Strategic Management Journal
Strat. Mgmt. J., **24**: 145–159 (2003)
Published online 11 October 2002 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/smj.286

COINTEGRATION OF FIRM STRATEGIES WITHIN GROUPS: A LONG-RUN ANALYSIS OF FIRM BEHAVIOR IN THE JAPANESE STEEL INDUSTRY

ANIL NAIR* and LARRY FILER
College of Business and Public Administration, Old Dominion University, Norfolk, Virginia, U.S.A.

This paper uses cointegration analysis to study the competitive interaction among firms within the integrated and minimill groups in the Japanese steel industry. The use of cointegration analysis overcomes some of the limitations associated with prior attempts at modeling firm behavior within groups, and allows us to model strategies that take considerable time to adjust. Results indicate that several strategies displayed slow adjustment characteristics. All of the strategies that displayed these properties were cointegrated within the group. Finally, over the long run, the rate of strategic response to 'shocks' in the system varied across members and strategies: some converged, while others diverged from the group relationship. We conclude by discussing the relevance of our findings to research on strategic groups and competitive dynamics among firms. Thus the paper contributes to the literature on strategic groups and competitive dynamics, and illustrates the use of cointegration analyses to study the competitive behavior of firms.

INTRODUCTION

Within competitive industries, firms are constantly jockeying for advantage as they initiate strategic actions and respond to their rivals' moves. Knowledge of when, how, and why firms act and rivals react can help managers plan strategic moves and assess the durability of their competitive actions. Thus, the study of competitive interactions and rivalry among firms has engaged strategy researchers from various perspectives (Barnett, 1997; Baum and Korn, 1996; Baum and Mezias, 1992, Baum and Singh, 1994; Camerer, 1991; Chen, 1996; Chen and Hambrick, 1995; Cool and Dierickx, 1993; D'Aveni, 1994; Porac, Thomas, and Baden-Fuller, 1989; Young *et al*., 2000).

Chen (1996) has argued that competitive dynamics among firms are most appropriately analyzed at the strategic group level. Strategic groups are bound by mobility barriers and contain firms that are similar to one another but different from those outside the group on key strategic dimensions (Porter, 1979). As strategic groups comprise firms that may have similar (not necessarily identical) resource and scope commitments (Cool and Schendel, 1987; McGee and Thomas, 1986; Thomas and Venkataraman, 1988), they offer a more manageable, coherent, and sanitized level of analyses. Dranove, Peteraf, and Shanley (1998) argued that the strategic group provides the boundary within which competitive interactions among firms occur and shape their behavior.

Rationale for study

This paper examines the impact of strategic group membership on the long-run competitive dynamics among members. The paper addresses

Key words: strategic groups; cointegration analyses; competitive dynamics
*Correspondence to: Anil Nair, College of Business and Public Administration, Old Dominion University, Hughes Hall 2008, Norfolk, VA 23529-0220, U.S.A.

Received 25 October 2000
Final revision received 15 July 2002

two limitations in previous research. First, past research on strategic groups and competitive interaction has exclusively examined short-run dynamics. However, strategic interactions among firms are best studied over a long run because such actions—unlike tactical actions, such as price cuts—tend to take considerable time to plan and implement (Chen, Smith, and Grimm, 1992). Firms are unlikely to respond quickly to competitors' changes in strategies such as plant size and capital stock.

Second, the modeling methods used in previous studies have limitations that make them inappropriate for long run analyses of firm behavior. We discuss these limitations in the methodology section of this paper. In response to these limitations, we advocate the use of a cointegration framework to examine the long-run behavior of firms within groups. This framework allows for a formal treatment of both short-run and long-run firm dynamics; thus, it circumvents the methodological limitations present in past research on competitive dynamics of firm strategies.

Thus, the paper directly tests Dranove *et al.*'s (1998) notion that strategic group membership influences firm behavior. Moreover, evidence that dynamic firm behavior is influenced by its membership within a particular group provides reinforcement for the strategic group construct. It suggests that the beleaguered strategic group construct (Barney and Hoskisson, 1990) is not merely a methodological artifact, but a legitimate reality that affects firm behavior.

To summarize, this paper has the following objectives:

- to examine how strategic group membership shapes the long-run competitive dynamics among firms; and
- to illustrate the use of cointegration analyses to study competitive dynamics among firms.

We organize this paper as follows. First, we discuss the nature of competitive dynamics among firms within strategic groups, and develop our propositions. Next, we provide a brief history of the Japanese steel industry (JSI) and then identify the presence of two groups in this industry. Following this, we discuss the sample, methodology, and analyses. Finally, we present the results of the analyses and discuss their implications for research on strategic groups and competitive dynamics.

GROUP MEMBERSHIP AND COMPETITIVE BEHAVIOR

Chen and Hambrick (1995) note that the basic building blocks of strategy are a firm's actions and responses to rivals. The study of competitive behavior of firms thus occupies a central role in strategy research (Baum and Korn, 1996; Chen *et al.*, 1992; Chen, 1996; Hoskisson *et al.*, 1999; Ketchen and Palmer, 1999; Smith *et al.*, 1997). Firm actions and reactions do not occur in a vacuum, but are likely to be influenced by the rivals in its environment (Houthoofd and Heene, 1997). While traditionally concentration ratios have functioned as proxies for rivalry within an entire industry, increasingly researchers are beginning to acknowledge that rivalry among firms tends to be much more complex and rarely uniform across an industry (Cool and Dierickx, 1993). For instance, there is evidence that interactions among firms tend to be influenced by the similarity or dissimilarity among them (Baum and Mezias, 1992; Young *et al.*, 2000). After Hunt (1972) identified the presence of firms that had similar strategies within the U.S. home appliance industry, researchers have examined the impact of such groups on performance (Cool and Schendel, 1987; Dess and Davis, 1984; Frazier and Howell, 1983), competition (Cool and Dierickx, 1993), and member behavior dynamics (Bresser, Dunbar, and Jithendranathan 1994; Fiegenbaum and Thomas, 1995; Mascarenhas, 1989; Porter, 1979).

Porter (1979) observed that competitive interaction among firms is likely to be influenced by its membership in a strategic group:

> [F]irms within a strategic group resemble one another and are likely to respond in the same way to disturbances, to recognize their mutual dependence quite closely, and to be able to anticipate each other's reactions quite accurately. (Porter, 1979: 215)

Several researchers have since examined how strategic group membership frames the competitive interaction among firms (Cool and Dierickx, 1993; Fiegenbaum and Thomas, 1995; Reger and Huff, 1993; Smith *et al.*, 1997). Porac *et al.* (1989) showed that managers' mental models of their competitors in the Scottish knitwear industry shaped their strategies and competitive actions. Cool and Dierickx (1993) empirically identified the presence of rivalry among members within and between strategic groups. Smith *et al.* (1997), in their study of the U.S. airline industry, found that competitive interaction among firms within some groups was very high, whereas in other groups it was low. Fiegenbaum and Thomas (1995) argued that membership in a group provides a referent function wherein members constantly evaluate themselves with respect to their group's norms.[1] As a consequence, competitive interaction among members drives firm behavior over time towards certain group norms.

