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ADMINISTRATION SIZE AND ORGANIZATION SIZE: AN EXAMINATION OF THE LAG STRUCTURE[1]

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Recent longitudinal studies of the relationship between organization size and administrative staff size (Freeman & Hannan, 1975) often have failed to replicate the findings of earlier cross-sectional research (Blau & Schoenherr, 1971). As a result, many researchers (Kimberly, 1976b) have argued that further longitudinal research is necessary.

Longitudinal analyses, however, are not without potential pitfalls (Kimberly, 1976a). One of the crucial analytical problems is the identification of an appropriate lag structure: that is, the amount of time it takes a dependent variable to respond to changes in an independent variable. However, as Freeman and Hannan have noted, "It is notoriously difficult to induce the proper lag structure from empirical analysis of a panel of observations" (1975, p. 216). In addition, there seems to be no a priori reason why the proper lag between two variables would be the same for all organizations, even if they are of the same organization type and even if they are observed over the same period.

In order to provide some empirical basis for understanding the lag structure of the often studied relationship between organization size and administration size, two basic questions were addressed for this paper. First, does the explanatory power of within-organization models of the administration/organization size relationship vary by the time lag of organization size? Second, given the discovery of differences among the time lag models in terms of explanatory power, can these differences be attributed to other organizational factors?

Background

In contrast with cross-sectional studies, the major benefit attributed to the use of longitudinal data for the study of organizational size and administration is the increased understanding of causal processes (Kimberly, 1976a; Meyer, 1972). Given that controlled field experiments with organizational structure often are impractical, most organizational theorists would agree that "though not a complete substitute for the experimental design,

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panel analysis goes farther toward resolving the ambiguities in causal inference than other forms of analysis" (Kessler & Greenberg, 1981, p. 26). Thus, the long standing concern of researchers with administrative economies or diseconomies of scale, or the relative adjustments of administration size to changes in the overall organization size (Blau, 1970; Parkinson, 1957), indicates that both organization size and administration size should be measured over time.

Unfortunately, the majority of longitudinal research on the relationship between organization size and administration size has been limited by relatively few data points (Freeman & Hannan, 1975). This limitation has resulted in cross-sectional research designs in which the change in size or administration over two or three data points is used as a variable for cross-sectional comparisons *between* organizational units of analysis (Ford, 1980). Although certainly more informative than single time period cross-sectional research, between-organization designs are limited in their ability to tap time-related processes of change. As such, they can be contrasted to *within*-organization designs such as that used by Ford (1980) in his study of 24 organizations over a 10-year period. With such data, Ford was able to compute regressions of administration size on organization size separately for individual organizations. His analysis allowed for a detailed investigation of the responsiveness of administration size to changes in organization size, including an assessment of administrative economies and diseconomies of scale under conditions of growth and decline for individual organizations.

The simplest time series regression analysis of Y on X uses data for the X_t and Y_t variables matched over the exact same time periods. This was the procedure used by Ford (1980) when he regressed, for the same years, administration size on organization size over 10 yearly data points. From the empirical perspective, such a model (which is called contemporaneous) assumes that administration size is affected only by organization size in the same year (Kmenta, 1971). From the substantive perspective, two possible conditions might result in the model being accurate. First, organizational decision makers delete or add administrators as an immediate reaction to the observation of a change in their organization's size. Second, prior planning by organizational decision makers results in the accurate anticipation of changes in size, with the planned adjustment of administrative staff size occurring simultaneously with the changes in organization size. However, the contemporaneous model may not be appropriate when the reaction of organizational decision makers to changes in organization size occurs not instantaneously, but at a later time period.

Unlike some other social and behavioral science fields such as marketing research and economics (Clarke, 1982; Weinberg & Weiss, 1982), and probably because there has not been a long tradition of longitudinal data analysis, organizational theorists have given only limited attention to the lag structures among their prime variables (Kimberly, 1976a). As a result, longitudinal research on organization size and administration size most often

has used contemporaneous models (Ford, 1980) even though early within-organization research (Tsouderos, 1955) suggested that administrative expenditures may lag behind changes in organization size.

The issue of identifying an appropriate lag structure is a general problem with time series data. The solution offered most often by economists (and others fortunate enough to have numerous data points) is the distributed lag model in which the dependent variable is regressed on the same independent variable lagged over more than one time period. Although there are several econometric techniques for dealing with distributed lag models (Kmenta, 1971), they probably are of limited use to organizational theorists. Longitudinal data on organizational structure seldom contain sufficient observations for examining a within-organization change with a single time lag, far be it from a distributed lag. Fortunately, there is an alternative procedure to the distributed lag model—a single lag model that is not contemporaneous. However, questions then arise regarding how to identify the appropriate single time lag between two organizational variables and whether the particular types of organizational subjects differ on this account.

