ARTICLES

Modeling the Impact of Public Management: Implications of Structural Context

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ABSTRACT

Management theory suggests that management matters in public organizations—its impact is conditional on structure and often nonlinear in form. This article distills much of the theoretical work on management in public organizations into a formal, testable model. Management is presented as more crucial in networks than in more structured hierarchies. Management influences organization performance by 1) creating structure for the organization and thus system stability, 2) buffering the organization from environmental influences, and 3) exploiting opportunities in the environment. Decisions about which of these actions to take are at the core of strategic management. This article is the first step in a full model of managerial action in public organizations.

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How does public management matter for the performance of public programs? Considerable literature suggests myriad ways that the actions of managers seem to shape the outputs and outcomes of public policy. Still, for all the investment by researchers and practitioners in the assumption that management matters—and that, indeed, the requisites of good public management are reasonably well known, codifiable, and teachable—precious little careful analytical attention has been devoted to an explication of the basic questions.

How might one test the crucial proposition that public management matters? Even more fundamentally, how ought one to model explicitly the impact of public management on governmental performance? Surprisingly, virtually no attention has been paid to this significant question. This article constitutes a first step on the road to modeling the performance of public management—in particular, how one might conceive of the relationship between the management and certain other important variables, vis-à-vis performance.[1]

MODELS OF PUBLIC-MANAGERIAL IMPACT: A RATIONALE FOR TWO STEPS FORWARD

What kinds of models have been developed to indicate—or hypothesize—the influence of the management function on performance?

Our review reveals few efforts to specify a model for what might be called public-managerial influence on performance. The core journals show not a single explicit modeling effort, let alone careful testing, in recent years.

The closest work along these lines is the research of Wolf (especially 1993), who tests several competing explanations for public agency effectiveness and devotes attention to agency leadership, a concept related to but not identical with our use of management. His units of analysis are agencies (actually, distinct effectiveness evaluations of agencies) rather than programs (or their distinct performance assessments), our focus of analysis (see below).[2] Importantly, nonetheless, Wolf finds that agency leadership matters in explaining effectiveness.

Two aspects of Wolf's suggestive work limit its direct applicability for present purposes and suggest reasons to undertake the modeling effort, as we have. First, his approach, based upon ordinary least squares maximum likelihood estimation, assumes linearity (1993, 169). Exploration of alternative specifications was beyond Wolf's purview, but it is at the center of our interest. Second, as he notes, the analysis identifies but does not address issues of endogeneity (p. 176); in particular, we think, management may be in part determined by other elements considered as part of the explanation—such as structure. We argue that these kinds of interactions, which we treat ultimately as reciprocal, need also to be considered in modeling the impact of public management.

The logic we sketch here is designed to move our understanding of public management forward in two ways. First, we treat the need to consider nonlinear relationships seriously, since we believe such specifications are more accurate representations of the ideas and observations of researchers. Second, we consider the

[1]Hypothesizing the details of the internal production function of public management is not a task that is explicitly addressed here. For an intriguing effort along these lines, see the efforts by Ingraham and colleagues via the Government Performance Project. In that effort, the concept dealt with is "management capacity," rather than management (Ingraham and Kneedler 1999; Joyce and Ingraham 1998). Another approach is offered by Rainey and Steinbauer (1999), who sketch elements of a theory of "effective government organizations" (our units of analysis are government programs). They consider features of leadership and other possible elements of public management (like development of human resources) but do not model the relationship among any of these elements or between the elements and other variables. Still, they seek a theoretical explanation of effectiveness and draw from empirical evidence to sketch propositions for testing. Rainey and Steinbauer base their work on the "argument that such theories as we have need much more articulation" (p. 2, n. 2) and argue that not all hypothesized relationships should be expected to be linear. And, like we do, they attend to the "accounts of the most influential and innovative agency leaders" which "emphasize their ability to turn into opportunities the constraints that supposedly impede many executives, and otherwise to cope with the pressures and complexities of their roles" (p. 20). The present effort seeks, among other things, an explicit representation of this opportunities-cum-constraints core of the public management function. We shall argue that public management encompasses significantly more than the POSDCORB notions of yesteryear, and we use our sketch of some of public management's requisites to develop what we regard as a plausible model for its impact on performance.

[2]In this presentation we emphasize programs as units of analysis because we direct attention to the issue of public management in and through *networks*. In principle, the question of the unit of analysis is flexible. The appropriate unit depends in part on the research question being explored. And the modeling agenda sketched below should be applicable for organizations as well, including the task of exploring the impact of differing degrees of structural stability on performance across public organizations.

notion that management matters not only in terms of its direct impact on performance—alone and in combination with other variables—but also in different ways for different structural contexts.[3] This second step will require us to consider structure as a variable; we do so by representing the ways that hierarchies and networks can contribute to affecting performance. For this reason in particular, we model not agency performance but program performance.