Dranove *et al.* (1998) analyzed the impact of group membership on firm behavior to resolve the elusive link between strategic groups and firm performance. They asserted that the strategic group provides the context within which strategic interactions among firms occur, and thereby impacts firm performance. According to them the interactions among group members '... alter the orientations, decisions, and actions of the individual members. Group-level effects change the behaviors of members from what they would be in the absence of the group. They are more than a simple aggregation of firm level effects and are not reducible to either firm-level or industry-level factors' (Dranove *et al.*, 1998: 1032). Thus, within a strategic group, members reference each other in formulating their strategic actions and reactions. At an extreme, such orientation may result in collusion. While members may not explicitly collude, they may yet display Cournot behavior, wherein firms act independently but take into account their peers' actions.[2]

If strategic group members' actions were made with an orientation towards their peers, strategic interaction among members over time would tend to display a general group-wide relationship. Therefore, as members evaluate the strategic actions of their peers in planning and implementing their strategies, they may converge or diverge from a group norm or equilibrium. As strategic actions (and reactions) tend to require planning, organization, commitment, and deployment of significant resources (Chen *et al.*, 1992; Hitt, Ireland, and Hoskisson, 2001), they take considerable time to implement. Thus, unlike tactical actions whose effects are observable quickly, strategic actions and reactions tend to be played out over the long run.

Cointegration of member strategies

Cointegration analysis is designed to test for long-run relationships between variables. The most common application of cointegration within economics is in the empirical examination of the concept of purchasing power parity (PPP) or the law of one price. The law of one price suggests that the commodity prices of the same good in different regions cannot deviate from each other for any extended period of time. Consider an environment where the price of corn in region A is higher than that in region B. In this situation, entrepreneurs would purchase corn from sellers in region B and then sell corn to buyers in region A. However, this behavior begins an increase in the demand for corn in region B which would tend to increase its price in that region, while lack of demand for corn, due to high prices, in region A would tend to lower its price. Thus, as time passes the relative price of corn (P_b/P_a) tends towards 1. This convergence between prices may take a significant time to occur.[3] While the law of one price implies that movements in the price of corn in region A tend to offset movements in the price of corn in region B, this may not be reflected in any one 'snapshot' of the data. Such a process would, however, be reflected in the behavior of the equilibrium error (that is, $P_a - P_b$). Specifically, the error should revert to the mean (that is, zero in this case). This is often referred to in the econometric literature as error-correcting behavior.[4]

If strategic group membership provides a referencing role for members (Fiegenbaum and Thomas, 1995), and the boundary and context for competitive dynamics (Dranove *et al.*, 1998; Chen, 1996), then strategies of firms within the group should reflect a consistent relationship that resembles the error-correcting behavior discussed above. A long-run relationship among

[1] These authors operationalized a group's reference point as the 'mean value along a strategic dimension,' for all firms in the group.

[2] In the classic Cournot model, firms make independent output decisions based on expectations of rivals' output decisions.

[3] Indeed, the convergence is achieved through arbitrage, and one can consider several factors that may impede arbitrage in the short run, such as transportation costs, asymmetric information, and geographical barriers.

[4] While the PPP example illustrates convergent behavior of prices across the two regions, it does not exclude the possibility that the resulting behavior may be divergent. In this case, the actor is using the relationship as a point of reference and continuously attempting to move away.

the strategies of member firms would be illustrative of group behavior. Thus:

Proposition 1: The strategies of firms within a strategic group (which require considerable adjustment time) should exhibit a long-run relationship.

While group members display a long-run equilibrium relationship in their strategies, as Dranove *et al*. (1998) suggest, individual firm strategies would tend to converge or diverge from this equilibrium as they make adjustment to their strategies based on the anticipated and actual changes in strategies made by their peers, and their own departure from the group equilibrium. Thus:

Proposition 2: Members react to a deviation from the long-run equilibrium by converging or diverging towards the equilibrium over the subsequent periods.[5]

RESEARCH SETTING, DATA, AND VARIABLES

Japanese steel industry

The carbon steel sector of the JSI has two groups of firms: 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 integrated mills produce steel by first converting iron ore into pig-iron in blast furnaces and subsequently reducing the pig-iron into steel in a basic oxygen furnace (BOF). The minimills produce steel by melting ferrous scrap in an electric arc furnace (EAF).

The sunk costs and differences in technology create differences in resource endowments and serve as mobility barriers (Bogner, Mahoney, and Thomas, 1994) that enable the existence of two separate groups. Groups in the (JSI) were subject to several of the macroprocesses (i.e., institutional, economic, and historical) discussed by Peteraf and Shanley (1997). Distinct historical forces shaped both minimills and integrated mills. For instance, 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 inputs comprising electric power and ferrous scrap (Kawahito, 1972). The differences in the technology adopted by the two groups (i.e., EAF vs. BOF) also meant that they were subject to different economic forces. For example, the differences in steel-melting technology between the groups translate into differences in economies of scale—the integrated mills need larger capacities to achieve scale economies when compared to minimills. Finally, the two groups were also subject to different institutional pressures. For example, government agencies such as the Economic Stabilization Board, MITI, and the Reconstruction Finance Bank of Japan coordinated the growth of the integrated mills (Kawahito, 1972; Yonekura, 1994), thereby subjecting them to different normative pressures from those belonging to the minimill group. The minimills received no such treatment and were largely allowed to fend for themselves. By virtue of their shared identities, the integrated and minimills constitute two distinct groups within the JSI.

Data

The study was based on data collected on eight publicly traded firms (four integrated mills and four minimills) for which data were available from 1980 to 1999. The integrated mills in the sample were Nippon, NKK, Kawasaki, and Sumitomo.[6] The minimills in the sample were Godo, Tokyo Steel, Tokyo Tekko, and Yamato Kogyo. These firms are listed on the Tokyo, Osaka, and Nagoya Stock Exchanges. Data on these firms were obtained from the *Analysts' Guide*, an annual publication of Daiwa Securities, a leading financial services firm in Japan. To ensure data reliability, the data collected from the *Analysts' Guide* were cross-checked with information obtained from the *Japan Company Handbook*. This investigation found no discrepancies between the two data sets.

[5] We thank an anonymous reviewer for suggestions in developing and framing the propositions.

