

**Ode To Luther Gulick:
Span of Control And Organizational Performance**

Kenneth J. Meier
Dept. of Political Science
Texas A&M University
College Station, TX 77843
409-845-4232
409-847-8924
kmeier@polisci.tamu.edu

and

John Bohte
Dept. of Political Science
Oakland University
Rochester, MI 48309

Financial Support for this research was provided by the Department of Political Science at Texas A&M University. We would like to thank Jeff Gill, George Krause, LeeAnn Krause, Tom Hammond and anonymous reviewers for this journal for comments on an earlier draft of this manuscript.

Abstract

Early management scholars such as Henri Fayol, Lydal Urwick, and Luther Gulick argued that principles such as specialization of labor and hierarchical leadership structures among others would result in optimal organizational performance. This perspective was attacked by Herbert Simon (1946), who argued that the principles of administrative management were vague and contradictory. Simon's devastating critique was widely accepted, and scholars soon turned their attention away from studying the principles of management.

Ironically, little systematic research existed on many of the principles of management at the time Simon leveled his critique. In this study, our goal is to refocus attention on a particular principle of management, span of control, most closely associated with Luther Gulick. After discussing the importance of span of control to our understanding of organizational behavior, we present a theory that links span of control to organizational performance. We then test our theory by examining how span of control relationships among personnel in public schools influence student performance, using data on 678 Texas school districts over a four year period. Our findings reveal that span of control relationships among organizational personnel significantly shape student performance.

Ode To Luther Gulick: Span of Control And Organizational Performance

In the early part of the 20th century, management scholars argued that the structural attributes of bureaucratic organizations played a major role in conditioning organizational performance. The administrative management movement was at the forefront in calling attention to the importance of structure as a determinant of organizational performance. Advocates of this approach--Henri Fayol, Lydal Urwick, and Luther Gulick--believed that adherence to a core set of management principles would help organizations achieve optimum performance in working toward their goals. The principle of division of labor, for example, allows workers to develop expertise in performing particular tasks. In contrast, charging employees with a wide variety of unrelated duties inhibits the development of expertise.¹ The principle of unity of command cautions against directives coming from too many superiors because conflicting signals could arise and lead to confusion among employees. A third principle, span of control, dictates that superiors should oversee a limited number of subordinates rather than a large number of subordinates. Monitoring and mentoring the work of subordinates is a less daunting task when the number of subordinates is small but becomes more difficult when superiors are charged with overseeing a large number of individuals.

Management scholars claimed that the implementation of these and related principles would result in organizations characterized by an almost mechanical efficiency, where relations between superiors and subordinates are clearly defined, workers specialize in particular areas and have clearly defined roles within organizational hierarchies, and organizational resources are used in the most efficient manner possible. Although the principles of management were viewed

by some as intuitively appealing guidelines for how to manage organizations, critics of the approach soon pointed out the weaknesses inherent in these management principles.

In a classic article titled “The Proverbs of Administration,” Herbert Simon (1946) presented a thorough critique of the principles of management approach (see also Waldo 1948). According to Simon, the principles of management were vague and plagued by contradictions. With regard to the principle of specialization, for example, Simon pointed to the vagueness and ambiguities involved in applying this principle in a real-world setting. Specialization might be defined by place or location, with one employee addressing multiple tasks in a particular organizational unit. Conversely, specialization could be defined in terms of function, where individual employees in a particular organizational unit each concentrate their energies on performing one specific task. Regarding unity of command, Simon argued that this principle contradicts the principle of specialization. Specialization allows employees to develop expertise in particular subject areas, yet if these employees are subject to directives from superiors in other parts of the organization who have no expertise in these areas, the benefits of specialization may be squandered. In short, Simon argued that for each principle of management, contradictory principles existed that made just as much, if not more, sense as guidelines for how to manage organizations. Simon’s critique was viewed as devastating, and the principles of management school of thought quickly fell out of favor to be replaced by a research focus on the decision-making processes of individuals in organizations.

Our purpose in this research is to reintroduce a key principle of management, *span of control*, to the study of public administration. Span of control, associated most closely with Luther Gulick (1937), has a straightforward logic; individuals in management positions should

oversee a relatively small number of subordinates. Urwick (1956), in fact, claimed six was the maximum. As the number of subordinates under an executive's control increases, monitoring the behavior of subordinates becomes more difficult. Herbert Simon (1946) criticized this logic, claiming that a case could be made for adopting a contradictory principle of management. If the span of control is limited and executives oversee a relatively small numbers of subordinates, the number of levels within an organization's hierarchy will increase. As the number of levels within an organization increases, the amount of red tape moving across different organizational levels also tends to increase. To avoid this problem, Simon suggested that organizations be designed with few organizational levels--a principle directly opposite to that implied by adherence to narrow spans of control in structuring relations between executives and subordinates.

Scholars of public administration uncritically accepted the arguments in Simon's work. Attempts at proving or disproving the worth of the principles of management quickly faded as public administration shifted away from examining the structural attributes of organizations and toward the study of organizational behavior, as suggested by Simon (Hammond 1990). With the principle of span of control, for example, there was no systematic evidence about the effects of variations in span of control on organizational performance at the time Simon leveled his famous critique. As Hammond (1990, 160) points out "Gulick explicitly stated that it is not known what the span of control should be" but instead called for additional research on the topic so that more precise answers might be obtained. As public administration shifted away from the principles approach, few efforts examined this question, leaving scholars with little knowledge about how variations in span of control affect organizational performance.

