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ADOPTION AND ABANDONMENT OF MATRIX MANAGEMENT PROGRAMS: EFFECTS OF ORGANIZATIONAL CHARACTERISTICS AND INTERORGANIZATIONAL NETWORKS

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Organizational design theorists argue that organizations adopt matrix (departmentalized) structures for technical reasons, to solve problems of internal coordination and information processing. Research on interorganizational networks suggests that organizations adopt new structures because of mimetic forces and normative pressures. We examined the effects of both sets of factors on the adoption of matrix management in a group of hospitals. Multivariate analyses revealed that matrix adoption is influenced not only by task diversity, but also by sociometric location, the dissemination of information, and the cumulative force of adoption in interorganizational networks. Such variables exert little influence on decisions to abandon matrix programs, however.

Matrix management, defined as laying one or more new forms of departmentalization on top of an existing form (Burns, 1989: 350), is frequently described in the organizational literature but rarely studied empirically. Two studies by Burns (1982, 1989) documented the prevalence of one particular matrix program over time and analyzed its structural elements. These studies provided support for some long-held propositions regarding matrix management but challenged others. For example, Burns (1989) verified the existence of a hierarchical ordering of matrix elements along the lines of a Guttman scale, as Galbraith (1972, 1973) proposed. Simple matrix programs develop liaison roles, similar to the role of a project manager, to provide coordination across functional departments. More complex matrix programs build upon simpler models by sequentially adding a matrix director, a matrix department, and a horizontal hierarchy with authority rivaling the vertical-functional hierarchy existing in an organization. Contrary to Kolodny's (1979) assertion, however, Burns found that matrix programs are not transi-

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tional, but are retained over time. Moreover, contrary to Davis and Lawrence's (1977) assertion, matrix programs remain structurally stable and do not evolve over time.

This study extended the cited research by examining the determinants of matrix adoption and abandonment. The topic is important for several reasons. First, implementing a matrix structure constitutes a shift from vertical-functional authority toward a hybrid, function-by-project, organization. The study thus sought to explain transitions from traditional to hybrid organizational forms (cf. Fligstein, 1985; Wholey & Burns, 1993). Second, matrix structures are team-oriented arrangements that promote coordinated, multidisciplinary activity across functional areas, broad participation in decisions, and the sharing of knowledge. Such structures were initially developed to aid technological innovation; they are typically found in rapidly changing organizations (Kanter, 1983, 1988) and resemble the team arrangements used in total quality management programs. Research on the adoption of matrix management may improve understanding of factors favoring structures that promote product innovation and quality management. Third, decisions to adopt and abandon a stable structure such as matrix management determine the prevalence of that structure in an organizational population. The observed stability of matrix programs suggests that adoption and abandonment are key events in their history. Although previous research suggests various rationales for the presence of matrices, there is little evidence other than that from case studies on influences associated with their adoption and termination; indeed, few studies have addressed the abandonment of any structural innovation (Kimberly, 1981; Knoke [1982] is an exception).

In this article, we examine two complementary explanations for the adoption and abandonment of new organizational structures like matrices. The first explanation is based in information-processing theory, the second, in network and institutional theories of innovation. Researchers studying organizational design have argued that organizations adopt matrix programs for technical reasons, to cope with the information-processing demands of large, complex organizations (Davis & Lawrence, 1977; Galbraith, 1972). These demands may be fostered by organizational domains with diverse products, clients, and services (Thompson, 1967) and by horizontal differentiation—functions, departments, and specialties (Galbraith, 1972). Both of these dimensions define "organizational diversity." Research on design has suggested that highly diverse organizations adopt a broad range of matrix elements, including liaison role, matrix director, and matrix department, to coordinate decision making. The empirical evidence for this suggestion is mixed, however. Although some researchers have reported a positive association between diversity and the range of matrix elements present (Lawrence & Lorsch, 1967; Van de Ven, Delbecq, & Koenig, 1976), others have reported no significant relationship (Burns, 1989). One possible interpretation of the mixed findings is that diversity may be a sufficient condition for adoption, but unnecessary. Organizations may adopt matrix management for nontechnical reasons unrelated to information-processing demands. One such reason is an organization's sociometric position in interorganizational networks, or its position in a pattern of social relations serving as situational constraints on organizational behavior (Coleman, Katz, & Menzel, 1966; Galaskiewicz, 1985; Granovetter, 1985). Normative pressures exerted by dominant organizations within those networks are another reason for matrix adoption (Becker, 1970; Burt, 1981; Rowan, 1982). Prior research has found both technical and nontechnical influences on the adoption of administrative innovations (Kimberly, 1978; Kimberly & Evanisko, 1981; Meyer & Rowan, 1977; Scott, 1990); however, technical factors may be more important among organizations adopting innovations earlier than others in a given network, and nontechnical factors may be more important among later adopters (Rowan, 1982; Tolbert & Zucker, 1983).[1]

The study investigated the impact of organizational and network factors on the adoption of matrix management in a panel of organizations over a 17-year period. Prior studies of the spread of administrative structures have been limited to a small number of organizational and network measures for which data were available over time (e.g., organization size, number of prior adopters). We specified a number of new organizational and network variables that more fully capture important institutional effects. We also examined the ability of the same organizational and network variables to explain decisions to abandon matrix programs. We could thus explore whether program adoption and abandonment processes are symmetrical or based on different factors.

TECHNICAL AND NONTECHNICAL BASES OF MATRIX MANAGEMENT IN HOSPITALS

The diffusion in the hospital industry of a specific matrix management program, "unit management," was studied. Unit management is a system of administration developed in a hospital's clinical areas to promote the coordination and integration of functional department personnel.[2] As Burns (1989) showed, unit management programs exhibit the series of lateral coordinative mechanisms Lawrence and Lorsch (1967) and Galbraith (1972, 1973) described. At a minimum, these programs place administrators in inpatient units to act as liaisons and coordinators of all functional department employees working in the units, such as head and staff nurses, housekeepers, dietary aides, technicians, and social workers. The unit managers

[1] The literatures on organizational design and interorganizational networks thus provide complementary rather than competing explanations of matrix adoption. Regardless of whether the forces precipitating adoption are technical or nontechnical, an organization's response constitutes rational action (cf. Burt, 1982; Granovetter, 1985). Adaptation to technical factors constitutes an efficient response to economic problems, and adjustment to nontechnical factors aids the pursuit of noneconomic goals such as sociability, approval, status, and power (Granovetter, 1985: 506).

[2] An informal survey of Arizona television stations conducted by the first author revealed that unit managers are also used in the broadcasting and motion picture industries.

invariably have decision-making responsibility for several administrative and policy areas, including developing administrative procedures, preparing budgets, and designing unit plans and programs. More complex programs feature a unit management director and department and a separate administrative hierarchy with authority to supervise the functional department's personnel. In such a system, the unit manager is a matrix boss and the head nurse becomes a two-boss manager, responsible to both the unit manager and the nursing supervisor. Collectively, unit managers constitute a horizontal overlay of project managers, coordinating all functional personnel on a given clinical area such as surgery, medicine, or pediatrics.