[6] The JSI has seven integrated mills (Nippon, Nisshin, Kawasaki, Nakayama, Sumitomo, Kobe, and NKK). A reviewer suggested that we identify smaller homogeneous subgroups within the group. We have identified a smaller group of integrated firms based on Yonekura's (1994) study of the JSI. Yonekura's study (1994: 268) suggests that Nippon, NKK, Kawasaki, and Sumitomo are the larger integrated firms that have interdependent strategies. We also performed the analysis with all the firms in the integrated group. Readers can write to the author(s) for the results with the complete set of integrated firms.

Strategy variables

As the first step, we identified a set of firm-level *realized* strategy variables (Mintzberg, 1987). These included the following resource commitments, scale and scope, efficiency, and asset parsimony measures (Cool and Schendel, 1987; Hambrick, 1983): cost efficiency, capital expenditures, capital intensity, exports, and the size of firms.

'Cost efficiency,' an important measure of a cost leadership approach (Porter, 1980), was assessed by calculating the ratio of cost of goods sold to total sales. '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. 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. 'Exports' is operationalized as the percentage of foreign sales to total sales for the firm. We assessed size as the number of employees on the firm's payroll for each year.

These variables were calculated for all eight firms in the sample for the period 1980–99.

METHODOLOGY

A necessary condition for the existence of cointegration between series is that each series be nonstationary.[7] Therefore, before undertaking tests of cointegration nonstationarity tests must be performed. Such tests include Dickey–Fuller (1981) and Phillips–Perron (1988). In addition to the nonstationarity condition, tests of cointegration also require that the system variables be integrated of the same order. For example, suppose the researcher detects nonstationarity in the level of a variable, but subsequently finds stationarity in the first difference of the series; they would conclude that the series is integrated of order 1, denoted I(1). Therefore, before testing for cointegration the researcher must be assured that the variables involved are all nonstationary (i.e., not I(0)) and integrated of the same order.

Once these initial conditions are satisfied, the researcher can then proceed with the tests of cointegration. Tests of cointegration would confirm the existence of long-run equilibrium behavior within the group. Once long-run equilibrium behavior of a group is identified, we can test for the convergence or divergence of firms from the equilibrium using the vector error correction model (described later in this section).

As we discussed earlier, this approach is superior to the traditional methods used in strategy research. For example, some studies in the past have used event history analysis (e.g., Baum and Korn, 1996) to model the interactions among firms. However, event history analysis is most appropriate when studying actions and reactions that are observable, and occur within a short time span. This analysis may be inappropriate for reactions that are unobservable and occur after considerable delay, as such responses may be contaminated by other events. Another method involved regressing the changes in a strategy variable against a deviation of a firm's strategy from a trend, such as strategic group average (Fiegenbaum and Thomas, 1995). However, Cooper (1972) and Sims (1977) contended that by differencing nonstationary data, information regarding the potential long-run relationships that exist between the levels of variables is lost.[8]

Cointegration analysis

There are several procedures available that test for cointegration and estimate a multivariate system, in which the series involved are both integrated (nonstationary) and are cointegrated.[9] The best known is the Engle–Granger (1987) methodology. However, a shortcoming of the Engle–Granger methodology is that it requires the researcher to label one variable as endogenous and the others as exogenous. Because of this, it is often possible for one specification to result in the finding of cointegration, while reversing the specification results in no cointegration. For our purposes this methodology is inappropriate. While we do have a rationale

[7] Unlike a stationary series, a nonstationary series or unit root process has no long-run mean reversion, and the variance of the series is time dependent and approaches infinity as time approaches infinity. These characteristics imply that shocks to the series persist indefinitely, while shocks to stationary series have only transitory effects.

[8] Moreover, it is difficult to distinguish whether any convergence to the average is not due to the regression to the mean effect (Kahneman and Tversky, 1979).

[9] The true value of these techniques is that they circumvent the need to difference the data prior to estimation. As mentioned earlier, the finding of cointegration between two variables suggests that important long-run information will be lost if the researcher differences the data and then estimates the model.

behind our choice of groups, we have no evidence to suggest that the strategies of a specific firm (say, Sumitomo) in the group 'cause' the strategies of the others.

Alternatively, Johansen (1988) proposes a one-step procedure to test for cointegration and estimate a model appropriate for cointegrated systems. This procedure does not require the researcher to make a priori judgement on the ordering of the variables within the model. The following discussion briefly outlines this methodology.

Consider a vector auto-regression (VAR) of first order:

$$x_t = A_1 x_{t-1} + \varepsilon_t \tag{1}$$

where x is a vector $(x_{1t}, x_{2t}, \ldots, x_{nt})'$ of dimension $(n \times 1)$; ε_t is an $(n \times 1)$ vector of residuals; and A_1 is an $(n \times n)$ matrix of parameters. Subtracting x_{t-1} from each side provides:

$$\begin{aligned}\Delta x_t &= A_1 x_{t-1} - x_{t-1} + \varepsilon_t \\ &= (A_1 - I)x_{t-1} + \varepsilon_t \\ &= \pi x_{t-1} + \varepsilon_t \end{aligned} \tag{2}$$

Again, x_t and ε_t are $(n \times 1)$ vectors, A_1 is $(n \times n)$, I is an $(n \times n)$ identity matrix and π is defined to be $(A_1—I)$. The rank of the matrix π equals the number of independent cointegrating vectors in the system. Recalling that the rank of a matrix is equal to the number of its nonzero characteristic roots, we can think of a test for cointegration using the matrix π. Suppose we obtain estimates of both π and of its characteristic roots (eigenvalues) λ_n. The following two statistics, as proposed by Johansen (1988), test for the number of characteristic roots that are insignificantly different from unity:

$$\begin{aligned}\lambda_{Trace}(r) &= -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \\ \lambda_{Max}(r, r+1) &= -T \ln(1 - \hat{\lambda}_{r+1}) \end{aligned} \tag{3}$$

where $\hat{\lambda}_i$ is the estimate of the eigenvalues obtained from the estimated π matrix and T represents the number of observations in the data set. The Trace statistic provides a test of a general hypothesis. In particular, we are testing:

$$\begin{aligned} H_0&: \ rank(\pi) \le r \\ H_A&: \ rank(\pi) > r \end{aligned} \tag{4}$$

Thus, the Trace statistic is a likelihood-based test for the hypothesis that there is at most r cointegrating vectors. Alternatively, the max statistic is a test with a specific alternative:

$$\begin{aligned} H_0&: \ rank(\pi) = r \\ H_A&: \ rank(\pi) \ne r \end{aligned} \tag{5}$$

The critical values of these tests were initially calculated in Johansen and Juselius (1990), but most texts provide the finite sample critical values approximated in Osterwald-Lenum (1992). These critical values are more appropriate for small samples and for groups which contain many series. Since we have four firms in each group and a rather short length for the data, the finite sample critical values will be used.

Error correction analysis

The discovery of cointegration among variables indicates the presence of a stable, long-run relationship. Therefore, we can estimate this relationship and examine the adjustment to deviations from this equilibrium.