As documented in considerable detail in the empirical literature on program implementation, many—and perhaps an increasing portion of—public programs operate through multiorganizational networks of linked agencies and other units (see Provan and Milward 1995; O'Toole 1997; Hall and O'Toole 1999; on the intergovernmental aspects, see Agranoff and McGuire 1998). Reasons are multiple, and they include governments' propensity to address "wicked" problems; continuing reliance on crosscutting mandates; popularity of public-private and other forms of partnerships; growing prominence of third-sector agencies as participants in program delivery; political and economic incentives to engage in complex contracting arrangements (Kettl 1993); and political and technical inducements to add participants during implementation to increase service delivery capacity and coopt influential actors into the coalition. Milward, Provan, and Else (1993) depict the results of such trends as a "hollow state" with a core of public management surrounded by an array of cross-institutional, primarily extragovernmental, ties. Despite the importance of these developments, their manifestations have varied considerably across governments, policy sectors, and programs. Accordingly, considerable variety remains in the institutional settings for public programs. For a number of programs, in fact, single agencies—or "lonely organizations" (Hjern and Porter 1981)—remain the relevant contexts (Montjoy and O'Toole 1979; Hall and O'Toole 1999).

The first point mentioned above can also be explained briefly. Nonlinear functions and interactive relationships involving public management seem implicitly to be at the heart of what many scholars assert or observe in assessing and explaining performance. Indeed, a persuasive literature documents excellence in public management and leadership (see, for instance, Ban 1995; Behn 1991; Cohen and Eimicke 1995; Doig and Hargrove 1987; Hargrove and Glidewell 1990; Holzer and Callahan 1998; Ricucci 1995; and Thompson and Jones 1994) as well as some of the special requisites of quality management of public programs in more complex, networked settings (Gage and Mandell 1990; Klijn 1996; O'Toole 1999; Provan and Milward 1995).

[3] In an elaboration of the core argument, furthermore (see item 3 in Notes on the Extension of the Model), we introduce the point that management may play a role in shaping the institutional context (structure) within which management itself operates.

Much of the logic used in this literature regarding the importance of the management function involves claims regarding nonlinear causality and/or interactive influence. Consider, for instance, the typical observation that skillful public managers find ways to make the most of resources available toward added value in performance. If this claim is to be tested carefully, an appropriate specification would require the use of an interaction term to represent the claim that neither resource levels alone, nor management independently, nor their summed impacts explains what these variables *plus their interrelation* can explain.

SOME CONCEPTS AND INITIAL ASSUMPTIONS

We begin with three core concepts: hierarchy, network, and management.

Hierarchies and networks are structural notions. The key dimension that distinguishes them is *formal authority to compel*. A hierarchy is a stable set of relations in which the positions are arrayed in a pattern of formally superior-subordinate authority links. While functioning hierarchies can vary greatly in structure, and while formal structure tells only part of the story, we simplify in the following exposition by treating hierarchy basically as a stabilizing or buffering arrangement. Formal authority to compel is related to stability, but stability can be considered a product of hierarchy, not a part of the latter's definition. Hierarchy, that is, can provide institutional support for the current bundle of routines, information systems, values, and other key elements that influence production—thus offering a crystallization of stable, cooperative effort, the operational status quo. In so doing, formal organization makes it possible to coordinate the efforts of many toward the achievement of common purpose without overwhelming the capacities of individual decision makers (Simon 1976). Still, stability may or may not be related to performance. Sometimes stability in the face of a performance-driven need to adapt or be flexible can hinder effectiveness. Either way, government agencies constitute structures built more or less around the hierarchical principle.

By considering hierarchy as a common form, we can focus on an additional structural dimension: the extent to which public programs are located fully within a single (hierarchical) agency or spread across parts of two or more organizations—within a single government, located across governments (such as intergovernmental grant programs), or encompassing links between public agencies and businesses or not-for-profit organizations. Such patterns of two or more units, in which not all the major components are encompassed within a single hierarchical array, are designated here as networks. Hierarchies, or parts of hierarchies, can be embedded in larger networked arrays. The nodes of networks can be occupied by individuals, organizations (including hierarchies), or parts of organizations. The network concept, too, encompasses a great variety of structural forms.

Networks themselves can vary greatly, of course—for instance, in terms of structural complexity. One aspect of complexity has to do with the sheer number of units connected in the multiorganizational array. This point is used later, as part of an explanation for how, and in what functional form, networks offer a more complex public-managerial environment than do hierarchies.

Our interest is in networks of a frequently occurring type: those that are not well established, but are in formation or flux—due either to the establishment of a relatively new program or a shift or perturbation in the environment in which an existing program has operated. Networks like these, quite common for public programs, represent a considerable degree of structural fluidity and therefore contain considerable uncertainty regarding relations, commitments, understandings, power, and information. While hierarchies frequently offer stability, these networks introduce instability and uncertainty (see Frederickson 1999), along with additional resources and capacity to act.

Networks of this type are quite common (O'Toole 1996; Hall and O'Toole 1999), but the literature of policy and politics contains evidence of highly stable networked relations as well. Two obvious instances are "iron triangles" of agency, interest groups, and legislative committee(s)—the very metaphor conveying anything but fluidity—and the interdependent patterns evident in corporatist political systems, where—in particular—business, labor, and government meet and bargain as coequals, with the objective of reaching common understandings that all are then obligated to execute during implementation.