Unit management has continuing relevance for hospital design. Research indicates that unit management programs are associated with the development of divisional structures in hospitals (Burns, 1985). Hospitals are establishing such structures at present to adapt to global reimbursement and budgeting methodologies, such as the diagnosis-related groups imposed by the federal government (Heyssel, Gaintner, Kues, Jones, & Lipstein, 1984). Moreover, matrix programs and divisional structures are likely to remain useful coordinative devices in hospitals despite recent advances in vertical information systems. Such systems, rudimentary or nonexistent in hospitals during our study period, have increased hospitals' information-processing capacity; however, the improvements have centered on speeding the flow of clinical information for billing purposes and on integrating clinical and financial data systems for reimbursement purposes. There is no indication that these advances have lowered personnel coordination requirements by either reducing staffing levels or improving scheduling between departments functioning in the patient units. For example, a recent survey of 2,625 community hospitals with 100 or more beds found that between 1986 and 1988 only 6.1 percent had implemented patient care information systems, but 2.0 percent had installed bedside terminal systems in inpatient units (Gardner, 1989, 1990). Indeed, the recent advances in joint clinical-financial information systems may promote the spread of matrix and divisional structures by bringing together unit managers and clinical area physicians in decision-making teams.

Between 1961 and 1978, roughly one-quarter of all large teaching hospitals implemented unit management (Burns, 1982). The hospital administration literature suggests that unit management was adopted to solve specific managerial problems associated with growing diversity and size (cf. Johnson & Tingey, 1976; Kovner, 1972; Starkweather, 1970). During the 1950s and 1960s, hospital size, patient volume, and service intensity increased to meet new demand generated by the expansion of health insurance. Head nurses, who had held the de facto responsibility for coordinating and supervising all personnel from different departments in clinical areas (Stevens, 1989), found that these growing administrative responsibilities restricted the performance of their clinical duties. Hospitals thus sought new methods to coordinate patient care and manage their expanding human and technical resources. Unit management was implemented to inject full-time managerial expertise at the patient unit level, to improve the utilization of nursing personnel, and to better integrate personnel and functions in clinical areas. The innovation was thus intended to help managers increase coordination and control in the face of an increasingly complex, intensive technology.

Other evidence suggests that nontechnical considerations were also responsible for the implementation of unit management. Mimetic forces have been found to play a major role in the spread of innovations across hospitals (Luft, Robinson, Garnick, Maerki, & McPhee, 1986; Russell, 1979; Stevens, 1989). The pattern of unit management adoption between 1961 and 1978 likewise suggests that a fad was sweeping through the hospital industry: the program adoption rate rose quickly during the 1960s and then dropped off and stabilized during the 1970s (Burns, 1982: 54 [Table 7]). The professional media may have abetted this contagion. During the 1960s, health administration journals published a flurry of articles on unit management (Burns, 1982: 43 [Table 1]) strongly endorsing it and touting its technical advantages (without presenting much supporting evidence). Despite the later decline in adoptions, the vast majority of programs continued to operate, and program descriptions continued to be published (Burns, 1982: 43 [Table 1]), suggesting that unit management had become well accepted by the 1970s.

Normative forces may also have been present. Local and regional networks that might transmit normative influences among hospitals mushroomed between 1940 and 1970 (Stevens, 1989: 200-283).[3] Community hospital councils and planning agencies formed in response to calls by the U.S. Public Health Service to implement area planning for hospital development under the so-called Hill-Burton program. At both the local and regional levels, networks of major medical centers and community hospitals formed to promote the diffusion of scientific information and technological advances. Those networks were fostered by such heavy federal investment in biomedical research as the National Institutes of Health and the Regional Medical Program Act. Federal research grants increased the scientific and technological resources of major medical centers, augmented their professional stature, and encouraged the hierarchical dissemination of information and services from the center of the hospital industry to its periphery.

THEORETICAL ISSUES

Theory of Organizational Information Processing

Organizational information processing theory seeks to explain organizational behavior in terms of information that must be gathered, interpreted, synthesized, and coordinated in the context of decision making (Knight &

[3] Within the past two decades, multihospital systems have emerged as a new source of network relations that foster the diffusion of information about new programs (McKinney, Kaluzny, & Zuckerman, 1991). Such networks were not widespread during the period studied here, however.

McDaniel, 1979; Smith, Grimm, Gannon, & Chen, 1991; Tushman & Nadler, 1978). Early theoretical formulations (Galbraith, 1972; Thompson, 1967) used the concept of "bounded rationality" to explain the specific strategies and structures organizations employ to manage these flows. According to this perspective, organizations are open systems and hence subject to uncertainty, and they have limited means with which to gather and process information. They therefore seek to develop strategies and structures that enable them to match their information-processing capacity with the information-processing requirements of their tasks (Daft & Lengel, 1984; Galbraith, 1972). Subsequent research has examined organizational characteristics, including complexity, slack resources, and external orientation, that facilitate or impede the development of this capacity (e.g., Smith et al., 1991; Van de Ven et al., 1976).

We employed theory and research on organizational information processing to develop technical explanations for the adoption of matrix management. One explanation focuses on the diversity and scale of organizational activities that require a matrix structure to ensure adequate coordination. Another explanation examines the level of organizational resources and capabilities that permits the consideration of new programs such as matrix management.

Organizational diversity and scale. Information-processing requirements are influenced by organizational diversity, measured as the breadth of a firm's domain and horizontal differentiation (Chandler, 1962; Galbraith, 1972; Tushman & Nadler, 1978). Diversity increases the number of decision-making points in an organization and causes coordination problems (Chandler, 1962). Some researchers have suggested that organizations use horizontal mechanisms, ranging from liaison roles and task forces to a pure matrix, to increase their capacity to handle high information-processing demands and diverse activities (Daft & Lengel, 1984; Galbraith, 1972; Lawrence & Lorsch, 1967). Thompson (1967) and Van de Ven and colleagues (1976) argued that such mechanisms also facilitate decision making and coordination by mutual adjustment.

> *Hypothesis 1: Task diversity is positively associated with the adoption of matrix management.*

A related influence on the amount of information to be processed is organizational size (Galbraith 1972: 385; Smith et al., 1991), which fosters internal problems of coordination or performance (Kimberly & Evanisko, 1981). Chandler (1962) suggested that changes in scale contribute to an increase in coordination requirements and a need for new coordinative mechanisms. Increased scale has both direct effects, through raising the number of relationships in an organization, and indirect effects, through increasing differentiation (Blau, 1970). If diversity remains constant, increased scale directly affects coordination requirements because the number of relations within an organization increases as a quadratic function of the number of members (*number of relations* = $n^*(n - 1)/2$; Lincoln, 1982: 13).

Hypothesis 2: Organizational largeness is positively associated with the adoption of matrix management.

Slack resources and capabilities. Organizational diversity and size increase a firm's information-processing requirements and subsequent search for new designs to handle those demands. Information search is a costly activity, however (March & Simon, 1958). The possession of organizational resources and capabilities can influence the speed and scope of this search (Meyer, 1982; Smith et al., 1991: 66). Organizational slack constitutes one set of resources that allow firms to adapt to internal pressures for adjustment (Bourgeois, 1981: 30). Following Cyert and March (1963), we defined slack as the income remaining after an organization has covered the costs necessary to sustain operations. Slack resources permit sophisticated information searches and consideration of new programs well in advance of the perceived need to implement them. Slack resources also reduce the barriers and risks to experimenting with new programs by enabling an organization to afford costly changes and absorb the cost of their failure. Such resources may be particularly helpful in establishing matrix structures, which require additional personnel, a coordinative department, and a new hierarchy (Burns, 1989).

