during the 1988–93 period. Next, we elaborate on this shift in group effect. But, before we do that, we discuss the ANOVA and regression results to identify the nature of direct effects.

The analyses compared

A comparison of the ANOVA and regression results indicates that, except for one instance, the two analyses are generally consistent. It is only for the ROA analysis for the 1980–87 time period that we note a discrepancy in the ANOVA (Table 2) and regression (Table 3a) results. The ANOVA analysis does not indicate a significant difference between the integrated mills and minimills in ROA; however, the regression results indicate that membership in the integrated group is positively associated with ROA (Model 4, Table 3a). We suspect that in this instance controlling for firm-specific factors in the regression analysis etched out the group effects masked in the ANOVA.

Explaining turnaround in group effect

Membership in the integrated group was positively associated with performance during the 1980–87 period, but had a relative negative impact during the 1988–93 period. As discussed earlier, differences in number and size of firms in the group, mobility barriers, and the bargaining power of the group members in the factor markets clearly benefited the integrated group members during the 1980–87 period.

However, our study of the industry suggests that three factors—that interestingly may have been beyond the control of JSI managers—appeared to have influenced the outcomes we observe in this paper during the 1988–93 period. First, the strengthening of the Japanese yen during the mid- to late 1980s had an adverse impact on

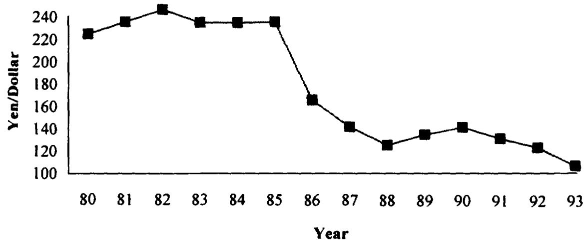

Figure 2. U.S.–Japan exchange rate

the performance of firms that were exposed to foreign markets (see Figure 2). As the integrated mills had generally greater exports than the minimills, they were more vulnerable to adverse exchange rate movements.

Second, it appears that the price coordination among firms had declined over the period. An examination of the Steel Price Index published by the Japan Steel Federation shows that the index steadily fell from 1980 to 1985, when it faced a steep decline in 1986 followed by a slight improvement during the subsequent years and another decline in 1992 (see Figure 3). On average, the price index between 1988 and 1993 did not reach the pre-1987 levels. The sluggish demand for steel might have led to the breakdown in price coordination among firms in the integrated group.[12] Additionally, the larger size and greater fixed and overhead costs of the integrated mill compared to minimills might have made them more vulnerable to enhanced price competition during this period. Thus, while members of the integrated group continued to enjoy some advantages because of their membership, these advantages diminished with changes in industry

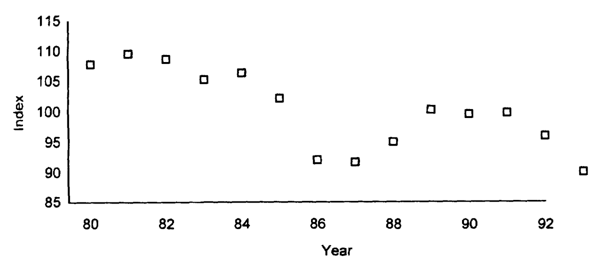

Figure 3. Steel price index, JSI (based on data from OECD reports)

[12] Steel production gradually increased between 1987 and 1990 but declined thereafter until 1993. The growth in GDP also saw a rise between 1987 and 1988 but sharply declined thereafter until 1993.

conditions, thereby producing the results we observe in Models 6 and 8.

Lastly, the declining prices of ferrous scrap may have had a relatively greater benevolent impact on minimills performance because of their greater dependence on it as a key input (see Figure 4).

Thus, the convergence of three developments—stronger yen, declining pricing power, and weaker ferrous-scrap prices—resulted in the change in performance impact of integrated group membership after 1987.[13]

LIMITATIONS AND FUTURE RESEARCH

Isolating the direct effect of group membership on firms remains difficult because of the fuzziness of firm, group, and industry boundaries. As a consequence, firm, group, and industry effects on firm performance may quite often be deeply entangled. This paper was an attempt to unravel and understand this messy relationship. Thus, we addressed one of the principal concerns in strategic group research by investigating the direct effect of group membership on firm performance by controlling for both environment and firm-specific effects.

While we were able to isolate the direct effects, we must acknowledge that the generalizabilty of our findings is limited by our choice of industry. We deliberately chose a setting-the carbon steel sector of the Japanese Steel Industry-that allowed us to identify groups without resorting to clustering algorithms. Perhaps future studies can use ideas offered by Peteraf and Shanley (1997) and Nath and Gruca (1997) to identify robust groups across industries to isolate firm, group, and industry effects on firm attributes and performance.

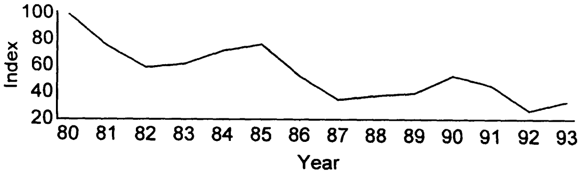

Figure 4. Scrap price index, JSI (based on data from OECD reports)

[13] Perhaps it was because firm strategies that were included in the variance–covariance analysis had not shifted appreciably during the 1980–93 period that we did not observe any transitions in the analysis and identification of strategically stable time period (SSTP).

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