Sargan (1964: 25–54) first considered a class of models that contained variables exhibiting this type of correcting behavior. Davidson *et al*. (1978) later referred to these models as error-correcting mechanisms (ECM). The advantage of these models was that they retained information on the levels of the variables without compromising the stationarity of the residuals. In fact, Granger (1981) suggested that there existed a direct relationship between the concept of cointegration and the mechanism of error correction. Granger (1983) formalized this intuition by developing a representation theorem connecting the moving average, autoregressive and error correction representations for cointegrated systems. The resulting model, known as a vector error correction model (VECM), is a generalization of a vector autoregression to allow for variables which contain I(1) processes.

Therefore, consider the following two-equation system:

$$\begin{aligned}\Delta PC^A &= \sum_{i=1}^{k} A_{1i} PC_{t-i}^A + \sum_{i=1}^{k} B_{1i} PC_{t-i}^B + \varepsilon_t^A \\ \Delta PC^B &= \sum_{i=1}^{k} A_{2i} PC_{t-i}^A + \sum_{i=1}^{k} B_{2i} PC_{t-i}^B + \varepsilon_t^B \end{aligned} \tag{6}$$

where PC^A and PC^B represent the price of corn in region A and B respectively and the lag length k is chosen so as to assure the residuals are white noise processes. The estimates A_i and B_i from Equation 6 characterize the dynamics of the system. However, cointegration between the two regional prices means that Equation 6 is a misspecified model. Indeed, an error correction process must be added to Equation 6. Therefore, the new model of price behavior becomes a vector error correction model of the form:

$$\begin{aligned}\Delta PC^A &= \sum_{i=1}^{k} A_{1i} PC^A_{t-i} + \sum_{i=1}^{k} B_{1i} PC^B_{t-i} \\ &\quad + \alpha^A(\beta_1 PC^A_{t-1} - \beta_2 PC^B_{t-1}) + \varepsilon^A_t \\ \Delta PC^B &= \sum_{i=1}^{k} A_{2i} PC^A_{t-i} + \sum_{i=1}^{k} B_{2i} PC^B_{t-i} \\ &\quad + \alpha^B(\beta_1 PC^A_{t-1} - \beta_2 PC^B_{t-1}) + \varepsilon^B_t \quad (7)\end{aligned}$$

Now, estimates of the short-run parameters (A_{1i}, A_{2i}, B_{1i}, and B_{2i}) along with estimates of the 'error correction term' (ECT) can be obtained through maximum likelihood estimation of Equation 7. The ECT consists of the speed of adjustment parameter α and the parameters of the equilibrium long-run relationship between PC^A and PC^B, which are β_1 and β_2. Clearly, our focus for this study is on the adjustment parameter α. This parameter can be interpreted as follows. Consider a situation in which the firm recognizes that its current size is above the equilibrium level. If the reaction by the firm is to reduce its size in the following periods, then the firm is converging back towards the equilibrium and this will produce a negative estimate of α. A negative α is indicative of converging behavior by the firm. Therefore, the cointegrating relationship within the group is acting as an equilibrium relationship for these firms. If however, the firm responds to this positive deviation from equilibrium in the subsequent periods by getting even larger this will produce a positive α. A positive α indicates that a firm is referencing its peers and yet diverges from the reference. This can be characterized as nonconforming behavior, where the firm is looking at its peers' actions (referencing) yet engaging in behavior that is different from the peers. Such nonconforming behavior may be characterized as differentiating or entrepreneurial.

In this fashion, our modeling of strategic group member behavior is far more flexible than previous work. In our framework, the necessary condition for existence of group behavior is the presence of a stable relationship between the firm's strategies (cointegration). However, we put no restrictions on the dynamics of this relationship between firms. In other words, unlike the previous work, we do not require that the strategies of firms in the group must converge. The section below tests for the existence of cointegration between the strategies of the sample firms, then estimates the dynamic behavior of the group within the context of a VECM.

RESULTS

Stationarity tests

We perform the Phillips–Perron (1988) unit root test for non stationarity.[10] Our specification contains neither a constant term nor a time trend.[11] Phillips and Perron derive test statistics which test the null hypothesis that y_t is indeed nonstationary. Failure to reject the null hypothesis is confirmation of nonstationarity.

The results of the PP test are presented in Table 1.[12] Panels A and C provide the results for the test conducted on the level of each strategy variable, while panels B and D provide the results for the first difference of each variable.[13]

[10] There are a multitude of nonstationarity or unit root tests that the researcher can utilize. We like the Phillips–Perron (PP) test over the traditional Dickey–Fuller because it allows for milder assumptions concerning the distribution of the errors. In particular, the PP test allows heterogeneity and weak dependence in the error process.

[11] Initially, we ran the unit root tests on a model that contained a time trend under the belief that the strategy variables would be time dependent due to technology shocks. Only the size and efficiency variables appear to be time dependent. However, the results of the unit root test suggest that both series were nonstationary around the trend. Therefore, to keep the results uniform for all strategies, we only report the results of the test performed on models without a constant or trend.

[12] Each of the strategy variables is modeled with one lag of the endogenous variable. The lag length was chosen so that the residuals were 'white noise.' This type of normality test on the residuals is a common technique to determine the appropriate lag length. However, there are a number of other tests that can be used to determine this value. We refer the reader to Enders (1995) for a detailed discussion of this test along with alternatives.

[13] It is important to reiterate that we are not only interested in the variable being nonstationary, but we also want the variable to be of the same order of integration across the firms.

Table 1. Unit root tests for integrated mill data[a]

	Capital expenditure	Efficiency	Exports	Capital intensity	Size
Panel A: Integrated mill data in levels					
Nippon	−2.70	−2.61	−1.31	1.46	0.39
Kawasaki	−2.46	−2.52	−1.24	0.57	−0.19
NKK	−2.35	−2.77	−1.36	1.41	−0.01
Sumitomo	−2.57	−2.67	−1.24	1.17	−0.39
Panel B: Integrated mill data in first differences					
Nippon	−4.57	−24.96	−13.82	−6.74	−22.27
Kawasaki	−4.20	−17.36	−10.74	−8.02	−25.57
NKK	−5.54	−20.74	−9.94	−21.98	−22.67
Sumitomo	−4.17	−16.99	−11.35	−9.41	−21.20
Panel C: Minimill data in levels					
Godo	−3.95	−1.75	−1.63	0.35	−0.98
Tokyo Steel	−2.90	−1.54	−1.39	−1.21	−1.62
Tokyo Tekko	−2.47	−1.62	−1.61	−1.21	−1.83
Yamato Kogyo	−3.63	−1.92	−1.71	−1.43	0.04
Panel D: Minimill data in first differences					
Godo	−6.88	−13.52	−5.41	−4.69	−15.89
Tokyo Steel	−4.58	−10.74	−5.61	−2.90	−21.05
Tokyo Tekko	−5.55	−11.91	−9.04	−4.21	−18.67
Yamato Kogyo	−6.24	−10.61	−4.40	−4.53	−39.21

[a] The test performed is the Phillips–Perron test on a model with no constant or time trend and one lag of the endogenous variable. This is a test of the null hypothesis of a unit root against the alternative that the variable is a stationary process. The critical values at 5% and 1% respectively are −1.95 and −2.66.