Hypothesis 3: A high level of organizational slack is positively associated with the adoption of matrix management.

Interorganizational Networks

In contrast to information-processing theory, which focuses on organizational effects, network theories focus on the effects of an organization's relationships with others. Research on networks has suggested that organizational behavior is "embedded in concrete, ongoing systems of social relations" (Granovetter, 1985: 487). As Scott noted, "being embedded in a network of social relations can bring one news of innovations, support for adoption, helpful hints regarding implementation, and social support encouraging change. Such processes clearly operate among professionals across organizations" (1990: 184). Organizational networks can require as well as support innovation (Granovetter, 1985). Superordinate agencies in those networks, including professional associations and dominant institutions, may exert normative pressures on organizations to adopt legitimate structural elements when legitimacy is denoted by professional approval or the cumulative level of adoption by others in a network. In such instances, the relevant cues stimulating adoption are not internal needs to coordinate information or internal resources promoting search, such as slack and boundary-spanning activity (cues important in information-processing theory), but rather, exposure to external sources of information and normative-institutional pressures.

Network embeddedness. Early network research examined how embeddedness in organizational networks of communication and influence affects adoption. One prominent contribution is the "two-step flow model" (Coleman, Katz, & Menzel, 1966; Katz, 1957). During the first step posited in this model, organizations that occupy central sociometric positions ("dominant organizations") tend to be early adopters of a matrix structure. Such organizations are likely to be the first to learn of the new structure through external professional networks and exposure to sources of information about it (Coleman et al., 1966). Such organizations also associate adoption with prestige and professional stature (Becker, 1970).

> *Hypothesis 4: Organizations occupying central sociometric positions in an organizational network are more likely than others to adopt matrix management.*

During the second step, dominant organizations convey information about the matrix structure to other organizations in local networks. The communication channels may be either formal ones, such as networks of hospitals affiliated with the same medical school and local hospital councils, or informal ones, such as discussions between physicians or nurses from different hospitals. Dominant organizations also influence the decisions of others to adopt in two related ways. First, they may actively seek to persuade others of the advantages of the matrix structure (cf. Coleman et al., 1966). Second, others may adopt in order to achieve the same level of prestige and visibility the dominant firms have, or at least gain their social approval. Thus,

> *Hypothesis 5: Organizations with high visibility and prestige in local networks that adopt matrix management influence organizations of lower prestige to follow suit.*

Finally, network embeddedness exposes organizations to other sources of information about the matrix structure, thereby increasing the amount of information received. Following Coleman and colleagues (1966) and Granovetter (1985), we posited that organizations embedded in professional networks possess multiple ties to professional organizations and associations, actively participate in those groups, and are themselves frequently sought out by those associations and organizations, which seek to inform or influence them. As a result, embedded organizations are heavily exposed to professional media and to the information they transmit, both directly and indirectly, from other organizations that have already received it. It is logical to expect professional organizations like hospitals to be exposed to published reports in professional media about matrix management. As a communicable disease spreads through contagion, matrix adoption spreads through the accumulation of reports providing organizations with sufficient information to weigh the merits of adoption.[4] Hence,

[4] This contagion process is also partly captured by the cumulative level of adoption nationwide, which is highly correlated with the cumulative publication of reports, and a time trend measure, time at risk for adoption, which is highly correlated with the cumulative level of adoption.

Hypothesis 6: The prior transmission of information about matrix management via professional media is positively associated with the adoption of matrix management.

Normative-institutional pressures. Professional media and dominant organizations are not the only sources of information about matrix management. Nor do they exert the only influence on other organizations to adopt. The collective action and pressure of organizations in a network are also cues for potential adopters. Institutional theorists have distinguished mimetic and normative components of this cue-taking process (DiMaggio & Powell, 1983). In mimetic components, organizational imitation is a standard response to uncertainty: faced with problems with unclear solutions, organizations adopt the solutions used by others. Such imitation represents an efficient mode of "problemistic" search (Cyert & March, 1963; DiMaggio & Powell, 1983: 151). In the normative components of cue-taking, the collective example, or force, of other adopters legitimates an innovation and increases pressure on other organizations to follow suit. Mimetic and normative forces are difficult to separate empirically, however. Researchers have employed the same indicators (e.g., the cumulative level of adoption) to measure both sets of effects (cf. Knoke, 1982; Rowan, 1982).

Institutional theorists have argued that organizations adopt structural elements in order to conform to prevailing norms in their institutional environments (DiMaggio & Powell, 1983; Meyer & Rowan, 1977). These norms are partly a function of the cumulative level of adoption among neighboring organizations. Tolbert and Zucker (1983: 26–27) described an innovation (civil service reform) institutionalized by "gradual legitimation," or the cumulative level of adoption. Their analysis indicated that early adoption is directed toward solving specific problems and thus is a function of organizational characteristics. Over time, such characteristics lose their power to predict adoption, however. In their place, increasing institutional pressure, measured by the cumulative level of adoption, explains subsequent adoption. Tolbert and Zucker further suggested that when an innovation is not institutionalized by gradual legitimation, regional and local institutional effects emerge as the key determinants of both early and later adoption.

Walker (1969), Burt (1981), and Knoke (1982) further suggested that several dominant actors and reference networks, which can be regional or local in scope, can exert such normative pressure. For example, Walker (1969) documented regional cue-taking among states in the adoption of new programs. States look to certain neighbors for guides to action; within these regional networks, followers adopt only after the regional leader has led the way. Similarly, Knoke (1982) showed that not only proximity to local innovators but also a region's cumulative level of adoption influenced the spread of municipal reform.

Rogers (1983) argued that homophily, or the sharing of values and norms, among the members of a network enhances the diffusion of information and promotes adoption. The cue-taking process described earlier may occur most extensively in networks in which local norms support a new program (Aldrich & Whetten, 1981; Burt, 1981). Research evidence on the diffusion of technological innovations in the steel industry (Czepiel, 1974) and cancer patient management strategies (Fennell & Warnecke, 1988) supports the homophily argument.

The institutional literature thus suggests that the cumulative level of adoption of a program in a network influences new adoptions, especially in later periods of the diffusion process. Within local networks, the degree to which the program is accepted also influences adoption.

Hypothesis 7: The cumulative force of prior adoption of matrix management by organizations in regional and local networks is positively associated with new adoptions.

Hypothesis 8: The cumulative force of adoption is more strongly associated with late adoption of matrix management than with early adoption. Organizational characteristics are more strongly associated with early adoption of matrix management than with late adoption.

Hypothesis 9: The greater the degree of local acceptance of matrix management, the greater the impact of network characteristics on adoption, and the lower the impact of organizational characteristics.