The Importance of Span of Control for Understanding Organizational Performance

Little systematic research examines how span of control affects organizational performance, but the limited evidence available suggests that span of control is an important variable that must be considered when examining how organizations perform their tasks. Joan Woodward's (1980) classic study of British industrial firms revealed that span of control varies a great deal across different organizational settings. Within each organizational category (unit, large batch and continuous production), successful firms used similar spans of control to structure relationships between executives and employees. Woodward's study remains one of the few systematic studies of span of control and organizational performance. Other studies of span of control (Holden, Pederson and Germane 1968; Hood and Dunsire 1981) tried to determine the exact span of control in organizations but did not relate it to performance (but see the experimental studies by Carzo and Yanouzas 1969).

Gaining a better understanding of how varying spans of control affect organizational performance is important from the standpoint of informing our existing theories of management-employee relations. Should executives exercise narrow or wide spans of control over employees? The famous Theory X and Theory Y (McGregor 1960) management schemes call for entirely different approaches to structuring relations between executives and subordinates. Under Theory X, spans of control should be very narrow because executives cannot trust their employees. Under Theory Y, spans of control should be loose so as to encourage employees to achieve their fullest potential by working independently and taking on new responsibilities.

Spans of control are also related to the principal-agent problem in organizations (see Brehm and Gates 1997). Narrow spans of control increase supervision and thus make shirking

less likely. In situations where principals (supervisors) and agents (subordinants) have similar goals (Kaufman 1960), spans of control can be expanded with little increase in shirking.

Spans of control are also relevant to individual responsibility in an organization and perhaps to theories of ethics as well. With narrow spans of control, supervision can be close, thus not permitting the individual employee to develop responsibility for his or her actions. Similarly, the importance of organizational ethics (Frederickson 1996; Wamsley et al. 1992) increases when spans of control increase and the organization cedes discretion to its members. Thus, increasing our understanding of how variations in spans of control affect organizational performance has implications for how management-employee relations could be structured.

A Theory of Span of Control

What is the appropriate span of control for optimizing organizational performance? We know little about this question primarily because rules of thumb, rather than sound theory have long served as the only foundation for answering this question. Gulick's (1937) essay only discusses examples of "appropriate" spans of control as suggested by those studying cabinets in Great Britain and France. One observer claims that executives should be charged with overseeing no more than six individuals, another suggests that ten to twelve is an acceptable range, while yet another points to five as the upper limit under which executives can effectively exercise their authority. Woodward's (1980) study supports the hypothesis that spans of control vary across production, mass production, and process firms. Woodward's findings, however, are specific to the three categories of industrial firms examined in her work and do not furnish a general theory about how variations in spans of control affect organizational performance.

The approach of these past efforts has been to study organizations empirically and then present assertions about how the principle of span of control should be applied to enhance organizational performance. The potential bias that comes with studying only a limited number of contextual settings (e.g., cabinets, industrial firms) and making generalizations about spans of control only after data have been collected is problematic from a theory building standpoint. Our approach is to develop a theory of span of control that is not explicitly linked to any one particular organizational setting but rather provides a general statement about the relationship between span of control and organizational performance. We then test our theory by studying spans of control among organizational personnel in Texas public schools, examining how relationships between leaders and their subordinates shape organizational performance.

The relationship between span of control and performance for any given organization should have two key characteristics. Generally as spans of control increase, there should be an increase in performance as the organization gains a higher percentage of production workers relative to control (supervisory) workers, *ceteris paribus*. Performance gains as the result of increases in the span of control, however, should be subject to diminishing marginal returns. At even higher spans of control, perhaps at levels well beyond normal for an organization, the addition of each additional subordinate might well reduce overall performance as the absence of coordination, management, and supervision results in the organization moving toward entropy (Williamson 1990). This suggests that the general relationship between performance and span of control might be best described as a quadratic similar to that in figure 1.²

[Figure 1 About Here]

Any quadratic relating production (Y) to span of control (X) within a given set of organizations can be defined by three key parameters as denoted in the following equation:

$$Y = \alpha - \gamma(X - \beta)^2 \quad \text{where,}$$

α is the highest value that Y can attain, that is maximum output,

β is the value of X (Span) where output is maximized, and

γ is a constant that adjusts the curve to be either narrower or wider (see Appendix A).

The theoretical result presented here needs to be modified for application to real organizations. The theoretical presentation did not incorporate costs, specifically the costs of additional employees. No organization, even a highly redundant organization seeking reliability and consistency above all else (e.g., space shuttle launches; see Heimann 1993; Romzek and Dubnick 1987), seeks performance regardless of costs.³ This means that organizations are unlikely to expand span of control beyond β unless there are other incentives to do so (see below). For most organizations, therefore, only the left side of the curve (in figure 1) is relevant. As costs become a consideration, the portion of the curve that is relevant moves even further to the left of the graph. This implies that for most organizations the curve can be approximated relatively well by a linear estimate of that part of the curve between points A and B.

The second alteration of the theoretical curve is that organizations will differ on a variety of factors that determine where β is for each organization. Organizations with better leadership or more investment in technology could well tolerate larger spans of control than organizations without these advantages.⁴ This implies that the optimal span of control can be estimated for a given set of organizations, but that some organizations will be able to accommodate somewhat larger spans of control without suffering ill-effects.