With four-year colleges and universities as the organizational sample, the present study examined three within-organization single lag models over eight yearly data points: (1) contemporaneous—administration size regressed on organization size from the same year; (2) a one-year lag—administration regressed on organization size from the previous year; and (3) a two-year lag—administration regressed on organization size from two years earlier. Using R^2 as a criterion for selecting the best model for each organization, a multiple discriminant analysis then was used to examine organizational factors that led to differences among organizations in determining their particular best model.

The three models suggest a range of responses from anticipatory to reactionary as to how organizations might adjust to changes in size. Although mathematically the contemporaneous model assumes an instaneous effect of size on administration, from the substantive perspective it was felt that this model represents the condition of accurate planning by college and university administrators. That is, because it is unlikely that colleges and universities fire and hire high level administrative staff (above the level of department chairpeople) immediately after the enrollment size is finalized for the year, this model implies that organizational decision makers accurately anticipated changes in enrollment and adjusted their staff accordingly. In contrast, the other two models represent an extension of the logic employed by Freeman (1979). In a study of school districts, he argued that a one-year time lag between size and administration was appropriate because it took into account that enrollment in one school year provided the basis for teaching and administrative hiring decisions in the next year. The models examined here allowed for a one or two-year reaction time to enrollment changes.

Method

Sample. A random sample of 200 four-year colleges and universities was selected from volumes 1 through 10 of the *Yearbook of Higher Education* (*YHE*) (Marquis Academic Media, 1969-1978). Missing data reduced the sample to 139 organizations with 10 yearly data points. Yearly data points were considered appropriate for colleges and universities based on the assumption that the majority of their personnel decisions regarding administrators are made on a yearly basis. In addition, although midyear dropouts and transfers may account for some changes in enrollment size, yearly changes would seem most salient for an organization with essentially a yearly cycle of input-throughput-output.

Procedure. Step 1. The first step of the analysis was to compute separately, for each of the 139 organizations, the regression of administration size on organization size using eight pairs of yearly data points. With each slope computed on data for one organization, the *within*-organization (or over time) relationship between administration size and organization size was represented.

Three equations, representing the different time lag models, were estimated for each organization: (1) contemporaneous—the number of administrators from 1971 to 1978 regressed on organization size from the same years, similar to Ford (1980); (2) one-year lag—administration size from 1971 to 1978 regressed on organization size from 1970 to 1977; (3) two-year lag—administration size from 1971 to 1978 regressed on organization size from 1969 to 1976.

In the regression analyses, organization size was represented by the full time student enrollment. Administration size was the number of full time academic administrators above the level of department chairpeople. Included in this classification were presidents/chancellors, all academic deans, and all division heads in the typical areas of college/university administration including instruction, academic affairs, student personnel, head librarian, admissions, business and finance, registrar, special programs, adult/continuing education, and research. Division head titles included vice-presidents/vice-chancellors, deans, and directors.

Given 10 years of available data, there was a tradeoff in the number of years available for the regression analyses and the number of years size could lag behind administration. Regressions over eight years allowed the one contemporaneous model and the two lagged models. Although it would have been interesting to examine lags of three or more years, it was decided that the reduction in data points would have been too prohibitive.

Logarithmic transformations (base 10) of administration size (number of administrators above the level of department chairpeople) and of the organization size (number of students) were employed. Following a procedure similar to the within-organization longitudinal study by Ford (1980), the economists' technique (Campbell & Siegel, 1967) of transforming both sides of an equation was used in order to estimate size elasticities or the

proportional changes in number of administrators responding to *proportional* changes in number of students (organization size). Transforming both sides of the equation allowed the models to represent the theoretically relevant proportional changes in administration (Blau, 1970) without using the often criticized ratio variables (Freeman & Kronenfeld, 1973; MacMillan & Daft, 1979).

Ordinary least squares (OLS) regressions were used to estimate size elasticities because only 13.2 percent of the regressions had significant autocorrelations (Durban-Watson D statistic).

Growing and declining organizations were analyzed separately because earlier research has suggested that the processes associated with organization growth and decline are not simply the reverse of each other (Ford, 1980; Freeman & Hannan, 1975). A growing organization was defined as one with a larger average size in the last five years of the study (1973-1978) than in the first five years (1969-1973). Declining organizations had a smaller average size in the last five years.