Abandonment of Matrix Management

The process of program abandonment has not received much theoretical or empirical attention. To begin to address the process, we posited that the effects of organizational characteristics and interorganizational networks on program adoption imply symmetrical effects on program abandonment. Following information-processing theory, we considered that as organizational diversity decreases (projects end, product lines are phased out), the matrix structure may be viewed as excessively complex and be dismantled. Similarly, decreased size can reduce the number of relationships that require coordination to below the perceived critical mass, and falling slack can reduce an organization's tolerance for costly programs. Following research on interorganizational networks and innovation, we considered that program abandonment may occur as organizations follow the example of role models (Kimberly, 1981: 92)—if prestigious firms in local networks terminate their programs, or as institutional support for a program wanes (Rowan, 1982)—as the cumulative level of program terminations increases in local or regional networks. One study that examined these arguments found no evidence for a symmetrical effect of the cumulative level of adoptions and terminations because of the small number of program terminations observed (Knoke, 1982).[5]

We suggest that external network factors are likely to play a much less important role in program abandonment decisions than in program adoption decisions. In the adoption process, organizations have no direct experience with matrix management and therefore seek external information to guide their decisions. In the abandonment process, organizations are more likely to base their decisions on their own experience with the program and are less apt to be swayed by external factors. However, such personal experiences may have more to do with political conflicts over a matrix (cf. Davis & Lawrence, 1977) than with weakened justifications for the matrix arising from declining task diversity, size, or slack. Hence,

> *Hypothesis 10: Three organizational variables are negatively associated with the abandonment of matrix management: diversity, size, and slack. Two network variables—the cumulative force of abandonment in local and in regional networks—are positively associated with the abandonment of matrix management.*

METHODS

Organizations

The study examined matrix program adoption in a panel—a set of respondents studied at two or more points in time—of hospitals measured in 1961, 1966, 1972, and 1978. The panel included all nonfederal general hospitals that had either large size (300+ beds) or teaching programs (residencies) at any point in the panel period.[6] A total of 1,375 hospitals met these criteria and operated continuously over the entire period.

[5] Other research has suggested that organizational characteristics may not exert symmetrical effects on adoption and abandonment. A study of the literature on organizational growth and decline, for example, revealed that changes in size have a larger impact on administrative ratios in growing than in declining firms (cf. Hannan & Freeman, 1978). Moreover, the administrative component decreases at a slower rate than the production component in a declining firm. These findings suggest that internal political processes mitigate the impact of decreasing size and diversity on managerial personnel and perhaps on managerial structures like the matrix. Similarly, research on organizational inertia suggests that new structures, once in place, may be altered or abandoned only very slowly because routinization and commitment to the structure occur (Hannan & Freeman, 1984; Kelly & Amburgey, 1991; Tushman & Romanelli, 1985).

[6] The omission of smaller, nonteaching hospitals from the sampling frame did not seriously bias our results. Earlier survey research has reported low rates (0.4%) of program adoption among small, nonteaching hospitals (cf. Burns, 1982: 46 [Table 3]; Jelinek, Munson, & Smith, 1971). Nor did the omission of such hospitals restrict the range of our organizational measures and make it difficult to test Hypotheses 1 and 2. For one of the indicators of size used, the number of beds, the hospitals we studied ranged from 150 to 1,250 beds. For two of the diversity measures Burns (1989) used, the ratios of outpatient visits and emergency visits to admissions ranged from zero to greater than one.

Large teaching hospitals were considered the population likeliest to adopt matrix programs because of their administrative complexity (Starkweather, 1970). We chose the period 1961–78 to capture both the diffusion process and the structural changes in hospitals that might influence adoption. Problems with data availability during the 1960s dictated the use of panel rather than time series analyses. We therefore elected to examine hospitals at six-year intervals, with major interest centering on 1966 and 1972. These two points coincided with the congressional enactment of the Medicare and Medicaid insurance programs through the Social Security Amendments of 1965 and the first significant expansion of the Medicare program through the Social Security Amendments of 1972. This legislation had a significant effect on patient demand for hospital care, which increased the volume and diversity of hospital activity. Although hospital data for 1966, 1972, and 1978 were available, data for 1960 were not. We resolved this problem by substituting data from 1961 for that from 1960.

A survey was administered in 1979 to all hospitals in the panel (see Burns [1982] for a description of the survey's administration). The questionnaire asked hospital administrators whether or not they had ever adopted the particular matrix program called unit management, defined as the presence of unit managers, administrators, or coordinators in hospital inpatient units.[7] If administrators answered the question affirmatively, they were also asked whether or not they had discontinued the program and in what years they adopted and abandoned it. Over 90 percent (N = 1,247) of the hospitals responded to the survey. Survey results indicated that 346 hospitals, or 27.2 percent of those responding, had adopted matrix management between 1961 and 1978. Of these, 96 hospitals abandoned matrix management during the same period.

The accuracy and adequacy of the single questionnaire item was verified in two ways. First, questionnaire responses were verified using published program descriptions, earlier survey research results (e.g., Jelinek, Munson, & Smith, 1971), and phone calls to many of the hospitals. Verification analyses and investigation of possible sources of survey error revealed little evidence of overreporting (see the Appendix). Second, the hospital administrators reporting the presence of matrix management completed a follow-up survey of matrix program structure (cf. Burns, 1989), which verified the existence of the program. It is important to note here that the follow-up study found that matrix programs remained stable rather than evolved over time. Because of their structural stability, we could examine program adoption processes over a historical period without having to consider possible confounding effects of program development.

The present study thus included 346 hospitals that adopted some ver-

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[7] Such programs were well recognized and understood by both hospital administrators and nursing directors, as evidenced by the extensive reporting of these programs in the hospital media (cf. Burns, 1982: 43–44) and the low degree of field bias in our survey results.

sion of unit management and 901 hospitals that did not. All 346 adopters exhibited certain basic matrix elements, such as horizontal coordinators who made decisions in one or more administrative policy areas.

Measures of Dependent Variables

Adoption and abandonment. The presence of matrix management was measured by a binary variable indicating that a hospital employed unit managers in its inpatient units (1 = employed, 0 = not employed) at some point during the study period (1961–78). The survey collected information on the presence or absence of matrix management, the time of its adoption, and the time of abandonment. We used these data to compute the probability of adoption and abandonment.

Measures of Organizational Characteristics

The organizational measures were taken from the annual surveys of U.S. hospitals conducted by the American Hospital Association (AHA) (American Hospital Association, 1962–79). These data, available on tape, include information on hospital scale, activity, and financial performance.

Organizational diversity. We measured domain diversity and horizontal differentiation by the respective diversity of the clients treated and the functions performed (Burns, 1989: 363). Diversity of clients is reflected in a hospital's mix of inpatient, outpatient, and emergency care. The wider the distribution of hospital activity across inpatient, outpatient, and emergency settings, the greater the interdependence between these settings, and hence the greater the coordination requirements (Chandler, 1962; Galbraith, 1972). For example, as the volume of emergency care rises, so does the number of patients admitted from the emergency room to a hospital's units. Diversity of clients thus had two indicators: emergency diversity, or the number of emergency department visits divided by total hospital admissions, and outpatient diversity, or outpatient visits divided by total admissions.[8]

Functional diversity encompasses the performance of teaching and research activities in addition to patient care. Teaching and research are typically associated with the treatment of the most complex, unusual, and severely ill cases. We measured functional diversity by the presence of an affiliation with a medical school (1 = affiliation, 0 = no affiliation) and the size of the hospital's teaching program (number of residents). We used principal components analysis to combine these indicators to form a measure of

[8] Such measures are particularly appropriate for the study of hospital matrix management. Previous evidence indicates that matrix programs often encompass outpatient clinics and emergency rooms in addition to inpatient floors (Burns, 1989). Among hospital matrix programs operating in 1978, 22.9 percent covered outpatient clinics, and 55.5 percent covered emergency rooms.

teaching diversity, constructing the measure from the factor loadings of the first principal component extracted (74 percent of common variance explained).[9]

Organizational size and slack. Size was measured by combining three indicators, the number of hospital beds, the volume of hospital revenues, and the volume of hospital expenses, using principal components analysis. The measure of size was constructed from the factor loadings of the first component extracted (81 percent of common variance explained). Slack was defined as total hospital revenues minus total expenses, multiplied by 100,000.