The first example we treat as largely irrelevant for our purposes, inasmuch as it references a kind of policy-making coalition rather than a network responsible for delivering program performance. The second instance is more significant. It points to a contingent aspect of the assumption we make about networks and uncertainty. With the limited concertation mechanisms and lack of consensus-building and -enforcing institutions in the United States, we expect policy networks in this country to be structurally more open, shifting, and uncertain during implementation than comparable programs in less pluralistic regimes.[4]

[4]See also point 6 in the Notes on the Extension of the Model.

Of course, these interpretations of hierarchy and network are extreme. Accordingly, our models actually use a dimension of structural variation: from complete certainty in management relationships (designated hierarchy) to total structural fluidity and consequent uncertainty (network). Actual structural settings range somewhere between these two.

In treating pure hierarchies and networks as poles of a continuum related to buffering in the interests of stability, we ignore, for present purposes, markets as institutional options. We do so not because markets cannot be used to implement public policy, but because we are interested in the management function in hierarchies and networks. Pure markets, by definition, are not directly and overtly managed by anybody.[5] To be clear, we are particularly interested in the ways hierarchies and relatively flexible networks differ with respect to their abilities to provide stability for program operations. Our interest in program performance and public management's role in it directs our attention to the hierarchy-network dimension.

And what of public management? Management refers to the set of conscious efforts to concert actors and resources to carry out established collective purposes (O'Toole 1999). The management function includes, then, the tasks of motivating and coordinating actors toward performance consistent with established intent—among other things. Considering this function broadly requires us to represent both the stabilizing and the more opportunistic elements that can contribute to performance. Among these latter possibilities are management's efforts to leverage other inputs to performance, to take advantage of environmental disturbances that can provide chances for performance improvement, and to reshape the structural setting in which both management and operations function. By *public* management we reference the performance of these functions in and on public programs—programs established authoritatively by governments.

A consideration of the management function in both hierarchies and networks reminds one that the task itself does not presume a particular structural arrangement—that is, hierarchies and the accompanying formal authority managers possess in such settings. In more networked contexts, those who practice management may need to attempt to concert people and resources toward public purposes, with these elements distributed across agencies, governments, or sectors. To some analysts, the very term *management* may seem misleading. A cluster of terms has been introduced with the aim of conveying the more multilateral aspects of this function in interorganizational settings—terms like *fixing*,

[5]Markets in practice are often structured and thus may come to resemble networks. How structuring and rules affect markets is an important question of policy design, but one we will not discuss in this article.

multilateral brokerage, and *facilitation* (Bardach 1977; Mandell 1984; O'Toole 1983). In the present analysis, the term *management* is used to encompass the whole set of tasks related to this function, whether operating in hierarchies or networks. The key difference between management in these two settings is that in the latter, management challenges arise also from the uncertainties and complexities of the structurally ambiguous setting itself.

One additional point about public management bears mentioning: the function can be shared by actors occupying multiple positions in the institutional setting, not merely from a single locus. In hierarchies, of course, those attempting management are linked via an authority arrangement, and therefore it is possible in principle to align and coordinate the managerial moves from the top. In networks, however, efforts to manage the network—including in the interest of different and potentially competing conceptions of purpose—can come from a number of directions or a number of actors, with only limited potential to render these consistent. As one manager tries to shape the setting and its performance along one course of action, others—at other nodes in the system—can press or concert people and resources in another direction.

In the modeling below, we simplify on this point by treating management as an implicitly unitary set of efforts. In other words, we model here an overall network management. We do develop some distinct elements to the managerial function and consider them separately. But the models developed in this way do not address directly the possibility of independent and uncoordinated—even potentially contradictory, or strategically opposed—management efforts. We do not consider explicitly the ways in which this feature of management in networks complicates the management function itself, but we would argue that the point is related to the nature of the games that managers must play. Other managers in a network can force a given manager to play a given game with a move. In effect, then, management, as represented in our models, can be considered a more simplified vector sum of the full set of management efforts. The moves that make up the vector eventually need to be categorized and analyzed by both direction and homogeneity (consistency). This complication could be the subject of later modeling efforts.

BUILDING THE MODEL

Our objective in modeling management as it affects both hierarchies and networks is to generate some precise predictions that can be tested empirically if adequate data can be found. The model strategy that we will use is to start with simple concepts and gradually add complexity to the model. As we suggested earlier, the model should not be considered deductive from a few axioms but rather reflective of both current theory and research on management, networks, and hierarchies.