Two substantive qualifications should be added to this theoretical discussion. First, span of control is a manipulable variable. That is, organizations can alter their span of control and, if the costs are consistent with the organization's mission, could increase spans of control to improve overall production. Second, span of control is only one factor among many that affects production. It is unlikely to be as important as the quality of inputs, the technology applied to the problem, the commitment of organizational employees, or a variety of other factors in the organization; that is, its impact will not be massive. This does not mean its impact is unimportant. Organizations are open systems (Rainey 1997), and the other factors affecting production may be beyond their control.

Methods

To what extent are span of control relationships influential in shaping organizational performance? The remainder of the paper examines this question using data on 678 school districts in Texas with enrollments over 500 students. The data cover the years 1994 to 1997 and were pooled for a total of 2712 cases over the time frame of the study. Schools are ideal organizations for examining how variations in spans of control affect relationships among organizational personnel. Schools, and school districts more generally, are highly professionalized hierarchical structures. Working relationships exist between teachers and school administrators, campus administrators and administrators at the district level, and teachers and students. Variations in spans of control can affect how each of these relationships are structured, and such variations ultimately have implications for how schools perform in educating students.⁵ Pooling the data set provides additional leverage because it permits the

determination of how changes in spans of control for a given organization affect performance for that organization.

A second reason for examining schools is they provide a homogenous sampling frame for studying how span of control relationships affect organizational performance. Woodward's (1980) study examined a diverse grouping of over 200 industrial firms in Britain. Casting a wide net over different types of firms makes any firm conclusions about how span of control affects any one particular type of organization difficult. An alternative strategy is to study a set of organizations that all perform the *same* function. Put another way, Woodward revealed that spans of control vary across organizations that have different modes of production. Our goal in this research is to determine what the optimal span of control is for a set of organizations that all use the same modes of production to achieve the same goal (i.e., educating students). In this sense, our work is complementary to Woodward's and extends an important hypothesis about span of control from her research.

Our strategy of analysis was to estimate an organization production function whereby all factors known to influence outputs are used in a regression to predict performance. Outputs in this case are defined as average district pass rates on standardized skills comprehension exams. To this model of performance, we will add several span of control variables also hypothesized to affect student performance. We will investigate both linear and nonlinear relationships and attempt to estimate optimal spans of control for these agencies (see figure 1). In addition, we will examine high performing districts to see if the impact of spans of control is different in these districts from the impact in districts that perform less well.

The pooled nature of the data require one additional adjustment. Autocorrelation is often a problem in pooled data. Accordingly, all models included a set of three dummy variables representing individual years to control for serial autocorrelation.⁶

Dependent Variable

We hypothesize that spans of control among actors in educational bureaucracies significantly affect organizational performance. Our measure of organizational performance is the percentage of students in each school district who pass standardized reading and mathematics tests each year. While tests such as these clearly do not measure the entire student learning experience, they do assess whether students are picking up basic academic skills from grade to grade. At a minimum, schools should be expected to produce students who have at least basic reading and math skills, and pass rates on these exams serve as good indicators of how schools perform in furnishing students with these skills.

Independent Variables, Controls

Organizational performance should be a function of the inputs organizations receive, the resources they apply to the process, the quality of technology applied to the process, and organizational leadership (Rainey 1997; Wolf 1997; but see Kaufman 1981). We have measures for both the inputs the organizations receive and the resources that they apply to the process. Since these organizations all perform the same function (and since we limit the study to those over a certain size), we can assume the technology used is relatively similar. Leadership will not be measured, but we will try to tease out its impact by focusing on organizations that outperform their production function (see below).

Inputs to these organizations means students, and the makeup of student populations varies widely across school districts in Texas. Urban school districts tend to have larger numbers of African-American, Latino, and low-income students than suburban school districts. Each of these types of students is likely to have learning disadvantages. Minority students come from disadvantaged circumstances and generally score lower on standardized tests than Anglo students (Rong and Grant 1992; Jencks and Phillips 1998). The probability of low-income students having difficulties performing well on standardized tests is also high (Coleman 1966). Three variables were used to control for district student makeup: percentage African-American, percentage Latino, and percentage low-income students per district. The variable for percent low-income students was defined as the percentage of students eligible for free or reduced price meals through school lunch programs. All relationships with performance should be negative.

Resources are divided into two categories—money and experience. While the relationship of money to educational performance is controversial (Hanushek 1986, 1996; Hedges and Greenwald 1996), financial resources do provide organizations with more opportunities to deal with a turbulent environment and should be linked to production. Our two measures of resources are the average teacher salary and per student spending on education. The former recognizes that education systems are personnel intensive organizations; some scholars argue that teacher salaries indicate how well school systems can compete in the market for scarce skills (Hanushek and Pace 1995). Per student instructional costs are a reasonable measure of resources applied to actually educating students because they do not include administrative expenses and extracurricular activities. Teacher experience should be linked to learning on the job and the ability to perform at higher levels. Our measure is the average number of years of teacher

experience for the district. All three measures should be positively related to organizational performance.