Measures of Interorganizational Network Location and Influence

To study the diffusion of an administrative innovation across hospital networks, research ideally would examine network relationships between hospitals' administrators, such as mutual membership in metropolitan hospital councils and planning agencies, and relationships between hospitals' nursing directors; both types of employees might spread information about matrix programs. Such an undertaking was not possible here because the study was retrospective and longitudinal. Instead, we measured the centrality of a hospital's network location in one sphere of activity, graduate medical education, and its effect on the probability of the hospital's adopting matrix management. We also measured the presence of various network influences operating at a given time of measurement in terms of their effect on the probability of matrix adoption by hospitals in a given network at a later time of measurement. These influences include the decision by a prestigious hospital to adopt or abandon matrix management, the volume of published reports on matrix management appearing in professional media, the cumulative levels of matrix adoption or abandonment in regional, or multistate, and local, or metropolitan, networks, and the cumulative experience with the matrix program among organizations in a local network.

Prestige. The degree to which a hospital occupied a central and prestigious position in a local hospital network was measured by the academic reputation and visibility of the medical school with which it was affiliated. Evan and Walker (1978) provided a justification for measuring a hospital's

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[9] Unfortunately, we could not measure diversity using the AHA's list of hospitals' services. Because the AHA adds and drops services from the list from one annual survey to the next, we had difficulty interpreting changes in the sum of services offered over time. For example, a hospital's reporting a particular service that was added to the 1972 survey incorrectly implies that the hospital lacked this service prior to 1972. Interpolation of the panel data to obtain annual figures thus became problematic. We did, however, use the lists from the 1972 AHA annual survey to verify the construct validity of some of our diversity measures. Outpatient diversity was moderately associated ($r = .45$) with the number of different outpatient services offered by a hospital ($N = 5$: outpatient psychiatric unit, rehabilitation unit, renal dialysis unit, abortion service, and organized outpatient department) but weakly associated with number of beds ($r = .17$). Teaching diversity exhibited a stronger association ($r = .44$) with the total number of services than with number of beds ($r = .32$).

centrality in terms of its medical school's centrality. Hospitals affiliated with a given medical school constitute a contractual group for the purposes of clinical instruction and resident staffing. Members of contractual groups differ in technological sophistication of the hospital, specialization of the medical staff, size, and age. These differences are positively associated with the prestige of the medical school defining that contractual group.

Data on medical school reputation and visibility were taken from a published study of medical school stratification conducted during the mid-1970s (Cole & Lipton, 1977), in which a national sample of medical school faculty members ranked the reputations of medical schools on the basis of the perceived quality of their medical faculties (distinguished = 6, poor = 1). Medical school visibility was the percentage of all respondents who felt they had sufficient information to rate a school. We combined the reputation and visibility ratings into one indicator using principal components analysis (one factor extracted; 99 percent of common variance explained). We thus measured prestige once, in the mid-1970s, and assumed that it was constant throughout the panel period. This assumption seems warranted since medical school reputations are based on basic science and clinical research performance (Cole & Lipton, 1977: 681), which are not likely to fluctuate in the short term (Cole & Lipton, 1977: 677).[10]

Published reports. The transmission of information about matrix management was measured as the number of reports of matrix programs appearing each year in health administration research and trade journals between 1961 and 1978. The frequency of those reports and the types of publications they appeared in are described elsewhere (Burns, 1982: 43–44). A content analysis of the reports revealed that only 3 percent dwelt on any negative aspects of the focal matrix program, suggesting a positive industry evaluation of matrix management and acceptance of the program.

Cumulative force of adoption. The cumulative regional force of adoption was measured by the percentage of hospitals in the same geographic region adopting matrix management by the year prior to a survey point. We specified nine geographic regions using the classification scheme of the American Hospital Association. The cumulative local force of adoption was measured in like manner among hospitals in the same Metropolitan Statistical Area (MSA), as defined by the National Bureau of Standards. We decided not to measure the cumulative force of adoption at the national level

[10] Because we measured prestige in terms of a hospital's medical school affiliation, it exhibited a marked association with the diversity of functions ($r = .56$). Three bits of evidence suggest prestige is not just another measure of diversity, however. First, correlational analyses revealed that prestige exhibited a significant, negative association with the time a hospital was at risk of adoption, but the diversity of functions exhibited an insignificant positive association. That is, high-prestige hospitals waited less time to adopt than more diverse hospitals. Second, both prestige and diversity of functions exerted significant effects on adoption in our regression analyses. Third, prestige is a measure of a hospital's network position, but diversity is an organizational measure.

for two reasons. First, such a measure would have been highly correlated (r = .84) with the time trend measure used in the analyses, time at risk for adoption, defined at the end of this section. Second, the measure of the number of published reports on hospital matrix programs in the national literature parallels the number of adoptions at the national level (cf. Burns, 1982: 43–44 [Tables 1 and 2]).

Cumulative experience with matrix management. We assumed that the greater the collective experience with the matrix program in a local network, the greater the degree of local acceptance and normative approval. We measured degree of local cumulative experience as the number of program years in an MSA observed prior to 1972. We defined a program year as one year of a hospitals' operating a matrix program and chose MSAs as the relevant geographic definition of a network because there were metropolitan hospital councils in many areas that shared information. In our data, the median number of program-years prior to 1972 is ten. The number of program years observed in an MSA is moderately associated with the cumulative local force of adoption (r = .42), suggesting that cumulative experience and cumulative level of adoption represent institutional influences. Using data only from the later period, we split the data in half and called MSAs that had a hospital using matrix management in 1971 and a cumulative experience of at least ten program-years the acceptance group and all other MSAs the nonacceptance group.

Models

The panel structure of the data led us to use discrete-time methods (Allison, 1982, 1984) to study the adoption and abandonment of matrix management. The panel data posed one difficulty for use of discrete-time methods, however. Adoptions were measured each year, whereas the independent variables were measured at four intervals between 1961 and 1978. To overcome this problem, we used linear interpolation to obtain annual data for the latter measures. The autocorrelation of these variables across the four intervals was quite high (average r = .85), with the exception of slack (r = .47),[11] suggesting that interpolation would provide reasonable estimates of annual values for most variables. All the independent variables were lagged one year.