The Basic System

Organizations, programs, and delivery systems can be characterized as inertial.[6] Such institutional arrangements offer significant advantages, from the point of view of performance, as analysts at least since Max Weber have noted. Current outputs will be greatly influenced by past outputs. If one defines outputs as O, then the basic model of any organization can best be represented with an autoregressive equation:

$$[1]\ O_t = \beta_0 O_{t-1} + \varepsilon$$

where current performance (O_t) is the result of past performance (O_{t-1}) discounted by a rate of stability (β_0) and a series of shocks to the system (ε). We leave unexamined in this effort the nature of O: what outputs the program produces, how they are measured, and whether multiple dimensions should be considered.[7]

The rate of stability (which can be thought of as [1-δ] where δ is the rate of change) is generally constrained to a value between 0 and 1. As values approach one, the system becomes highly stable; as values approach zero, the system moves quickly toward entropy.[8] If values exceed 1.0, the system will increase without limit; that is, it will explode.[9]

Shocks to the system (ε) can come from a variety of forces in the environment. Legislatures or executives can change program priorities or increase or decrease funding or program scope; organizational rivals or coalition members can make decisions that directly or indirectly affect the organization; the economic or social environment can change. These shocks are exogenous, but there also may be endogenous shifts in the dominant coalition, as well as deliberate, planned shocks.[10] Efforts at organization development are familiar instances of the latter variety. In the sections below, we begin to differentiate some of the exogenous elements of ε and incorporate them into our modeling process.

Networks and Hierarchies

As we have explained, networks and hierarchies can be viewed as two poles of a continuum with hierarchies characterized

[6]We use the term *organization* or *program structure* as a general notion, not a synonym for hierarchy. The actual shape of such a structure in a given case is an empirical question. It is also likely that management itself can be considered to be an inertial system. We do not develop this last point in the current exposition.

[7]All these issues can be handled through appropriate conceptualization and methods. (For a treatment of both equity and excellence criteria in this regard, see Meier, Wrinkle, and Polinard 1999a.)

[8]By limiting the value of β_0, we are essentially setting up a servomechanism with negative feedback. When β_0 is larger than 1.0, positive feedback occurs.

[9]When positive feedback exists and program structures explode is an interesting question, but one that will not concern us here. Organizations or systems, therefore, can die in two distinctly different ways, with a bang (through positive feedback) or with a whimper (running down to entropy).

[10]Another possibility is that members of an organization might voluntarily seek networks to facilitate the jobs that they perform. Frederickson's (1999) study of local governments shows that networks often arise voluntarily among local government units that perform similar functions.

by authority relationships allowing individuals to demand compliance by others.[11] Networks, in contrast, typically lack authoritative links between nodes, and collective action requires negotiation and cooperation. Viewed in this way, a network can be oversimplified and considered as the absence of hierarchy.

Networks and hierarchies generate predictable impacts on the inertial system, once one notes that formal authority is associated with stability. If we think for a moment of the ideal typical hierarchy (H) and the ideal typical network (N), then in a hierarchy, the rate of stability approaches 1.0.

$$[2] \text{ if H, then } \beta_0 \rightarrow 1.0$$

Because hierarchies are by nature stable, we would not expect the stability coefficient to be much below 1.0. For a network, the rate of stability often moves away from 1.0 to some lesser value and in extreme cases to 0.

$$[3] \text{ if N, then } \beta_0 \rightarrow 0$$

Hierarchies according to this logic are more stable systems. Once set on a path, they will generally continue along the trajectory with little deviation barring a major shock to the system. Networks in contrast are loosely coupled; indeed, they often are characterized by a lack of institutionalization: members (often themselves portions of hierarchical organizations) may be only imperfectly aware of the structure of their own interdependence, links between nodes may be imperfectly formed and in flux, uncertainty is likely to be relatively high, and influences from outside the system are likely to penetrate more readily. (On this last point, see below.) Networks lose a great deal of energy simply in their day-to-day operation (or alternatively take a great deal of energy investment to maintain). Even without shocks to a network, the network will eventually run down unless additional efforts are made to maintain and revitalize the network. Networks, in short, need management.[12]

Defining networks and hierarchies as poles of a continuum permits us to conceptualize a network as the absence of hierarchy, and hierarchy as the epitome of institutionalized action. If we had a good measure of hierarchy (H) and normalized it to approach 1.0 at the highest levels of hierarchy and to approach 0 at the pure network level, then equations [2] and [3] can be combined with equation [1] for a more general view of organizational inertia. Because the rate of stability is *in part* a function of the hierarchy of the system:

[11]Compliance is, of course, a matter of degree. The Barnard (1938)-Simon (1976) view of authority is such that compliance can never be assumed.

[12]Strictly speaking, stability can be a product of additional influences beyond either hierarchy or network management. See Notes on the Extension of the Model.

$$[4]\ \beta_0 = f(H)$$

we can partition the rate of stability into hierarchy (H) and other factors (β_1) including the functional adjustment to hierarchy, thus producing the more general equation [5]:

$$[5]\ O_t = \beta_1 H O_{t-1} + \varepsilon_t$$

This equation shows that an increase in hierarchy results in a more inertial or stable program structure. In a pure hierarchy with $H = 1$, we would expect $\beta_1 H$ to be very close to 1.0. The bulk of the variation in $\beta_{11} H$, therefore, must be contained in the hierarchy term unless we permit β_1 to have values substantially less than 1.

Shocks and Reaction to Shocks

A major difference between networks and hierarchies is in how they are affected by external shocks from the environment.[13] The literature on innovation and change in organizations suggests that hierarchical systems are not prone to fast responses to environmental changes. Hierarchical systems tend to buffer shocks with a fair degree of effectiveness. Networks in contrast are more open so that buffering is less effective.