Span of Control Variables

Span of control, in general terms, can be viewed as a set of ratios that link sets of leaders and subordinates. Mintzberg's (1979) examination of structures suggests that span of control will vary at different levels within an organization. Four different span of control variables are relevant. First, administrators supervise teachers; the *administrative-teacher span of control* is measured directly as the ratio of teachers to administrators in a district. The mean administrator-teacher span is 13.8 with a range of 3.0 to 30.5. The administrator-teacher span of control is one that should be limited by concerns of efficiency, thus, we would expect the relationship would be approximated well by a positive linear relationship illustrated by the part of figure 1 between points A and B. Second, central office administrators supervise school-level administrators, a *midlevel management span of control*. This span can be measured as the ratio of the number of school level administrators to the number of central office administrators. The broad span of control for teachers contrasts with a relatively narrow midmanager span of control averaging 2.4 with a range of .2 to 11.3.⁷ Similar to the administrator-teacher span, the midlevel management span should also be limited by concerns of efficiency and thus well approximated by the linear part of our theoretical span of control curve.

Third, *class size* can also be viewed as a span of control measure in a school. Class size is essentially a surrogate for the number of students a teacher must supervise and instruct. For these organizations the mean student teacher ratio is 14.5 with a range from 8.9 to 19.1.⁸ Class size is a somewhat different type of span of control measure because larger spans may actually

reduce student performance and thus the relationship should be negative. At the same time, class size reductions are expensive, and schools with limited resources could well be forced by political realities to have classes larger than optimal (Weglinsky 1997). This logic suggests that environmental constraints force organizations to operate on the full range of the span of control curve, and that the class size relationship should be nonlinear (or from points A to C in figure 1).

Fourth, schools are relatively flat organizations so that spans of control quickly translate into a given size for the organization (see Mintzberg 1979: chapter 8). The education literature has consistently found that smaller schools have a positive impact on students, an impact attributed to the informal relationships between students, teachers and administrators that occur in smaller organizations (Betts 1995). The negative relationship between *school size* and performance, however, is one that is likely to be affected by other incentives to increase the size of schools. A larger school with more students permits schools to compete more favorably with other schools in athletic and academic competitions. The size of the school is probably also reflected in higher salaries for administrators. These incentives suggest that school size would operate on the full range of the span of control graph and thus be a nonlinear relationship (or from points A to C in figure 1). In our data set, the average school size is 459 with a range of 102 to 1148 students.

Findings

Our theory of span of control suggests that spans should operate on the linear part of the curve (that is, between points A and B in figure 1) unless there are incentives to increase spans for other reasons than organizational performance. Two spans of control are likely to be affected by such incentives--class size and school size. To determine if the relationships for the various

spans of control are nonlinear, squared terms were included in the base model. Those results appear in Table 1. A glance at Table 1 clearly indicates, as expected, that the relationships for the teacher-administrator span and the midlevel span are not nonlinear, so these terms were dropped, and the reduced model appears in Table 2.

[Tables 1 & 2 About Here]

Not only is the nonlinear relationship for the two span of control measures (class size and school size) interesting in terms of theory, the relationships have practical applications. One can take the partial first derivative of these equations with respect to performance and set this value equal to zero. Solving that equation for the span of control will tell us the “optimal” span of control. By optimal span of control, we mean the largest span of control that positively affects output without considering cost factors. These calculations show that the optimal student to teacher ratio is 18.0 and the optimal school size is 649. On average and all other things being equal, these figures suggest that student to teacher ratios will have positive effects on organizational performance up to 18 but actually reduce overall outputs at levels above that. A similar conclusion is possible in regard to school size. For the teacher-administrator ratio and the midmanagement ratio, the relationships are positive—suggesting that output can be increased by widening the span of control.

The results in Table 2 apply to these organizations on average. An organization with better management or some other advantage might well be able to push its spans of control larger than an organization that lacks these qualities. One way to illustrate the differences across types of organizations is through the use of Substantively Weighted Analytical Techniques (SWAT). SWAT is an approach introduced by Meier and Keiser (1996) to merge sensitivity analysis with

traditional multiple regression. The idea behind the technique is that multiple regression generalizes to the average case. Meier and Keiser (1996) argue that public managers are often more interested in above average cases since these can be used as role models to improve performance. The SWAT methodology takes organizations that score well above the regression line (or below depending on the situation) and weights these cases more heavily than the remaining cases. The difference between this weighted regression and the regular regression, according to Meier and Keiser (1996), shows how high performing organizations use their inputs in comparison to "average" agencies. SWAT techniques (see Appendix B) have been applied in a variety of situations to different types of organizations (see Waller 1997; Smith 1998; Gill 1997; Meier, Gill and Waller 2000; Meier, Wrinkle and Polinard 1999a; 1999b).

To compare how span of control affects different types of agencies, we designate those organizations that produce student test scores much higher than the production function in table 2 predicts (more than 1.0 standard deviations above the regression line) as good or high performing organizations. Similar organizations that produce much lower test scores than would be expected given inputs, resources, and spans of control (more than 1.0 standard deviations below the regression line) are designated as low performing organizations. The SWAT technique of substantively weighted least squares was used to generate slope estimates for the production function variables. In the process of conducting the analysis, two additional relationships were discovered. For the low performing organizations, the administrative-teacher span and the midlevel management span became nonlinear. Unlike the average agencies and the good agencies, therefore, low performing agencies have reached, and some go beyond the points of

diminishing returns on the two internal spans of control. Incorporating that factor into the estimates, we get the span of control slopes that are found in Table 3.