Following Allison's (1982: 75) suggestions, we reconstructed the data to

[11] We did not explicitly control for autocorrelation in our analyses for two reasons. First, neither Allison (1984) nor Yamaguchi (1991) mentions autocorrelation as a potential problem in hazard rate models. Second, our results suggested it was not a problem. Unobserved sources of heterogeneity across organizations associated with a dependent variable cause autocorrelation. These unobserved effects are forced into the error term and lead to autocorrelated errors. For hazard rate models, the consequence is negative time dependence (Allison, 1984). That is, as organizations with these unobserved characteristics adopted, they would have dropped out of the group of potential adopters, and the hazard rate would have fallen. We controlled for time at risk for adoption. Our models report positive time dependence, which "can always be regarded as evidence that the hazard rate increases with time" (Allison, 1984: 32).

include one record for every hospital for every year and then pooled the data over time. For the adoption analyses, we examined those hospitals at risk of adopting matrix management, or the hospitals not operating a matrix management program in a given year. We then used logistic regression analysis to estimate the effects of the exogenous factors on adoption. In subsequent analyses, we split the sample into early and late periods (1961–71 and 1972–78) to investigate period differences in adoption. 1971–72 was chosen as the dividing point to reflect a stabilization in cumulative adoption that occurred at that time at the national level (see Figure 1).

Because adoption is likely to be a time-dependent process, we included the logarithm of the time a hospital was at risk of adopting matrix management as an additional control measure. Time at risk for adoption was defined in different ways for different hospitals. For hospitals open throughout the 1961–78 period, we measured it as the number of years elapsed since 1961 that the hospitals waited to adopt matrix management. For hospitals established after 1961 ($N = 78$), we measured it as the number of years elapsed since the hospitals' foundings that they waited to adopt the program. For hospitals that abandoned the program, we measured time at risk for adoption as the number of years elapsed since the program's termination. Rowan (1982: 276) and Tolbert and Zucker (1983) suggested that positive time effects on adoption can be evidence for such institutional pressures as growing consensus in favor of an innovation. We preferred to treat time at risk more conservatively as a control measure. Organizational inertia arguments suggest that time has a negative effect on program abandonment.

RESULTS

Descriptive Statistics

Univariate statistics on our independent variables are not presented because of our use of panel data. Instead, we present data on two types of bivariate relationships. Table 1 lists the correlations among the independent variables based on the pooled data. Examination of the table suggests little collinearity among variables, with the exception of emergency and outpatient diversity. Collinearity is not an issue, however, because exclusion of either variable from the regression models did not alter any of the estimates or their significance levels. We therefore retained both in the analyses.

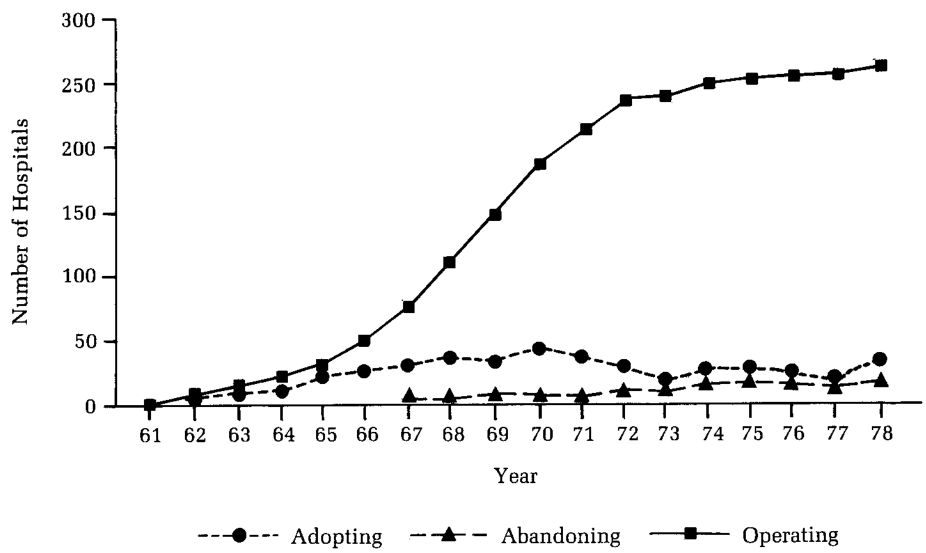
Figure 1 charts the numbers of hospitals using matrix management, adopting matrix management, and abandoning matrix management, by year, at the national level. The growth in the number of matrix management programs closely approximates the mathematical model for an S-shaped logistic curve, with growth defined as the product of the proportion of hospitals at risk of adoption and the proportion of hospitals that have already adopted. Diffusion proceeded slowly in the years preceding 1964, increased quickly between 1964 and 1971, and then leveled off after 1971. The growth period represents a greater number of hospitals adopting than dropping matrix management. The flattening of the curve after 1971 reflects both decreasing

TABLE 1
Correlation Matrix for Independent Variables Based on Pooled 1961–78 Data[a]

Variables	1	2	3	4	5	6	7	8	9
Task diversity									
1. Emergency diversity									
2. Outpatient diversity	.58								
3. Teaching diversity	.15	.31							
Organizational variables									
4. Size	.17	.23	.41						
5. Slack[b]	−.17	−.16	−.05	.04					
Interorganizational networks									
6. Prestige	.18	.29	.56	.36	−.11				
7. Reports[c]	−.01	.00	−.09	−.15	−.05	.00			
8. Regional force of adoption[c]	.12	.08	.01	.08	−.10	.01	.18		
9. Local force of adoption[c]	.06	.04	.05	.09	.01	.00	.05	.09	
Time trend									
10. Time at risk for adoption	.17	.11	.01	.39	.09	−.07	.10	.33	.07

[a] N = 14,183.
[b] Value is multiplied by 100,000.
[c] Variable was lagged one year.

FIGURE 1
Demographics for Adoption of Matrix Management



adoptions and increasing abandonments. The overall shape of the curve suggests that our panel interval encompasses the main period of matrix management diffusion.

Similar curves showing the number of hospitals annually using, adopting, and abandoning matrix management at the MSA level were plotted (figures are available from the authors). The number of MSAs with at least one adopter rose quickly during the middle and late 1960s and then leveled off in the early 1970s. Within MSAs, the mean number of matrix programs rose faster over time in areas in which at least one adoption had occurred than in all MSAs combined. This pattern suggests that adoptions clustered in areas in which an innovator was already present.

Determinants of Matrix Adoption

The columns under model 1 in Table 2 present the estimates for the effects of the independent variables on adoption, based on data pooled over the entire period. The results support many of our hypotheses. Consistent with Hypothesis 1, two of the three diversity variables—outpatient and teaching diversity—exert a significant, positive effect on adoption. Contrary to Hypotheses 2 and 3, the other organizational variables, size and slack, have no effect on the decision to adopt matrix management. The absence of any effect of slack may be the result of imprecision in estimating annual values for this measure from the panel data. Two interorganizational network measures (prestige and reports) also exert positive effects on adoption, supporting Hypotheses 4 and 6. They indicate that the greater the visibility and prestige of the medical school network a hospital is located in and the greater the amount of published information on matrix management that is available, the greater the likelihood of adoption. We address the effect of matrix adoption by a high-prestige hospital on adoption by a low-prestige hospital (Hypothesis 5) in the next section. Finally, in support of Hypothesis 7, the regional and local cumulative forces of adoption positively influence adoption. The greater the proportion of regional and local hospitals adopting matrix management at a given measurement point, the greater the probability of other community hospitals adopting it later.[12]

Influence of Dominant Organizations

To investigate whether dominant organizations in a local network influenced peripheral organizations to imitate their adoption behavior (Hypothesis 5), we examined the pattern and sequence of adoptions in each area

[12] We performed two additional analyses to see whether adoption was a function of change in diversity and size or a hospital's geographic region. Including measures of change in diversity and size—the change in the proportion of outpatient visits to admissions and the proportionate change in one indicator of size, the number of beds—failed to improve the model's fit (results are not presented). Including dummy variables for region yielded similar results. The effects of geographic region are consistent with results published earlier (Burns, 1982) and thus are not included in Table 2.