Shocks that get through the organization's buffering mechanism, however, have different impacts on hierarchies and networks. Although shocks are less likely to pass through the hierarchy's buffering, when they do reach the organization they can have a dramatic impact. Returning to equation [1] for a hierarchy (and thus $\beta_0 \rightarrow 1$):

$$[1]\ O_t = \beta_0 O_{t-1} + \varepsilon$$

let us divide the ε into some shock X_t that gets through the organization's buffering system with an initial impact of β_2 and a random component ε_t.

$$[6]\ O_t = \beta_0 O_{t-1} + \beta_2 X_t + \varepsilon_t$$

In this case, a one unit change in X_t results in a β_2 change in O_t all other things being equal. However, this is the impact of X_t on O for time t only. Because X_t has increased the value of O_t, then in year t+1, this larger value of O_t also influences the size of O_{t+1}. Because O_t is β_2 larger as the result of X_t, O_{t+1} will be $\beta_2\beta_0$ larger as the result of the impact of X_t the previous year. Such impacts continue to reverberate through the system in future years gradually becoming smaller (forming what is known as a geometrically

[13]Our definition of environment is more encompassing than that of Lynn, Heinrich, and Hill (1999, 27-28). It includes both the environmental forces they note and the clientele factors. We prefer the term *target population* rather than *clientele*, but consider target population to be part of the program's environment.

distributed lag; see Hamilton 1994) but still cumulating into a relatively large impact.

The overall impact (I) of a one-unit change in X can be determined by the following formula where the terms are defined as above:

$$[7]\ I = \beta_2/(1-\beta_0)$$

A relatively small shock that gets through the organization's buffering system, as a result, can have a major, long-term influence on the organization depending on the size of the coefficient of stability. As an illustration, suppose the initial year impact (β_2) had a value of 1. If the coefficient of stability is .99 (quite likely in a strongly hierarchical organization), then the total impact is 100 or (100=1/(1-.99). If the coefficient of stability is only .7, the total impact of X in this case falls all the way to 3.33. Shocks can have a variety of functional forms and both short and long run impacts; with an adequate data set all these impacts can be estimated.[14] The important point in our discussion, however, is that relatively small changes in a system can have major, long-run implications simply because the program structures are inertial systems.

Buffering

Organizations establish units or processes to buffer shocks from the environment. In a network the boundary between the structure and its environment blurs. Buffering in networks is more difficult to accomplish simply because the nature of networks creates additional interdependencies that cannot be isolated from the technical core of the system.

We think that the most appropriate way to model the buffering process in a program structure is simply to use the reciprocal of hierarchy as the factor that discounts any environmental shocks:

$$[8]\ O_t = \beta_1 HO_{t-1} + \beta_2 X_t(1/H) + \varepsilon_t$$

In this way, an increase in hierarchy acts directly on the exogenous shock to limit its impact on the organization. Any shock that gets through the buffering process of hierarchy, however, can have a substantial, long-run impact on the organization. For a network, in contrast, buffering is relatively weak, so shocks easily reach the organization. The impact of these shocks, however, is far less—simply because the networks are more loosely coupled.

[14]The techniques of ARIMA modeling or combining ARIMA modeling with traditional time series can do this. For an illustration, see Wood and Waterman (1994).

Management: A Tangent and a Reformulation

What we shall call the normal theory of management[15] is simply that it is one additional factor that affects the performance of a program structure. The normal theory would require modifying equation [6] to have management (M) combine with other factors in a direct, linear manner:

$$[9]\ O_t = \beta_0 O_{t-1} + \beta_2 X_t + \beta_3 M + \varepsilon_t$$

If X_t stands for a matrix of all other factors that affect the system (thus are viewed as shocks) such as resources, constraints, external demands, and so forth, then the test for whether management matters in a program structure is whether or not the coefficient for management (β_3) is significantly greater than zero. Management can still have a substantial impact on the system with a large coefficient or by operating through a large coefficient of stability over a long period of time.

A more elaborate theory of management would eliminate the linear aspect and permit management to interact with each of the other terms in the equation as in equation [10], which represents an interactive model of management:

$$[10]\ O_t = \beta_0 O_{t-1} + \beta_2 X_t + \beta_3 M + \beta_4 M O_{t-1} + \beta_5 M X_t + \varepsilon_t$$

In this case, the test of whether management had a nonlinear impact or not would be a joint test (either f-test or log likelihood ratio test that both β_4 and β_5 are equal to zero). Equation [9] can be viewed as the same as equation [10] if β_4 and β_5 are restricted to equal zero.[16]

Equation [10] is clearly a nonlinear specification of the role of management. An alternate view of nonlinear relationships would be to simply estimate the entire equation as a set of non-linear relationships as in equation [11]

$$[11]\ O_t = \beta_0 O_{t-1}^{\beta_1} X_t^{\beta_2} M^{\beta_3} + \varepsilon_t$$

Although this equation at times creates some difficulties depending on the assumptions that are made about the error term, it can be estimated by either taking the log of both sides of the equation and then estimating via ordinary least squares or by using nonlinear least squares to estimate the equation directly.