[Table 3 About Here]

Since nonlinear relationships are more difficult to interpret, we will consider the linear relationships first. Increasing spans of control at the mid-management level affects different types of organizations differently. Increasing the midlevel span of control in good organizations has a much larger impact (.403) than it does in all organizations (.2335). At the same time, the administrative-teacher span in the good organizations effectively drops to zero, suggesting that this span of control has little if any impact on organizational performance. From a managerial perspective this implies that *organizations already performing at a high level* can increase midlevel spans of control and pay little attention to the administrator-teacher span (within reasonable ranges).

A good way to compare the nonlinear relationships is to estimate the slope of the line at the mean value for the variable. To do this, one takes the partial first derivative of the equation and estimates the slope for the mean value of the span of control variable. These results are reported in table 4. At a student teacher ratio of 14.5, a reduction of one student per teacher improves student performance by .78 percentage points in all districts, 1.04 percentage points in the high performing districts, and only .55 percentage points in the low performing districts. At normal levels of student-teacher ratios, what distinguishes the good districts from the average and low performing districts is that they get far more performance out of class size reductions, about one-third more than average districts and nearly four-fifths more than the low performing districts.

[Table 4 About Here]

Similar figures are presented in table 4 for school size. Again the impact of reducing school size is larger in the good districts than in the average districts (about one-fourth larger) and slightly larger than in the low performing districts (about 3 percent). The other interesting finding about the slopes at average spans of control is that for low performing agencies, the midlevel span of control slope has already turned negative. At a span of control of 2.4, low performing organizations have already exhausted the benefits they can obtain from increasing the span of control and are facing negative impacts. This compares unfavorably to the good districts where the relationship remains positive and linear. One possibility that must be considered is that low performing districts are low performing as a result of poor midlevel management. The inability to handle spans of control as small as 2.4 raises concerns about the quality of management.

Table 4 also reports the optimal class size and school size values for each type of district assuming that cost considerations do not matter (an unrealistic assumption but the results would be similar at lower levels where costs might suggest an optimum point). Good school systems quite clearly can operate with larger class sizes than either average districts or poor performing districts (the school size optimums do not provide such clear findings). Why might this be so? Virtually any variable not included in the model might enable an organization to operate with larger spans of control. Although we are speculating, we think that management leadership/ability is likely to be a key factor in stretching the optimal span of control. Note again that low performing districts have an optimum level because the relationship is nonlinear for

these variables for administrative-teacher spans and midlevel management spans. Neither average districts nor good districts appear to be constrained by a maximum on these dimensions.

Conclusion

This research argued that valuable management information could be garnered by returning to some long abandoned structural concepts in public administration. To illustrate this process, we examined the impact of spans of control on organizational performance. Such studies are possible and likely to be useful when comparing organizations that perform similar functions so that relative performance can be linked to structural factors. A theoretical model of spans of control was presented suggesting a nonlinear relationship of a specified form. Pragmatic concerns in individual organizations might limit the range of relationships that are possible, however, and thus in some cases relationships can be adequately estimated with linear techniques.

The study found that four different measures of spans of control were related to performance in school systems. In two cases, the incentives to go beyond normal operating spans of control were present, and nonlinear relationships were identified. The impact of spans of control was not large in comparison to factors such as resources or organizational inputs, but spans of control did have statistically significant impacts on performance. In times when public sector organizations are increasingly asked to justify their performance, even modest gains are well worth exploiting.

Discovering different optimal spans of control at different levels in the organization suggests some additional theoretical relationships in regard to span of control. Compared to contemporary organizations, those in Gulick's time faced far less complexity and much less

dynamic environments. Superiors, at that time, probably had more authoritative knowledge relative to subordinates and did not need to vest the discretion in subordinates that is needed in dynamic situations where knowledge is crucial.

We can speculate that differences in knowledge permit or perhaps require the use of larger spans of control. Students are heavily dependent on teachers for instruction; this is not a relationship among peers. A relatively large span of control (e.g., 15+), therefore, is possible, but the size is subject to limits. In such a circumstance, smaller spans of control permit greater individual instruction and thus higher levels of output.

In the relationship between teachers and administrators, the knowledge advantage is with the teacher. Teachers have authority and autonomy over their own classrooms with little direct supervision. Principals ideally are facilitators rather than managers. In such circumstances, larger spans of control are not only possible but there may be no practical upper limit.

The relationship between central administrators and campus administrators, in contrast, links two functions that are very similar. Neither type of administrator has a technological or knowledge advantage; interactions are likely to occur on those aspects of the job that cannot be routinized. Spans of control in such circumstances are likely to be smaller. In good organizations, there are unlikely to be practical limits to increasing this span of control if superiors are willing to delegate. In poor organizations, an upper limit on spans is quite likely.

This theoretical speculation based on our findings suggests that both Gulick and Simon were right, and also wrong. Simon is correct that there was no single correct span of control; it varies at different levels of the organization and in different organizations. Gulick is also correct

that smaller spans of control are better when the superior has information and skills advantages over the subordinates. Small spans of control facilitate the mentoring and teaching process.

This study only examined one type of organizations, school districts. It limited its scope so that comparable models could be generated and thus the impact of structure isolated. School districts are highly professionalized organizations that generally permit employees to operate with a great deal of discretion. The findings here are most likely to apply to similar organizations. While we have speculated on relationships for other types of organization, a full assessment of the role of structures on organizational performance, however, requires that this study be replicated for other types of organizations. When that is accomplished, theoretical progress should be rapid simply because such studies would permit generalizations about when, how much, and in what types of organizations that structural factors matter.