TABLE 2
Estimates of Hospitals' Adoption of Matrix Management, 1962–78

Variables	Model 1 *b*	Model 1 s.e.	Model 2 *b*	Model 2 s.e.
Task diversity				
Emergency diversity	.03	.04	.04	.04
Outpatient diversity	.02*	.01	.02*	.01
Teaching diversity	.21**	.07	.20**	.07
Organizational variables				
Size	.07	.04	.07	.04
Slack[a]	.06	.04	.06	.04
Interorganizational networks				
Prestige	.20**	.05	.30**	.08
Reports[b]	.11**	.02	.11**	.02
Regional force of adoption[b]	.05*	.02	.05*	.02
Local force of adoption[b]	1.63*	.82	1.42	.87
Network influences				
Structural equivalence			.22	.14
Center-periphery effect			.28	.23
Periphery-center effect			−.28	.23
Time parameter				
Time at risk for adoption	.11	.11	.09	.11
Intercept	−5.14**	.25	−5.40**	.32
Improvement in χ^2[c]	157.44**		3.58	
Pseudo R^2[d]	.06		.06	
N	14,183		14,183	

[a] Value is multiplied by 100,000.
[b] Variable was lagged one year.
[c] Model 1 is compared to an intercept-only model (10 *df*); model 2 is compared to model 1.
[d] The percentage reduction in the model logarithmic likelihood is compared to an intercept-only model.
* $p < .05$
** $p < .01$

over time. In areas in which two or more adoptions occurred, we classified the second and all subsequent adoptions into one of three categories: adoption by a hospital (1) within the same network (affiliated with the same medical school) as a hospital that had adopted, (2) in a less prestigious network (affiliated with a medical school of lower prestige), and (3) in a more prestigious network (affiliated with a medical school of higher prestige). We labeled these three categories of network influence "structural equivalence," "center-periphery," and "periphery-center," respectively. In areas with three or more adoptions, the sum of adoptions falling in the three categories typically exceeds the total number of adoptions. This pattern may occur as follows: If there are three hospitals of varying prestige (high, medium, and low) operating matrix management programs in a prior year, a new adopter of medium prestige would fall into all three categories by virtue of being of lower prestige than the first (center-periphery effect), equal prestige with the second (structural equivalence effect), and higher prestige than the third (periphery-center effect).

Hypothesis 5 suggests that adoptions subsequent to an initial adoption should be concentrated among hospitals of lower prestige than the first adopter, hospitals whose administrators are likely to perceive normative pressure to adopt (center-periphery effect). In fact, when we classified all subsequent adoptions into the three categories, we observed 248 (54.6%) instances of center-periphery influence, 146 (32.2%) instances of structural equivalence influence, and only 60 (13.2%) instances of periphery-center influence.[13] The results suggest that the diffusion of matrix management at a local level proceeds primarily from higher- to lower-prestige hospitals, and secondarily between hospitals in the same network.

To assess the network influence effects with the other variables controlled, we developed dummy variables for the three network effects and included them in our regression analysis (model 2, Table 2). Their addition did not significantly improve the fit of the adoption model. None of the effects on adoption was significant, although the direction of the effects was in the expected direction. The structural equivalence and center-periphery effects were positive, and the periphery-center effect was negative. Moreover, including these effects rendered the effect of the local force of adoption insignificant. This relationship suggests that the measure of local influence partly captures these network diffusion effects, which may be quite strong at a local level.

Determinants of Early and Late Adoption

Hypothesis 8 suggests that organizational characteristics influence adoption in the early phases of the diffusion process, and institutional factors influence adoption in later periods. The estimates shown in Table 3 partially support this hypothesis. In the early period, teaching diversity and size do exert positive effects on adoption, as does prestige. The proportion of other hospitals in a region using matrix management (regional force) exerts a positive impact on adoption during the later period. Finally, time at risk for adoption exerts a significant, positive effect only in the early period.

The tests of significance for the coefficients reported in Table 3 do not indicate whether the effect of a given variable differs significantly between the early and late periods. To ascertain such period effects, we reestimated the first model shown in Table 2 by including a dummy variable denoting period and nine interaction terms, each representing period times an independent variable. In the new model, only two interaction terms are significant at the $p < .01$ level: period by regional force and period by size.

[13] The 454 adoptions classified according to these three categories are based on 346 total adoptions of matrix management. Data on total adoptions by year and the network sequence of adoption in areas with multiple adopters are available from the authors.

TABLE 3
Estimates of Hospitals' Adoption of Matrix Management for Early and Late Periods

Variables	1971 or Earlier *b*	1971 or Earlier s.e.	1972–78 *b*	1972–78 s.e.
Task diversity				
Emergency diversity	.06	.06	.01	.07
Outpatient diversity	.01	.01	.03	.02
Teaching diversity	.21*	.09	.19	.10
Organizational variables				
Size	.45**	.09	.08	.06
Slack[a]	.08	.08	.08	.05
Interorganizational networks				
Prestige	.18**	.06	.09	.08
Reports[b]	.04	.02	.05	.06
Regional force of adoption[b]	−.06	.04	.13**	.04
Local force of adoption[b]	1.11	1.38	1.39	1.27
Time parameter				
Time at risk for adoption	.68**	.20	.54	.33
Intercept	−4.98**	.32	−6.43**	.91
Improvement in χ^2[c]	167.56**		35.11**	
Pseudo R^2[d]	.10		.03	
N	7,439		6,744	

[a] Value is multiplied by 100,000.
[b] Variable was lagged one year.
[c] Values are for comparison to an intercept-only model.
[d] The percentage reduction in the model logarithmic likelihood is compared to an intercept-only model.
* $p < .05$
** $p < .01$

Our results thus provide some support for Tolbert and Zucker's (1983) finding that organizational effects weaken over time while institutional effects grow more pronounced. Contrary to their argument, however, the effect of time at risk for adoption also weakens over time and hence does not suggest growing institutional pressures to adopt.

Impact of Local Acceptance

To investigate the impact of an area's previous experience with matrix management on adoption (Hypothesis 9), we focused the analysis on differences in the adoption process in the later period (1972–78) between MSAs that had gained much experience with matrix management prior to 1972 (the acceptance group) and all other MSAs (the nonacceptance group). Hypothesis 9 predicts that network forces positively influence adoption in areas with prior matrix experience, but organizational characteristics influence adoption in areas in which hospitals have little prior experience with matrix management.

The estimates in Table 4 partly support the hypothesis. Outpatient department diversity and size influenced adoption in MSAs in which matrix management had not been accepted by 1971. Contrary to the hypothesis, however, the regional force of adoption also influenced adoption. In MSAs in which matrix management had been accepted by 1971, organizational and network variables did not influence adoption. To verify these results, we reestimated the regression model including the nine interaction terms. The interaction for outpatient diversity is not quite statistically significant ($p < .15$), and the interaction for size is significant ($p < .05$). There is thus partial support for our contention that the effect of these variables varies by local acceptance rate.