The results for the integrated mill group suggest that both the *capital expenditure* and the *efficiency* variable are stationary (I(0)) for each of the three firms. For *capital expenditure*, the test statistics are −2.70 for Nippon, −2.46 for Kawasaki, −2.35 for NKK, and −2.57 for Sumitomo. At the 5 percent level of significance, the critical value for the PP test is −1.95; thus we reject the null of nonstationarity in all cases. The test statistics for the *efficiency* variable are −2.61 for Nippon, −2.52 for Kawasaki, −2.77 for NKK, and −2.67 for Sumitomo. Therefore, as with the *capital expenditure* variable, we conclude that the *efficiency* variable is a stationary process. This suggests that there is no permanence to the shocks that affect these strategies. More importantly, it also establishes that these strategies are not candidates for cointegration and thus traditional regression techniques (such as those used by Fiegenbaum and Thomas, 1995) are appropriate for examining convergence or divergence, since differencing does not result in a loss of information. In contrast to the previous results, the *export*, *capital intensity*, and the *size* variables are each characterized by nonstationary processes.

Panel B illustrates that we can reject the null of a unit root for the first difference of each of these three variables (*exports*, *capital intensity*, and *size*). Therefore, since each of these three strategies is nonstationary for each of the four integrated mill firms, these strategies are candidates for possible cointegration and will be tested further. The *capital expenditure* and the *efficiency* variable are stationary and are dropped from further consideration.

The results for the minimill firms are quite similar to the above results. The *capital expenditure* variable for each firm is stationary. The other four variables—*efficiency*, *exports*, *capital intensity*, and *size*—are all found to be nonstationary in their levels, and stationary in the first difference for each of the four firms. Therefore, for the minimill group, we do further analysis on all strategy variables except *capital expenditure*.

The next step in the analysis is to determine whether the firm's strategies are cointegrated.

Cointegration tests

As discussed in the previous section, we employ the Johansen (1988) methodology. Panel A of Table 2 contains the results of cointegration tests using the integrated mill data. The table should be read as follows. For each of the variables, we provide the two test statistics suggested in Johansen (1988), λ_{Max} and Trace. Each row represents a test of the null hypothesis of rank $= k$, where k is given in the first column. For example, the second column of the first row in Panel A provides the test statistic for λ_{Max} where the null hypothesis is that the cointegrating rank for the *export* strategy system is zero. The next column provides the results of the Trace test, which is a more general test, as described in the proceeding section. The finite sample critical values at 95 percent for both tests are provided in the last two columns of the panel.

Results for the integrated mill group suggest that the *export* strategy clearly contains one cointegrating relationship with the value of λ_{Max} (41.35) exceeding the critical value of 27.07, and Trace (65.85) exceeding the critical value of 47.21 at 95 percent. The results from the test of the null of rank $= 1$ results in failure to reject the null. Results for the *capital intensity* variable show the presence of two cointegrating vectors. At 95 percent the null of rank $= 0$ and rank $= 1$ are both rejected. This is not unusual in this type of analysis. However, as with a multiple equilibrium finding, when multiple cointegrating vectors are found, generally only one of the relationships is truly feasible. Therefore, in the subsequent estimation, we will estimate a model containing one and not two cointegrating vectors. The test for the size variable provides mixed results. The null of rank $= 0$ can not be rejected under the λ_{Max} test ($21.95 < 27.07$); however, the null of rank $= 0$ can be rejected for the Trace test ($48.00 > 47.21$). As is common with hypothesis testing, different tests can and do lead to different conclusions. Since there is indication of a possible cointegrating relationship, we will proceed to specify and estimate an error correction model for *size* in the next section.

Panel B of Table 2 contains the analysis for the minimill group. For the minimill group each of the four nonstationary variables (*efficiency*, *exports*, *capital intensity*, and *size*) are found to contain at least one cointegrating relationship. The *export* variable is found to contain two cointegrating relationships. Akin to the capital intensity variable in the integrated group, we will estimate the model with just one cointegrating vector.

Thus, overall we find that all the nonstationary strategies in the integrated mill and minimill

Table 2. Johansen cointegration test[a]

Panel A: Integrated mill group

	Exports		Capital intensity		Size		95% critical value	
	λ_{Max}	Trace	λ_{Max}	Trace	λ_{Max}	Trace	λ_{Max}	Trace
$r = 0$	41.35	65.85	59.14	93.02	21.95	48.00	27.07	47.21
$r = 1$	20.63	24.50	22.99	33.88	15.81	26.05	20.97	29.68
$r = 2$	3.11	3.86	10.87	10.89	10.20	10.25	14.07	15.41
$r = 3$	0.75	0.75	0.02	0.02	0.05	0.05	3.76	3.76

Panel B: Minimill group

	Efficiency		Exports		Capital intensity		Size		95% critical value	
	λ_{Max}	Trace	λ_{Max}	Trace	λ_{Max}	Trace	λ_{Max}	Trace	λ_{Max}	Trace
$r = 0$	30.08	56.68	30.10	62.92	54.82	77.82	29.86	55.27	27.07	47.21
$r = 1$	12.63	26.59	23.52	32.82	17.62	22.99	14.74	25.41	20.97	29.68
$r = 2$	10.75	13.96	9.11	9.30	5.37	5.37	10.01	10.67	14.07	15.41
$r = 3$	3.21	3.21	0.19	0.19	0	0	0.66	0.66	3.76	3.76

[a] The critical values are the finite sample values reported in Osterwald-Lenum (1992). The model is run with one lag of the endogenous variables.

group were cointegrated. These findings support Proposition 1.

Estimation of the vector error correction model

Table 3 provides the estimates of the speed of adjustment parameter along with the corresponding results from the t-test of significance.[14] From the integrated group analysis in panel A, several key results stand out. First, the model for *exports* contains two significant speed of adjustment parameters: that of Kawasaki (1.131) and Sumitomo (0.885). In addition, both estimates are positive, suggesting that any action by the firm that leads to a positive deviation from the long-run relationship results in the firm continuing to diverge in the following periods. Nippon does display convergent behavior (−0.588), but the estimate is insignificant at common levels.

Second, the results for *capital intensity* are quite different. Three of the four group members possess statistically significant and negative estimates for the adjustment parameter, indicating convergent behavior by all three. Even Kawasaki's estimate is negative, however insignificant. So, there appears to be a strong convergent tendency behind the capital intensity decisions of the firms.