Appendix A

Any quadratic equation relating productivity (Y) to span of control (X) within a given set of organization can be defined by three key parameters as denoted in the following equation:

$$Y = \alpha - \gamma(X - \beta)^2 \quad \text{where,}$$

α is the highest value that Y can attain, that is maximum productivity,

β is the value of X (Span) where output is maximized, and

γ is a constant that adjusts the curve to be either narrower or wider.

The slope of the quadratic at any point on the curve can be represented by a tangent to the curve at that point. The point where the slope shifts from being positive to negative (that is where the slope is equal to 0) will correspond to the maximum point on the curve or (β, α) . This can be demonstrated by expanding the quadratic term in the equation:

$$Y = \alpha - \gamma(X - \beta)^2$$

$$Y = \alpha - \gamma(X^2 - 2X\beta + \beta^2)$$

$$Y = \alpha - \gamma X^2 + \gamma 2X\beta - \gamma\beta^2$$

Then one takes the first derivative of Y with respect to X to determine the slope at any point on the curve:

$$\delta y / \delta x = -2\gamma X + \gamma 2\beta$$

Setting the first derivative equal to 0, shows that the slope of the quadratic is zero when

$$0 = -2\gamma X + \gamma 2\beta$$

$$\gamma 2\beta = 2\gamma X$$

$$\beta = X$$

The slope is equal to zero at β , substituting this value into the original equation for X, shows that when X equals β , Y equals α . No other value of X will produce a higher value of Y. In substantive terms, this means that a span of control of β will generate the maximum amount of production or α .

Appendix B. A Primer on SWAT

SWAT is a family of techniques that use information contained in regression residuals to gain additional information about organizations and policies. We use the elementary form of SWAT in this analysis: SRLS (Substantively Weighted Least Squares). SRLS is based on simple weighted multivariate linear regression which is run 10 consecutive times on the same data, although users are free to vary this parameter. The first iteration weights all data points equal to one (i.e. unweighted OLS regression), followed by regressions that consecutively down-weight by 0.1 each case whose jackknifed residual is less than 1.00 (or one standard deviation above the regression line). The i th jackknifed residual (also called an externally studentized residual) is the normal residual weighted inversely proportional to the estimate of the regression standard error leaving out the i th case. The idea is to measure the influence of one particular case on the OLS calculations. Virtually any statistical software package can perform weighted least squares and thus SWAT.

After 10 iterations high performing cases will have weights at 1.0 and the other cases will have weights at 0.1. At this point, variables whose regression coefficients are found to be different from OLS slopes are identified as indicating those factors which have a different effect on higher performing cases (these coefficients appear in table 3). SWAT, therefore, identifies cases that perform well above expectation (high jackknifed residuals) given their allotted resources not just high performers due to resource richness. A similar process is used for the poor performing districts.

All data, documentation for this study can be obtained from the authors; software to run SWAT can be downloaded www.calpoly.edu/~jgill/

Table 1. Impact of Span of Control on Organization Performance

Independent Variable	Slope	Error	t-score
Spans of Control			
Administrator-Teacher	.2485	.2530	.98
Squared	-.0033	.0081	.41
Midlevel Management	-.1346	.2666	.51
Squared	.0460	.0320	1.52
Class Size	-4.0298	1.1718	3.44
Squared	.1133	.0397	2.85
School Size	-.0116	.0035	3.33
Squared	.8974*	.3027*	2.96
Control Variables			
Teacher Salaries (K)	.6604	.1042	6.34
Expenditures (K)	.1884	.4392	.43
Teacher Experience	.4058	.0954	4.26
Black Students	-.2565	.0143	17.96
Latino Students	-.1166	.0105	11.16
Low Income Students	-.2563	.0146	17.55
Year 95	5.5461	.3774	14.70
Year 96	10.2195	.4404	23.20
Year 97	15.8844	.5270	30.14

R-Square = .71 Adjusted R-Square = .71 F = 392.93

N of Cases 2710 Standard Error = 6.85

*coefficient multiplied by 100,000 to facilitate presentation.

Table 2. Impact of Span of Control on Organization Performance:

Final Regression

Independent Variable	Slope	Error	t-score
Spans of Control			
Administrator-Teacher	.1467	.0492	2.99
Midlevel Management	.2335	.1121	2.08
Class Size	-3.9788	1.1714	3.40
Squared	.1112	.0397	2.80
School Size	-.0117	.0034	3.38
Squared	.9070*	.3003*	3.02
Control Variables			
Teacher Salaries (K)	.6579	.1041	6.32
Expenditures (K)	.2041	.4388	.47
Teacher Experience	.4117	.0951	4.33
Black Students	-.2571	.0143	18.01
Latino Students	-.1166	.0105	11.16
Low Income Students	-.2560	.0146	17.55
Year 95	5.5480	.3774	14.70
Year 96	10.2146	.4403	23.20
Year 97	15.8734	.5269	30.12

R-Square = .71 Adjusted R-Square = .71 F = 445.12

N of Cases 2710 Standard Error = 6.85

*coefficient multiplied by 100,000 to facilitate presentation.