The difficulty with each of these conceptualizations of management is that they do not take into account the structure in

[15]Normal not in the sense that this perspective matches the typical observations of scholars and practitioners, but normal signifying the basic approach under the simplest assumption possible: that management is just another input to production.

[16]In the language of modeling, equation [10] is the unrestricted equation, since all coefficients are allowed to take on any value; equation [9] is the restricted equation, since some coefficients must be equal to zero.

which the program operates. O'Toole (1999; see also 1996) argues that management becomes more important in a network situation than in a hierarchy. In a network, not only do managers have to spend more time on organizational maintenance (because the organization is less inertial) but they also have to spend more time interacting with the environment because the organization is more open to environmental influences. None of the above specifications incorporates the greater importance of management in networks as compared to hierarchies.

One crucial task of management is to maintain the structure: to frame the goals, to set the incentives, and to negotiate the contributions from members and from those with whom the system interacts (Barnard 1938; Simon 1976). The system maintenance aspect of management, we think, can best be modeled as in equation [12] where management (M) supplements hierarchy (H) in the inertial (read structural) portion of the model:[17]

$$[12]\ O_t = \beta_1(H+M)O_{t-1} + \beta_2 X + \varepsilon_t$$

In this equation, as hierarchy increases, the role of management becomes less necessary since hierarchy by itself generates a relatively stable system. As hierarchy declines, however, this system tends toward entropy unless management increases its impact on maintaining the structure.

Maintenance is only one function of management;[18] let us term this function M_1. An equally important function of management is to guide how the system interacts with its environment, in modeling terms, how it deals with the shocks to the system. We will designate this second aspect of management as M_2.[19] We use different subscripts to allow for the possibility that these two functions can vary independently of each other yet still have something in common that we would consider management.

M_2 can be modeled, but only if the management strategy of the system is known relative to the environment. Management can either adopt a strategy of buffering the environment or actively seek to exploit the environment for the benefit of the program system.[20] If the decision is to buffer the system from the environment, this management strategy can be modeled as follows where management interacts with hierarchy in the buffering processes:

$$[13]\ O_t = \beta_1(H+M_1)O_{t-1} + \beta_2 X_t(1/HM_2) + \varepsilon_t$$

In this equation, management dampens the impact of environmental shocks and works with hierarchy in this process.

[17] The structural portion of our model should be considered analogous to Lynn et al. (1999) structures, or what they call "S."

[18] This approach, involving a partitioning of public management into distinct components, may seem reminiscent of Moore's familiar notion of managing upward, downward, and outward (1995). There are similarities between the two conceptualizations, but the sets of functions/directions are not identical.

[19] Our conception of M_2 is similar to Frederickson's (1999) concept of administrative conjunction. We later divide this aspect of management into two parts so that we can incorporate the concept of risk into management behavior.

[20] Buffering is perhaps more common, but there are public- and private-sector cases where top management exploits the environment to either influence policy or generate long run support. Selznick's (1949) study of the TVA is one example; another is J. Edgar Hoover's use of publicity and focus on specific crimes to enhance the FBI (Poveda 1990).

Management that seeks to exploit the environment will not try to buffer environmental influences but rather will attempt to magnify some of those influences so that they have a major impact on the program structure (and quite likely other systems that interact with the program). Exploiting the environment means operating in opposition to the dampening effect of hierarchy as in the following model:

$$[14]\ O_t = \beta_1(H+M_1)O_{t-1} + \beta_2 X_t(M_2/H) + \varepsilon_t$$

Equations [13] and [14] can be combined into a more general model of the system's action by defining a new variable M_3 as the portion of environmental management that will be devoted to exploiting the environment and by assuming that environmental actions that do not attempt to exploit the environment will be used to buffer that environment (designated as M_4). We then get equation [15] that combines buffering and exploiting the environment in the same model:

$$[15]\ O_t = \beta_1(H+M_1)O_{t-1} + \beta_2 X_t(M_3/HM_4) + \varepsilon_t$$

Rearranging the terms of equation [15], we get

$$[16]\ O_t = \beta_1(H+M_1)O_{t-1} + \beta_2(X_t/H)(M_3/M_4) + \varepsilon_t$$

Equation [16], representing a general model of public management, is useful because the ratio of M_3 to M_4 describes how risk seeking the program system is. As the amount of effort devoted to exploiting the environment increases, this ratio increases. As the system devotes greater efforts to buffering, the structure becomes more risk averse and the size of this ratio decreases.[21]

With regard to equation [16] it might be useful to think of the three forms of management summing up to some constant value. Organizations must decide how to allocate their managerial resources (M) to three tasks: M_1, or stabilizing the internal operations of the system; M_3, or exploiting shocks in the environment; and M_4, or protecting the organization from environmental shocks. Because hierarchies are more stable and have greater buffering capacities, they can operate with fewer managerial resources than a network can and still maintain an equal level of performance. A hierarchy that has a level of managerial resources equal to that available in a network will also be able to devote more of those resources to dealing with the environment than can the network.

[21]An illustration of the use of organizations' preferences for risk in the budgeting process can be found in Krause (1998).