Finally, the fourth column of the panel provides the results from estimation of the error correction model for the *size* strategy. Three of the four estimates are significantly positive, that of Kawasaki, Sumitomo and NKK. Only the estimate for Nippon is statistically negative. In addition, the estimates are much smaller in value than the estimates for the other strategies. This shows that it takes the members much longer to react to deviations in the size equilibrium.

Panel B of Table 3 provides the estimates for the mini mill group. Overall, convergent behavior dominates the panel. Estimates for the *efficiency* variable as well as the *export* variable are negative for each firm. In addition, the adjustment of *efficiency* is statistically significant for Godo and Tokyo Tekko at 5 percent and 10 percent respectively, while the response to deviations in the *export* equilibrium are significant for Tokyo Tekko and Yamato Kogyo at 5 percent and 1 percent respectively. The results for the *capital intensity* variable indicate two statistically significant convergent responses (both at 1%) for Tokyo Steel (−0.840) and Tokyo Tekko (−0.529). The results

[14] While estimation of our corollary to (7) produces estimates of several coefficients, our focus is on the speed of adjustment parameter (α).

Table 3. 'Speed of adjustment' estimates[a]

Panel A: Integrated group

	Exports	Capital intensity	Size
Nippon	−0.588	−0.329*	−0.140**
Kawasaki	1.131**	−0.152	0.045***
Sumitomo	0.885*	−0.396***	0.065***
NKK	0.438	−0.185**	0.062***

Panel B: Minimill group

	Efficiency	Exports	Capital intensity	Size
Godo	−2.212**	−0.120	0.104	−0.386
Tokyo Steel	−0.837	−0.361	−0.840***	0.948**
Tokyo Tekko	−1.403*	−0.589**	−0.529***	−0.199*
Yamato Kogyo	−0.030	−0.980***	−0.189	0.156*

[a] The estimation sample is 1980 to 1999. (*), (**), and (***) denote significance at 10%, 5%, and 1%, respectively. The significance test is the traditional t-test with $n = 18$, which results in a critical value of 1.330 at 10%, 1.734 at 5%, and 2.552 at 1%. The model is estimated with one lag of the endogenous variables.

for size indicate two cases of statistically significant estimates of divergent behavior. The estimate for Tokyo Steel's adjustment is 0.948, which is significant at 5 percent and the estimate of adjustment for Yamato Kogyo is 0.156, which is significant at 10 percent. Tokyo Tekko (−0.199) has a statistically significant estimate of convergence at 10 percent. Finally, only Tokyo Tekko shows consistently significant convergent behavior for each variable.

These results tend to support Proposition 2, that while strategic group strategies display long-run equilibrium, individual member strategies tend to display behavior that converges or diverges around the equilibrium.

DISCUSSION AND CONCLUSION

This paper had two objectives: first, identify how strategic group membership influences the long-run competitive dynamics among members; and second, illustrate the use of cointegration analyses to study competitive dynamics among firms. Next, we discuss how the paper addressed the two objectives.

Competitive interaction among firms within groups

In our first proposition we argued that within a strategic group firm strategies that take considerable time to adjust are cointegrated. We found that in seven out of seven cases, firm strategies that were nonstationary (that is, displayed long-run adjustment process) were cointegrated within the group. Overall, the results support the proposition and provide empirical substantiation of Dranove *et al.*'s (1998) argument that group membership determines the interaction among members.

Additionally, our results provide three new insights into the competitive dynamics among group members. First, we observed that not all strategies contain permanent components; that is, some strategies were stationary. Second, we found that strategies that were nonstationary were cointegrated. Finally, when a cointegrating relationship among strategies was found, results suggest that competitive interaction among group members included convergent and divergent behaviors.

Next, we comment on each of the above observations.

Nonstationary strategies

We found that except for *efficiency* and *capital expenditure* variables for the integrated group and *capital expenditure* for minimill group, all the remaining firm strategies were nonstationary. These nonstationary series display no long-run mean reversion, and shocks to the series tend to 'die out' slowly over time. In contrast, stationary series display a short-run equilibrium; such strategies are more fluid and are adjusted quickly when changes are made within the group. That is, other group members quickly responded to any change in efficiency by a member in the integrated group. The same was true of capital expenditure for both the integrated and minimill group. The quick adjustment in strategies for these cases is intriguing. One possibility is that coordination among the integrated mills was more concerted in terms of efficiency. 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). Such coordinated actions may have resulted in quick responses to any change by a single member, or the changes were almost simultaneous. Similarly, capital expenditures were perhaps driven by the industry's investment cycle, availability of technology, or closely coordinated by the group members. It must be acknowledged that even stationary series within groups may display short-run competitive dynamics; however, as our interest was in the long-run dynamics, we did not examine the short run-dynamics. The overwhelming finding of nonstationarity is consistent with the notion that strategic actions require considerable time to implement; thus, strategic interactions are best studied using models that can capture long-run interdependence.

Cointegration of strategies

We found that *all* of the nonstationary series were cointegrated. The presence of cointegration among the strategy variables means that they display a long-run equilibrium-type relationship within the group, and do not stray far from this equilibrium. It suggests that within a group these strategies exhibit interdependence in the long run and may display little interdependence in the short run. Thus, use of models that only capture short-run dynamics may wrongly conclude the absence of competitive interdependence within a group, when a long-run one actually exists.

Estimates of adjustment parameters

Once we identified the presence of long-run interdependence for each strategy within the groups, we examined the exact nature of this relationship. The finding of cointegration indicates that the firms are referencing each other in a consistent manner; and the referencing may result in convergent or divergent behavior. In 11 (out of 28) instances, firm strategies displayed an error correction process that was significant and converged towards the group equilibrium. These results are similar to findings in Fiegenbaum and Thomas (1995), where in the short run they found that members tended to follow group norms or reference points for certain strategies. However, in seven instances we found positive and significant results, suggesting that some firm strategies displayed a behavior that was divergent from their group. The evidence of convergent and divergent behavior is consistent with Dranove *et al.*'s (1998) argument that strategic groups shape the competitive interaction among members and influence firm strategies. That is, groups may contain enough strategic space for competitive interactions to be convergent or divergent.[15] A closer look at the results reveals some interesting patterns. One observes that for the minimills, in seven instances strategies are convergent towards the equilibrium and only in two instances do firms try to diverge from the equilibrium. The two instances are when Yamato Kogyo and Tokyo Steel tend to diverge from the equilibrium on size. Perhaps we find greater evidence of convergence because firms in the group were more satisfied with their performance and were therefore adhering to group recipes. As the largest independent minimill, Tokyo Steel has several times charted its own course. For example, in 1984 Tokyo Steel under President Iketani became the first minimill to introduce the large-size H-beam (Berry, 1996). Tokyo Steel is not a member of any Keiretsu and President Iketani does not chair an association or committee (Meyer, 1992), making the firm relatively more independent in its behavior.