Table 3. Span of Control Comparisons: High and Low Performing Districts

Span of Control Measure	All Districts	Good Districts	Low Performing Districts
Administrator-Teacher	.1467 (.0492)	.0190 (.0525)	1.0171 (.2464)
Squared	----	----	-.0238 (.0077)
Midlevel Management	.2335 (.1121)	.4030 (.1270)	-.8155 (.3261)
Squared	----	----	.1436 (.0432)
Class Size	-3.9788 (1.1714)	-3.2966 (1.2604)	-6.2390 (1.2172)
Squared	.1112 (.0397)	.0779 (.0429)	.1962 (.0462)
School Size	-.0117 (.0034)	-.0138 (.0038)	-.0075 (.0035)
Squared	.9070* (.3003)	1.0263* (.3437)	.4544* (.3081)
Adjusted R-Square	.71	.61	.74
Standard Error	6.85	3.55	3.52
F	445.12	282.19	440.67
N	2710	2710	2710

*coefficient multiplied by 100,000 to facilitate presentation.

Table 4. Estimates of Slopes for Nonlinear Relationships

	Slope for		
	All Districts	Good Districts	Low Performing Districts
At Class Size of 14.5	-.78	-1.04	-.55
At School Size of 459	-.00342	-.00438	-.00342
At administrative span 13.8	----	----	.36
At midlevel span of 2.4	----	----	-.13
Optimal Class Size	18.0	21.2	15.9
Optimal School Size	649	673	825
Optimal Administrative Span	----	----	21.4
Optimal Midlevel Span	----	----	1.1

References

- Betts, Julian R. 1995. "Does School Quality Matter? Evidence from the National Longitudinal Survey of Youth." *Review of Economics and Statistics* 77 (May): 231-50.
- Brehm, John and Scott Gates. 1997. *Working, Shirking and Sabotage: Bureaucratic Response to a Democratic Public*. Ann Arbor: University of Michigan Press.
- Carzo, R. and J. N. Yanouzas. 1969. "Effects of Flat and Tall Organization Structure." *Administrative Science Quarterly* 14:178-191.
- Coleman, James S. et al., 1966. *Equality of Educational Opportunity*. Washington, D.C.: U.S. Government Printing Office.
- Frederickson, H. George. 1996. *The Spirit of Public Administration*. San Francisco: Jossey-Bass.
- Gill, Jeff. 1997. "Generalized Substantively Reweighted Least Squares Regression." Political Methodology WWW Site. http://wizard.ucr.edu/polmeth/working_papers97.
- Gulick, Luther. 1937. "Notes on the Theory of Organization" in Luther Gulick and Lydal Urwick Eds., *Papers on the Science of Administration*, pp. 191-5. New York. Institute of Public Administration, Columbia University.
- Hammond, Thomas. 1990. "In Defence of Luther Gulick's 'Notes on the Theory of Organization.'" *Public Administration* 68, 143-173.
- Hanushek, Erik. 1986. "The Economics of Schooling: Participation and Performance." *The Journal of Economic Literature* 24: 1141-1177.
- Hanushek, Erik. 1996. "School Resources and Student Performance." In *Does Money Matter?*, Gary Burtless, ed. Washington, D.C.: Brookings Institution.
- Hanushek, Erik, and Richard R. Pace. 1995. "Who Chooses to Teach (and Why)?" *Economics of Education Review* 14: 107-17.
- Hedges, Larry V. and Rob Greenwald. 1996. "Have Times Changed? The Relation Between School Resources and Student Performance." In *Does Money Matter?*, Gary Burtless, ed. Washington, D.C.: Brookings.
- Hedges, Larry V., Richard D. Laine, and Rob Greenwald. 1994. "Does Money Matter? A Meta-Analysis of Studies of the Effects of Differential School Inputs on Student Outcomes." *Educational Researcher* vol. 23: 5-14.

Heimann, C.F. Larry. 1993. "Understanding the Challenger Disaster: Organizational Structure and the Design of Reliable Systems." *American Political Science Review* 87: 421-35.

Holden, Paul E., C.A. Pederson, and G.E. Germane. 1968. *Top Management*. New York: McGraw Hill.

Hood, Christopher and Andrew Dunsire. 1981. *Bureaometrics: The Quantitative Comparison of British Central Government Agencies*. University: University of Alabama Press.

Jencks, Christopher, and Meredith Phillips, Eds. 1998. *The Black-White Test Score Gap*. Washington, D.C.: The Brookings Institution.

Kaufman, Herbert. 1960. *The Forest Ranger*. Baltimore: Johns Hopkins University Press.

Kaufman, Herbert. 1981. *The Administrative Behavior of Federal Bureau Chiefs*. Washington, D.C.: The Brookings Institution.

McGregor, Douglas. 1960. *The Human Side of Enterprise*. New York: McGraw-Hill.

Meier, Kenneth J. and Lael R. Keiser. 1996. "Public Administration as a Science of the Artificial: A Methodology for Prescription." *Public Administration Review* 56: 459-466.

Meier, Kenneth J., Jeff Gill and George Waller. 2000. "Optimal Performance vs. Risk Aversion: An Application of Substantively Weighted Least Squares," In Hal Rainey, Jeffrey L. Brudney and Laurence O'Toole, *Advancing Public Management: New Developments in Theory, Methods and Practice*. Washington, DC: Georgetown University Press, 77-95.

Meier, Kenneth J., Robert D. Wrinkle and J.L. Polinard. 1998a. "Representative Bureaucracy and Distributional Equity: Addressing the Hard Question." *Journal of Politics* 61: 1025-1039.