NOTES ON THE EXTENSION OF THE MODEL

The presentation of different versions of the model in the preceding section constitutes the basic account. Brief mention also can be made of a set of additional observations and partial arguments that can be useful in the further development of this logic.

A preliminary point can be made in this regard. The overall argument we present here has emphasized the distinction between hierarchy and network for assessing public management's impact on performance. We have framed the logic in this fashion because we believe the emphasis is apropos, plausible, and salient. At the same time, the crux of the argument should hold more generally beyond the hierarchy-network distinction, since the fundamental issue is not hierarchies and networks per se, but structural stability-instability. With an appropriate measure of stability, therefore, the approach could be applied to programs of all sorts—and to units of analysis like organizations as well as program structures.

Beyond pointing to this implication, we can suggest an additional six routes for further exploration of the model.

Environmental Complexity

The general model (equation [15]) incorporates the entire environment of the organization through the X-term. This X-term should be thought of as a matrix of influences. Networks and hierarchies clearly differ in the size of the environmental matrices they have, with the network environment having more elements as shown in [17] where the subscripts designate elements in the environment of (n)etworks and (h)ierarchies.

$$[17]\ \Sigma X_n > \Sigma X_h$$

This generates a far more complex environment for the network than for the hierarchy.

Hierarchy as a Limit on Relationships

Hierarchy may be viewed as a means of limiting the number of relationships that an organization must incorporate. If there are n equal actors that must deal with each other in a network, then the total number of relationships is n(n-1). If n actors are placed in a hierarchy with one actor designated as the superior, the total number of relationships is reduced to n-1. If the n-1 subordinates are divided into two organizational levels, the number of relationships drops to (n-1)/2 for the organization head while remaining at n-1 for the entire organization.

In small groups, the problems of a network versus a hierarchy are less problematic than in a larger group, simply because the maximum number of relationships in a network increases as a square of the number of members. In a hierarchy, the number of relationships increases only in proportion to the number of members if no additional levels are created for the organization. With additional levels, the number of relationships for any individual drops dramatically in comparison to that of an unconstrained network.

The different functional forms for how relationships increase with an increase in actors in hierarchies and networks provide a relationship-based metric, or at least an explanation, for the differential increases in complexity of networks vis-à-vis hierarchies as actors are added to the system. Points 1 and 2 in combination suggest that networks experience more complex environments and larger networks also can possess much more internal complexity than do hierarchies of similar size.

Still, few networks operate without constraint. That is, many of the possible relationships between members will not come into play because the interdependencies are small or remote. Program authority can be used to reduce the number of participants or alternatively can vest participation rights in more individuals. Because relationships often are not required, the number might decline simply because some members do not think the network is salient enough for them to invest much time in developing relationships.

The Relationship Between Hierarchy and Management

Since at least Simon's classic formulation (1976), it has been understood that managers operate within the constraints of structure while they also craft those constraints over the longer haul so as to shape the possibilities for performance in the future (for a more detailed treatment, see O'Toole 1999). While such managerial tasks as shaping structures and building cultures are frequently discussed in the literature of public management,[22] how to deal with such tasks in systematic empirical investigations is a topic that is sometimes acknowledged (as in Wolf 1993; Ingraham and Kneedler 1999) but has thus far eluded formal treatment.

Our general theory treats hierarchy and management as substitutes for each other, both in terms of organizational stability and

[22]Consider, for instance, the long line of classic cases stemming from such instances as Hoover at the FBI, Lilienthal with the TVA, Moses and Triborough, and Webb at the helm of NASA.

in the buffering process. Over time, management can invest in creating greater structure—that is, in increasing the hierarchy of the organization. Thus, even though an absence of hierarchy creates a need for greater management, effective management can build a capital stock of hierarchy that can reduce the need for management in the future. The relationship between hierarchy and management, therefore, is dynamic over time as represented by equation [18].

$$[18]\ H_t \rightarrow M_t \rightarrow H_{t+1}$$

The interrelationships between management and hierarchy can be empirically separated with a variety of time series techniques such as vector autoregression or an instrumental variables approach within a normal time series model.

Hierarchies, Networks, and Variance

Inherent in our discussion of networks is the idea that the results of any process in a network are likely to be subject to much greater variation or greater uncertainty (see Frederickson 1999) than they will in a hierarchy. This variance results from several factors. First, the coefficient of stability is higher for hierarchies so activities will occur in a narrower range than they will for networks. Second, networks are more loosely coupled than are hierarchies, and thus the ramifications of any shock or any action of another actor is less predictable. Third, the environment of networks is more complex than that of hierarchies and, therefore, more variables could influence what occurs in a network.

These factors suggest that modeling the variances of systems could provide some leverage in understanding the difference between hierarchies and networks. We employ the h and n subscripts again and first note that any estimate of a parameter β will have a standard error (se). Even if β_h equals β_n, se_n should be significantly greater than se_h. Techniques are available to model such variance (Alvarez and Brehm 1995) either as a characteristic of a parameter estimate or as it changes over time (through techniques used to assess heteroscedasticity).