The integrated mills provide a more complex picture, where in almost five out of nine instances firms are moving away from the equilibrium, and only in four cases are firms indicating a convergence equilibrium. Among the integrated mills firms tend to converge only on capital intensity; on the other hand, for exports and size variables, firms tend to be trying to diverge from the equilibrium. These results suggest that the integrated mill actions are not as strongly coordinated (O'Brien, 1989) as they used to be earlier. Yonekura (1994: 268) noted that in the JSI Nippon has been considered the first son, NKK 'an obedient second son', whereas Kawasaki and Sumitomo are characterized as the 'mischievous third sons.' However, Yonekura acknowledges that NKK has not always been obedient; for example, in 1983 it took the initiative and entered into an alliance with National Steel in the United States without waiting for Nippon. The relatively greater finding of divergence among the integrated mills may be attributed to their poorer performance (compared to the minimill group) (Yonekura, 1994) and the greater competitiveness of the JSI due to declining demand in the 1990s (Furukawa, 2001). The competitive environment and poorer performance may have spurred firms to engage in nonconforming behaviors such as entry into new markets, diversifications and alliances.

Cointegration analyses

While the first objective of the paper was to examine the long-run competitive interaction among group members, the second objective of the paper was to demonstrate the use of cointegration analyses to the study of competitive dynamics among firms. As cointegration analysis captures the transmission of impulses across a system, it is certain that evidence of cointegration indicates the deliberate actions and responses of firms over the long run. Thus, cointegration analysis overcomes the limitations associated with other approaches—such as event history analyses, reference point modeling, and Euclidean distance analyses (Deephouse, 1999)—to the study of competitive interaction among firms. The cointegration approach overcomes some of the limitations of these approaches by specifically modeling how firms react to actions of competitors. Firms are not constrained by the speed and/or direction of their reactions. However, this approach has its own limitations as well. Given that the VECM is a model that separates short-run movements from long-run movement, this analysis performs best on data sets of sufficient length. Higher-frequency data (i.e., monthly, quarterly) do little to improve the results.

[15] We thank an anonymous referee for this insight about strategic space.

In addition, the results are biased towards finding cointegration when using a large number of variables. Therefore, using this approach to analyze the dynamics of a group consisting of more than seven or eight firms would require the pairwise testing of cointegration. Moreover, another limitation of the study, as we found in our analyses, is that meeting nonstationarity requirements may result in the loss of some strategy variables. However, this need not completely jeopardize the analysis. Indeed the finding that some strategies are stationary while others are non-stationary is an interesting result in its own right.

Conclusion

This paper has contributed to the understanding of long-run competitive behavior of firms within groups and the functional relevance of strategic groups. It shows that the competitive interactions among firms within groups are complex; they often play out over long periods, and may result in imitative or differentiating behavior. Overall, the study finds support for Dranove *et al.*'s (1998) assertion that strategic group member behavior is oriented towards that of other firms in the group. Moreover, the paper also contributes to the literature on strategy research by demonstrating the use of a new methodological tool to study the interaction among actors over the long run.

This study helps managers and industry analysts appreciate how the competitive dynamics and firm strategies over the long run are influenced by the firm's membership within strategic groups. It gives a better understanding of how membership in a strategic group and the competitive context of firms shape their strategies over the long run. This understanding may help managers predict the behavior of their rivals, and reconceive their strategic positions and competitive responses to their rival's actions. If managers have a better perspective of how their strategies are influenced by their context, they may examine the impact of such influence on their performance and be more conscious and aware of their own strategic behavior. Additional studies can help identify which strategies take significant adjustment time, which deviations in strategies group members should respond to, and whether such behavior ultimately influences firm performance. It may help managers understand how their firm's environment-scanning systems and organizational structures influence their response to competitive actions of their rivals. Future studies can explore several contingencies, such as firm-level variances, that contribute to variances in member responses. Moreover, future studies can examine how long-run competitive dynamics among firms *across* groups differ from dynamics *within* groups. For example, integrated steel manufacturers such as Nippon did try to compete with Tokyo Steel in the large size H-beam market (Meyer, 1992). Comparison of the effect of across- and within-group competition and referencing on firm behavior may provide more compelling evidence of the impact of strategic groups on member behavior and performance. Of course, such studies need not be limited to strategic groups; researchers may use the methodology of cointegration to study the competitive interaction among any set of actors they choose.

ACKNOWLEDGEMENTS

We thank Steve Maurer, David Selover, and two anonymous reviewers for their generous comments and suggestions. We also thank Naohisa Goto of the University of Kitakyushu for assistance with interpreting Japanese data and results. The paper has benefited from collaboration with Suresh Kotha on an earlier paper. The authors acknowledge financial support from a grant provided by the College of Business and Public Administration of Old Dominion University. Professor Filer would also like to acknowledge financial support from an Old Dominion University Summer Research Fellowship.

REFERENCES

Analysts' Guide. Various years. Daiwa Institute of Research: Tokyo.

Barnett WP. 1997. The dynamics of competitive intensity. *Administrative Science Quarterly* **42**(1): 128–160.

Barney JB, Hoskisson RE. 1990. Strategic groups: untested assertions and research proposals. *Managerial and Decision Economics* **11**(3): 187–198.

Baum JAC, Korn HJ. 1996. Competitive dynamics of interfirm rivalry. *Academy of Management Journal* **39**(2): 255–292.

Baum JAC, Mezias SJ. 1992. Localized competition and organizational failure in the Manhattan hotel industry, 1898–1990. *Administrative Science Quarterly* **37**: 580–604.

Baum JAC, Singh JV. 1994. Organizational niche overlap and the dynamics of organizational failure. *American Journal of Sociology* **100**: 346–380.

Berry B. 1996. The nucors of Asia: Hanbo and Tokyo Steel. *New Steel* **12**(1): 60–69.

Bogner WC, Mahoney JT, Thomas H. 1994. Paradigm shift: parallels in the origin, evolution and function of the strategic group concept with the resource-based theory of the firm. Working paper, School of Business, University of Illinois.

Bresser RKF, Dunbar RLM, Jithendranathan T. 1994. Competitive and collective strategies: an empirical examination of strategic groups. In *Advances in Strategic Management*, Vol. 10B, Shrivastava P, Huff AS, Dutton JE (eds). JAI Press: Greenwich, CT; 187–211.

Camerer CF. 1991. Does strategy research need game theory? *Strategic Management Journal*, Winter Special Issue **12**: 137–152.

Chen M-J. 1996. Competitor analysis and interfirm rivalry: toward a theoretical integration. *Academy of Management Review* **21**(1): 100–135.