Step 2. Because regressions representing the three time lag models were computed for each organization, it was possible to estimate which model represented the "best fit" (or most appropriate lag structure) for each organization. The criterion for the selection of the best fitting model was the highest R^2 among the regression equations. Organizations were considered to have a "best" time lag model when the highest R^2 of the three time series regressions was at least .1 above the other two R^2s. A fourth classification was used for organizations that did not meet the .1 criterion for differences in R^2. Although .1 was an arbitrary criterion, it should be noted that it was the *minimal* separation, and the vast majority of the models were separated by more than .1.

The distribution of best model classifications was: 33.1 percent contemporaneous, 16.2 percent one-year lag, 23.4 percent two-year lag, and 27.3 percent ambiguous. A cross-tabulation of the growing and declining organizations by the best fitting lag model classification showed no significant relationship (chi-square $= 2.15$, $p > .5$).

Discriminant Analysis Variables. A stepwise multiple discriminant analysis was used to investigate whether several organizational characteristics discriminated among the organizations classified into the four groups. The dependent variable used in the multiple discriminant analysis was labelled "best model" and represented the categorization of all organizations into the four groups described above (contemporaneous, one-year lag, two-year lag, or ambiguous).

Because no previous research was found that examined empirically organizational factors that affect the lag structure between organization size and administration size, independent variables were selected both to represent components of organization structure used commonly in the literature (Pugh, Hickson, Hinnings, Macdonald, Turner, & Lupton, 1963) and to represent variables with theoretical links to organizational change and adaptation. However, because the data were derived from a secondary

source, the selection of variables was limited, and it was not possible to consider some potentially important structural characteristics (e.g., formalization, centralization).

Based on their prominence in Blau's (1970) theoretical work focusing on size, administration, and structural differentiation, variables representing the size of the administrative staff, size of the organization, and structural differentiation were included in the discriminant analysis. Two size measures were used for organization size and administration size. Proportional changes in total organization size and in administration staff size were examined because they represented the magnitude of change that took place in the organization during the study period. Because it is common to include the initial level of a variable when a ratio or net change in the variable over time is used in regression analyses (Dewar & Hage, 1978; Freeman & Hannan, 1975), the initial levels of organization size and administration size (size in 1971) were included in the discriminant analysis. The initial size variables represented the overall scale of operations; the change variables represented the extent of variation over time. A large base size may provide sufficient organization slack to eliminate the need to make rapid adjustments in administration size in response to changes in organization size. Extensive changes in administration size may indicate fast adjustments to organization size change; conversely, large changes in organization size may make it more difficult for quick administrative adjustments.

Although the cross-tabulation of growth and decline by the best model classifications was not significant, a dummy variable indicating growth was used to explore the effect of growth/decline on lag structures when other variables were controlled. Auspices (public ownership or control) and organizational age were considered relevant variables because earlier research on colleges and universities demonstrated that these variables are related to other structural variables (Blau, 1973). Rainey, Backoff, and Levine (1976) also have argued that public organizations are less innovative than private, a situation that may affect responses to changes in size. Because it has been hypothesized (Miles & Randolph, 1980) that organizations vary in their ability to react to changes depending on their life cycle stage, it seems possible that organizational age affects lag structures. Rubin's (1979) argument that some colleges and universities do not successfully adapt their organizational structures in response to environmental change suggested that organizational characteristics that might show a more adaptive management should be examined. If organizations with a more adaptive management are quicker to change their organizational structure, a shorter time lag in reactions of administration size to organization size would result. A measure of relative degree of top management positional reorganization was used.

Operational indicators of the variables used in the discriminant analysis are:

1. Age: The founding date subtracted from 1982.
2. Public: A dummy variable indicating that the organization was a public (as opposed to private) institution.
3. Initial size: The full time student enrollment of the college or university in 1971.
4. Delta size: The proportional change in enrollment (1978/1971).
5. Growth: A dummy variable indicating that the organization had a larger average size in the last five years of the study (1973-1978) than it did in the first five years of the study (1969-1973).
6. Initial administration size: The number of the administrators (as defined earlier) in 1971.
7. Delta administration: The proportional change in administration size (1978/1971).
8. Mean differentiation: The average number of departments from 1973 to 1978. Structural differentiation was measured from 1973 because the number of departments was not reported by the *YHE* prior to 1973.
9. Position reorganization: The total number of title changes in the academic administration positions (1969-1978).