Trust

Because relationships in a network are without hierarchy but have interdependencies, relationships with other actors can be viewed as a series of games with specific characteristics (O'Toole 1993 and 1996). Although relationships may or may not be permanent in a network, the games among players tend to be repeat games either over time, across program elements, or across jurisdictions. Repeat games take on some important characteristics, the most prominent of which is that each player builds a set of expectations based on past relationships with a player.

These long-term relationships can build trust among the paticipants that will generate cooperative behavior. Network relationships, therefore, are likely to be best modeled in Bayesian terms, with each actor having prior probabilities about the actions other actors are likely to take. With each iteration of the game, consistent behavior will decrease the uncertainty of the game (or that portion of uncertainty that is generated by the other actors as opposed to that generated by exogenous factors). With cooperation (or alternatively by driving out cooperation), the equilibrium is likely to be different from the equilibrium of a similarly structured game that is played only once.

System Stability

Although hierarchies are more stable than networks, all other things being equal, factors other than hierarchy can induce stability in a system. In several policy systems in the United States, stability is generated by shared goals (see Mintzberg 1979 on alternative coordinating methods). In agricultural research or farm credit policy (see Meier, Wrinkle, and Polinard 1999b) the actors of the policy network share a set of long-standing policy goals. The consensus on these goals reduces the need for hierarchical coordination. In agricultural credit, the existence of a clear bottom line for the policy permits agency adjustments to the policy with little guidance from hierarchical superiors (see also Khademian 1995; Kaufman 1960). Shared goals can also result from common professional training (see Frederickson 1999; Mintzberg 1979).

Mutually reinforcing goals also can be used to generate stability in the absence of hierarchy. Policy subsystems in the United States composed of interest groups, bureaus, and relevant congressional committees are known to arrive at a set of agreements that allows each actor to achieve its goals by facilitating the goal achievement of the other actors.

System stability also can be achieved by metaprocesses. Corporatist political systems, referenced earlier, provide an example. They solve political problems by bringing all relevant interests together and forcing them to work out an agreement that is acceptable to all. The credibility that such policies will be implemented prevents strategic behavior and generates an expectation that all parties to the agreement will live by it.

Ostrom (1990) has shown, as well, that nonhierarchical self-governing systems for managing common-pool resources can be highly stable over long periods once appropriate community-generated norms have been created and (meta)processes involving communication, monitoring, and sanctioning are underway.

IMPLICATIONS

Our effort at modeling the management dimension of programs has several implications for the study of public management. First, we have demonstrated that it is possible to go beyond ambiguous prescriptions and provide precise specifications that are consistent with the observations of public management scholars. The models presented here, however, should be viewed as hypotheses. *We could well be wrong, but we care less about being correct in the details than we care about catalyzing work along these lines.* Progress can be expected only through precise and ultimately falsifiable predictions about managing public programs. Only then can the interplay of empirical research interact with theory to provide a cumulative body of knowledge.

Management, in our view, is crucial but also contingent. We have emphasized how management is influenced by structure (networks versus hierarchies); future work is likely to specify other contingencies. We also argue that structural contingencies are shaped in part by prior management activities. Management in our models has different functions—buffering, exploiting the environment, maintaining a stable system, establishing structural forms, and so forth. The model is the first step in a more explicit unpacking of the sometimes ephemeral management notion.

The model also offers a concrete rationale for why network settings are less buffered. By presenting management in its structural context in terms of relationships, we introduce a way to understand why many networks are more complicated environments for performance and for management. The n(n-1) term suggests a geometric, not merely arithmetic, aspect to the impact of size on network complexity. Management, however, is not the whole story in shaping network stabilizations. Shared values, common routines, and standardized learning are other methods of network stabilization. Some of these other methods may be the result of strategic management choice, or they may simply evolve from repeated interactions with network participants.

Our analysis sets the environment to the game-playing parts of public management. We do not and cannot offer specific predictions about managerial moves/behavior/choices. In fact, the analysis here simplifies on a critical point by assuming that management is a function performed via a single actor or office. Yet there is good reason to question this assumption and note that multiple managers may be working at cross purposes in a network. While these can be conceptualized as a vector sum for purposes of the model, in the abstract sense, the complication creates a possibly inherent measurement problem. The theoretical argument here is that management is likely to be more important in more-networked settings, but the possibility of multiple points of management means we may not be able to demonstrate the point empirically (O'Toole 1999). Or, to be more precise, demonstrating it would require identifying the managerial points/offices of leverage, developing sensible measures of the differential emphasis on the different forms of management (the different types of M—or at least two of the three—in equation [16]), assuming constant total M while value of H is steady (then the third M can be derived) sketched in the modeling effort, and then compiling a vector sum, in time series, for testing.

Finally, a major issue can be noted. In this modeling effort, we have placed a good deal of stress on the importance of an appropriate data set or sets to test the ideas. The data demands, in fact, might seem to be unrealistic. While perfect data would be ideal, our more realistic hope is that the model can be segmented and approached in parts for testing. The several notes on the extension of the model render nearly explicit what we hope is clear at this point: This perspective suggests the initiation of a research *agenda* rather than the sketch of a one-shot research design.

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