Chen M-J, Hambrick DC. 1995. Speed stealth, and selective attack: how small firms differ from large firms in competitive behavior. *Academy of Management Journal* **38**: 453–482.

Chen MJ, Smith KG, Grimm CM. 1992. Action characteristics as predictors of competitive responses. *Management Science* **38**: 439–455.

Cool K, Dierickx I. 1993. Rivalry, strategic groups and firm profitability. *Strategic Management Journal* **14**(1): 47–59.

Cool K, Schendel D. 1987. Strategic group formation and performance: the case of the U.S. pharmaceutical industry, 1963–1982. *Management Science* **33**(9): 1102–1124.

Cooper RL. 1972. The predictive performance of quarterly econometric models of the United States. In *Econometric Models of Cyclical Behavior*, Hickman B (ed.). NBER Studies in Income and Wealth, Columbia University Press: New York; 36.

D'Aveni RA. 1994. *Hypercompetition: Managing the Dynamics of Strategic Maneuvering*. Free Press: New York.

Davidson J, Hendry D, Srba F, Yeo S. 1978. Econometric modelling of the aggregate time-series relationship between consumer's expenditure and income in the United Kingdom. *Economic Journal* **88**: 661–692.

Deephouse DL. 1999. To be different, or to be the same? It's a question (and theory) of strategic balance. *Strategic Management Journal* **20**(2): 147–166.

Dess GG, Davis PS. 1984. Porter's 1980 generic strategies as determinants of strategic group membership and organizational performance. *Academy of Management Journal* **27**: 467–488.

Dickey D, Fuller W. 1981. Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica* **49**: 1057–1072.

Dranove D, Peteraf M, Shanley M. 1998. Do strategic groups exist? An economic framework for analysis. *Strategic Management Journal* **19**(11): 1029–1044.

Enders W. 1995. *Applied Econometric Time Series*. Wiley: New York.

Engle R, Granger C. 1987. Cointegration and error-correction: representation, estimation and testing. *Econometrica* **55**: 251–276.

Fiegenbaum A, Thomas H. 1995. Strategic groups as reference groups: theory, modeling and empirical examination of industry and competitive strategy. *Strategic Management Journal* **16**(6): 461–477.

Frazier GL, Howell RD. 1983. Business definition and performance. *Journal of Marketing* **47**: 59–67.

Furukawa T. 2001. A marketable battle for Tokyo Steel. *New Steel* **17**(3): 26–27.

Granger C. 1981. Some properties of time-series data and their use in econometric model specification. *Journal of Econometrics* **16**: 121–130.

Granger C. 1983. Co-integrated variables and error-correcting models. UCSD Discussion Paper 83-13.

Hambrick DC. 1983. High profit strategies in mature capital goods industries: a contingency approach. *Academy of Management Journal* **26**: 687–707.

Hitt MA, Ireland D, Hoskisson RE. 2001. *Strategic Management: Competitiveness and Globalization* (4th edn). Southwestern Publishing: Cincinnati, OH.

Hoskisson RE, Hitt MA, Wan WP, Yiu D. 1999. Theory and research in strategic management: swings of a pendulum. *Journal of Management* **25**(3): 417–422.

Houthoofd N, Heene A. 1997. Strategic groups as subsets of strategic scope groups in the Belgian brewing industry. *Strategic Management Journal* **18**(8): 653–666.

Hunt MS. 1972. Competition in the major home appliance industry, 1960–1970. Doctoral dissertation, Harvard University.

Japan Company Handbook. Various years. Toyo Keizai: Tokyo.

Johansen S. 1988. Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control* **12**: 231–254.

Johansen S, Juselius K. 1990. Maximum likelihood estimation and inference on cointegration with application to the demand for money. *Oxford Bulletin of Economics and Statistics* **52**: 169–209.

Kahneman D, Tversky A. 1979. Prospect theory: an analysis of decisions under risk. *Econometrica* **47**(19): 263–291.

Kawahito K. 1972. *The Japanese Steel Industry*. Praeger: New York.

Ketchen DJ, Palmer TB. 1999. Strategic responses to poor organizational performance: a test of competing perspectives. *Journal of Management* **25**(5): 683–699.

Mascarenhas B. 1989. Strategic group dynamics. *Academy of Management Journal* **32**(2): 333–352.

McGee J, Thomas H. 1986. Strategic groups: theory, research and taxonomy. *Strategic Management Journal* **7**(2): 141–160.

Meyer R. 1992. Steeling business. *Financial World* **161**(20): 44–46.

Mintzberg H. 1987. The strategy concept I: five Ps for strategy. *California Management Review* Fall: 11–23.

Mohan K, Berkowitz M. 1988. Raw materials procurement strategy: the differential advantage in the success of Japanese Steel. *Journal of Purchasing and Materials Management* **24**(1): 15–22.

O'Brien P. 1989. The development of the Japanese steel industry. Harvard Business School Case # 387118.

Osterwald-Lenum M. 1992. A note with quantiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistics. *Oxford Bulletin of Economics and Statistics* **54**: 461–471.

Peteraf M, Shanley M. 1997. Getting to know you: a theory of strategic group identity. *Strategic Management Journal*, Summer Special Issue **18**: 165–186.

Phillips P, Perron P. 1988. Testing for a unit root in time series regression. *Biometrika* **75**: 335–346.

Porac JF, Thomas H, Baden-Fuller C. 1989. Competitive groups as cognitive communities: the case of Scottish knitwear manufacturers. *Journal of Management Studies* **26**(4): 397–416.

Porter ME. 1979. The structure within industries and companies' performance. *Review of Economics and Statistics* May: 214–227.

Porter ME. 1980. *Competitive Strategy*. Free Press: New York.

Reger RK, Huff AS. 1993. Strategic groups: a cognitive perspective. *Strategic Management Journal* **14**(2): 103–123.

Sargan J. 1964. Wages and prices in the United Kingdom: a study in economic methodology. In *Econometric Analysis for National Economic Planning*, Hart P, Mills G, Whittaker J (eds). Butterworths: London; 25–54.

Sims C. 1977. *New Methods in Business Cycle Research*. Federal Reserve Bank of Minneapolis: Minneapolis, MN.

Smith KG, Grimm C, Young G, Wall S. 1997. Strategic groups and rivalrous firm behavior: towards a reconciliation. *Strategic Management Journal* **18**(2): 149–158.

Thomas H, Venkataraman N. 1988. Research on strategic groups: progress and prognosis. *Journal of Management Studies* **25**: 537–555.

Yonekura S. 1994. *The Japanese Iron and Steel Industry, 1850–1990*. St Martin's Press: New York.

Young G, Smith KG, Grimm CM, Simon D. 2000. Multimarket contact and resource dissimilarity: a competitive dynamics perspective. *Journal of Management* **26**(6): 1217–1236.