Meier, Kenneth J., Robert D. Wrinkle, and J.L. Polinard. 1998b. "Equity Versus Excellence in Organizations: An Application of Substantively Weighted Least Squares." *American Review of Public Administration* 29 (March), 5-18.

Mintzberg, Henry. 1979. *The Structuring of Organizations*. Englewood Cliffs: NJ: Prentice Hall.

Rainey, Hal. G. 1997. *Understanding and Managing Public Organizations*, 2nd ed. San Francisco: Jossey-Bass Publishers.

Romzek, Barbara and Melvin J. Dubnick. 1987. "Accountability in the Public Sector: Lessons from the Challenger Tragedy." *Public Administration Review*, vol. 47: 227-38.

Rong, Xue Lan and Linda Grant. 1992. "Ethnicity, Generation, and School Attainment of Asians, Hispanics, and Non-Hispanic Whites." *Sociological Quarterly* vol. 33: 625-35.

Simon, Herbert. 1946. "The Proverbs of Administration." *Public Administration Review*, 4. (no. 1): 16-30.

Stimson, James. 1985. "Regression in Time and Space: A Statistical Essay." *American Journal of Political Science* 29 (November): 914-947.

Smith, Kevin B. 1998. "The Full, and then Some, Prison Blues: Crime, Punishment and Deterrence." Paper presented at the annual meeting of the Midwest Political Science Association, Chicago, IL.

Urwick, Lydal F. 1956. "The Manager's Span of Control." *Harvard Business Review* (May-June), 39-47.

Waldo, Dwight. 1948. *The Administrative State*. New York: Ronald Press.

Waller, George. 1997. "For the Want of a Modem and a Comfortable Chair: School Facilities and State Education Performance." *American Journal of Political Science* 42 (April), 705-8.

Wamsley, Gary L., Charles T. Goodsell, John A. Rohr, Orion White, and James Wolf. 1992. "A Legitimate Role for Bureaucracy in Democratic Governance." In Larry B. Hill, ed. *The State of Public Bureaucracy*. Armonk, NY: M.E. Sharpe, Inc.

Wenglinsky, Harold. 1997. *How Educational Expenditures Improve Student Performance and How They Don't*. Princeton, NJ: Educational Testing Service.

Williamson, Oliver. 1990. *Organization Theory: From Chester Barnard to the Present and Beyond*. New York: Cambridge University Press.

Wolf, Patrick 1997. "Why Must We Reinvent the Federal Government? Putting Historical Developmental Claims to the Test." *Journal of Public Administration Research and Theory* 7 (July): 353-89.

Woodward, Joan. 1980. *Industrial Organization: Theory and Practice*, 2nd ed. New York: Oxford University Press.

Biographical Statements

Kenneth J. Meier is Charles Puryear Professor of Liberal Arts at Texas A&M University.

Formerly an editor of the *American Journal of Political Science*, his current research uses public organizations to test theories of organizations. His recent books include *The Politics of Fertility Control Policy* (Chatham House, 2000) with Deborah R. McFarlane, *What Works? New Approaches to the Analysis of Programs and Policy* (Westview 2000) with Jeff Gill, and *Reinventing the Presidency?* (Chatham House 2001) with George C. Edwards.

John Bohte is assistant professor of political science at Oakland University where he teaches in the MPA program. He is a student of budgeting and public organizations and has published in *Public Administration Review*, the *Journal of Politics*, and the *American Journal of Political Science*. He is working on projects related to organizational failures and on the impact of organization decisions on disadvantaged clientele.

Endnotes

1 . Division of labor is also likely to affect motivation. On the one hand, less division permits some job enrichment/enlargement which could be positively correlated with higher morale. On the other hand, less division might make the manager's job too difficult and actually reduce morale.

2 . The actual distribution might be anyone of a family of single peaked distributions. The weakness of the quadratic is that it is symmetrical. The advantage of the quadratic is that it is the most tractable and the easiest to estimate. The precise nature of the nonlinear curve is a subject for future research .

3 . This statement implies that optimal performance is relative to the organization and its function. An organization that collects trash, for example, will likely put more stress on efficiency rather than maximum production compared to a rape crisis center simply because the risk of failure is greater in the second organization. Highly redundant organizations are created when the costs of failure are high. This reflects a value judgement that efficiency is less important than the level of production.

4 . This factor becomes even more important in comparing organizations that perform different functions. Woodward (1980) finds that different production processes are associated with different structural forms (and thus spans of control).

5 . The selection of Texas Schools should not affect the results a great deal since Texas is a diverse state with a large number of districts. The patterns here should be relatively similar to those in other states with a large and diverse population.

6 . Texas school districts have improved dramatically on this test over the four year period; similar gains for Texas are apparent on the National Assessment of Educational Progress. The inclusion of individual year dummy variables is the traditional way to correct for serial correlation in panels such as this one with few years and many cross sections. The other statistical threat to panel analysis is heteroscedasticity (Stimson 1985). The panel contained a modest amount of heteroscedasticity but this problem was not severe and did not affect the results of the analysis.

7 . Spans of control can be fractional because districts report personnel figures in full time equivalents. In this case, a full time superintendent might be supervising a part time principal.

8 . The student teacher ratio will be significantly smaller than actual class sizes since an individual teacher will not teach every hour that students attend classes. Other teachers only interact with small numbers of distinct students (e.g., special education teachers). The current measure is an overall mean of the mean class size in districts so the range is for district means not actual class sizes. Texas by comparison is among the leaders in small class sizes.