Results

The stepwise multiple discriminant analysis had one statistically significant function ($p < .01$). Table 1 shows the rotated (varimax) standardized discriminant function coefficients for the independent variables and the group centroids (means) for each of the four categories representing the best or ambiguous time lag models.

Table 1
Rotated Standardized Discriminant Function Coefficients and Group Means (Centroids)

Variable	*Coefficient*
Delta size	1.00
Mean differentiation	.02
Position reorganization	-.03
Group	*Centroids*
Contemporaneous	.02
One-year lag	-.43
Two-year lag	-.17
Ambiguous	.36

Of nine possible variables, three were entered into the discriminant function. These included the proportional change in size over the eight years studied, reorganization, and the mean number of departments.

Group means (centroids) of the organization's standardized discriminant scores ($m = 0$, $sd = 1$) showed that the prime effect of the discriminant function was to distinguish between the ambiguous classification and the one-year lag classification. Nearly one standard deviation separated the two groups (mean discriminant scores = .36 and -.43, respectively). Although close to the one-year lag in discriminant space, the two-year lag best model classification was not as clearly distinguishable from the ambiguous classification.

The largest discriminant coefficient in the function was positive and produced by delta size.

Discussion and Conclusions

The major conclusion of this study is that appropriate single time lags for longitudinal studies of organizational properties may not be applicable to an entire organizational sample—even when that sample is homogeneous in terms of organizational type. In addition, if lag structures are affected by other organizational factors, then the process of conducting longitudinal research is even more complex than many authors (Kimberly, 1976a) have estimated previously. When compared to cross-sectional research, not only must more complex statistical techniques be employed but, also, researchers must take care to explore the different lag structures in their organizational samples and to investigate any variables that could potentially affect their hypothesized causal lags.

Because change in size was the lagged independent variable in the within-organization regression analyses, and because delta size was the major discriminating variable, it is suggested that the magnitude of change in an organizational characteristic may determine its lag structure. Thus, this finding gives a possible clue for developing empirical solutions to the methodological problem of identifying appropriate lag structures—focus on the extent of change in the independent or lagged variable as a potential factor influencing lag time.

The effect of delta size shows that relatively more extensive changes in size discriminated primarily between the model of no discernible pattern in the time and response to changes in organization size and the model of a one-year time lag. A less notable discrimination occurred between the ambiguous model and the two-year lag model. The relationship of delta size with the ambiguous classification could result from the existence of moderating factors that limit or enhance the responsiveness of administrative size when there is a larger degree of change in enrollment. For organizations falling into the one-year lag best model classification, it seems possible that proportionately larger changes in organization size may destabilize some organizations, inhibiting their ability to plan for changes in administrative staff size, an ability necessary to have organizational decision makers plan accurately for contemporaneous adjustments to changes in size.

Two important factors to be considered in future longitudinal research on organization size and administration size are the types of administrative

personnel studied and the possible dependence of lag structures on the nature of the organizational subjects' industry.

A volatile and competitive industry may impact on managerial planning because changes in size or volume of operations may be more difficult to anticipate; therefore, it can be hypothesized that reactive rather than proactive decisions regarding staff would result. In addition, within a keenly competitive industry, organizational slack would be minimal and excess administrators might be dangerously costly. In such an environment, it seems that personnel changes would have to be made in less than the yearly increments typical for colleges and universities.

Because researchers often find inconsistent relationships between size and administration across different categories of administrative personnel (Ford, 1980), it might be possible that different categories of administrators would show different time lags in response to changes in size. For instance, it can be hypothesized that, when the personnel component represents administrators from the top levels of the organizational hierarchy or represents administrators who are difficult to replace (such as highly trained professionals), the size of the personnel component is relatively inelastic in response to short term declines in organizational size. Such a situation would result in a relatively long time lag necessary for an accurate representation of the administration size/organization size relationship.

Finally, given the increased proclivity for longitudinal research in organizational theory, it seems that future empirical and theoretical work is necessary to address at least four questions, *the answers to which are very likely specific to the type organization studied and the variables under analysis*. These are: (1) What are the substantively meaningful lag periods for measurement (e.g., one day, one week, etc.)? (2) Given an appropriate lag period, how many periods need to be observed in order to assess change? (3) How many different lag structures are needed for an accurate description of the organizational sample? (4) What are the potential factors—both structural and environmental—that may affect the lag periods and the rapidity of change?

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