Determinants of Matrix Abandonment

Finally, we investigated whether organizational and network factors had symmetrical effects on adoption and abandonment (Hypothesis 10).

TABLE 4
Estimates of Hospitals' Adoption of Matrix Management in Late Period by Groups[a]

	Nonacceptance Group		Acceptance Group	
Variables	***b***	**s.e.**	***b***	**s.e.**
Task diversity				
Emergency diversity	−.19	.12	.14	.11
Outpatient diversity	.07**	.02	−.01	.04
Teaching diversity	.10	.14	.27	.16
Organizational variables				
Size	.30**	.10	−.04	.09
Slack[b]	.04	.11	.07	.07
Interorganizational networks				
Prestige	−.04	.12	.15	.11
Reports[c]	.07	.08	.02	.09
Regional force of adoption[c]	.22**	.05	.03	.07
Local force of adoption[c]	1.54	1.43	2.70	5.58
Time parameter				
Time at risk for adoption	.82	.48	.50	.46
Intercept	−7.54**	1.37	−5.73**	1.28
Improvement in χ^{2d}	34.09**		15.03	
Pseudo R^{2e}	.06		.03	
N	4,538		2,206	

[a] Late adoption period is 1972–78. The acceptance group includes MSAs with at least ten program-years of experience with matrix management by 1971 and in which at least one hospital was operating matrix management in 1971.
[b] Value is multiplied by 100,000.
[c] Variable was lagged one year.
[d] Values are for comparison to an intercept-only model.
[e] The percentage reduction in the model logarithmic likelihood is compared to an intercept-only model.
** $p < .01$

Table 5, model 1, presents the estimates for the effects of the independent variables on the likelihood of abandoning matrix management. One of the diversity measures, outpatient diversity, negatively influences discontinuance. Hospitals with low diversity in their inpatient-outpatient mix were more likely to abandon the program. There is also a slight indication that abandonment is more likely to occur among smaller hospitals ($p < .18$). The regional proportion of hospitals discontinuing matrix management by a prior measurement period positively influences the likelihood of abandonment. Thus, regional cues influence abandonment, and both regional and local cues influence adoption. This pattern may simply reflect the fact that adoptions exceeded terminations and, thus, cues regarding abandonment at the local level are insufficient to influence decisions to abandon matrix management.

TABLE 5
Estimates of Hospitals' Abandonment of Matrix Management Program, 1962–78

	Model 1		Model 2	
Variables	***b***	**s.e.**	***b***	**s.e.**
Task diversity				
Emergency diversity	.11	.09	.09	.09
Outpatient diversity	−.09**	.03	−.10**	.03
Teaching diversity	.06	.11	.08	.11
Organizational variables				
Size	−.10	.07	−.10	.07
Slack[a]	.03	.07	.03	.07
Interorganizational networks				
Prestige	−.10	.07	−.09	.07
Reports[b]	.04	.04	.03	.04
Regional force of abandonment[b]	.28**	.11	.29**	.11
Local force of abandonment[b]	−1.42	4.15	−1.35	4.15
Change				
Proportionate change in number of beds from prior year			−.05**	.02
Change in outpatient diversity from prior year			.07	.10
Time parameter				
Time at risk for adoption	.17	.16	.17	.16
Intercept	−3.34**	.40	−3.28**	.40
Improvement in χ^2[c]	29.06**		8.15**	
Pseudo R^2[d]	.03		.04	
N	2,695		2,540	

[a] Value is multiplied by 100,000.
[b] Variable was lagged one year.
[c] Model 1 is compared to an intercept-only model; model 2 is compared to model 1.
[d] The percentage reduction in the model logarithmic likelihood is compared to an intercept-only model.
** $p < .01$

The negative effects of outpatient diversity and size provide some weak evidence supporting Tolbert and Zucker's (1983) claims about organizational determinants of abandonment. These effects suggest that some smaller, less diverse hospitals either experienced implementation failure or adopted the program for inappropriate reasons and then later dropped it. An alternative explanation is that those hospitals decreased in diversity and size during the panel period and discovered the matrix program was no longer necessary. To compare these explanations, we reestimated the abandonment model, this time including measures of change in outpatient diversity and the proportionate change in size measured most simply as number of beds. The results (model 2, Table 5) provide support for both explanations: low diversity and decreasing size influence abandonment.

Overall, however, the abandonment model provides a weaker fit to the data than the adoption model in Table 2. We reestimated the abandonment model to explore the impact of period, local acceptance, and network influence on the probability of abandonment (analyses similar to those in Tables 2–4), but we hypothesized no specific effects. Results from the original model were replicated for the later period and for areas not accepting matrix management. The network influences (compare column 2, Table 2) exerted no significant effect on abandonment. The majority of terminations fell into the structural equivalence category, with hospitals abandoning the matrix following the example of hospitals within the same network rather than that of hospitals in more prestigious networks. There is thus no evidence of local institutional effects on abandonment.

DISCUSSION

This study tested several hypotheses regarding influences on the adoption of matrix management. In partial support of information-processing theory, we found significant effects for two of the three measures of diversity (Hypothesis 1) but found no evidence for the effects of organizational scale or slack resources (Hypotheses 2 and 3). Overall, these findings suggest that hospitals with high diversity are more likely than others to adopt matrix management. However, our results also suggest three modifications of information-processing theory and analytic discussions of matrix design. First, the adoption of matrix management is not solely influenced by organizational diversity. Additional findings were that the prestige of a hospital influences not only its own decision to adopt (Hypothesis 4) but also the decisions of neighboring hospitals (Hypothesis 5). Other significant effects suggest that professional media (Hypothesis 6) and regional and local hospital networks (Hypothesis 7) are influential. Our results thus suggest that organizational networks influence the diffusion of administrative innovations in much the same way that they influence the spread of technological innovations (Kimberly & Evanisko, 1981; Stevens, 1989).

Second, the effects of organizational characteristics on matrix adoption are contingent on the period in the diffusion process studied and a local area's contemporaneous acceptance of the innovation. In partial support of

Tolbert and Zucker (1983) was our finding that teaching diversity and organizational size effects diminish over time, but the effect of the regional force of adoption increases (Hypothesis 8). In partial support of homophily arguments, organizational diversity and size effects dominate in metropolitan statistical areas with low prior acceptance of the matrix innovation, but those effects disappear in MSAs accepting the innovation (Hypothesis 9). The contingent nature of the organizational effects provides one explanation for the lack of evidence supporting Hypotheses 2 and 3. Contrary to Hypothesis 9, however, there is no evidence for the expected contingent effects of the network influences.

Third, the network embeddedness argument, which receives some support here, provides an alternative interpretation for the effects of "external orientation" and the capacity to process external information noted in previous research (Dollinger, 1984: Miles & Snow, 1978). Organizational information-processing theorists have argued that firms with extensive "boundary-spanning" capacity and environmental sensory systems are more open to change, more likely to detect another firm's actions, and more likely to respond (and respond quickly) to those actions (Dollinger, 1984; Pearce, 1983; Smith et al., 1991). Smith and colleagues observed that external orientation had a positive effect on the likelihood and speed of response and attributed that effect to the quantity and richness of market information this orientation provides. Similarly, network researchers have argued that cosmopolitan opinion leaders in a network are likely to have more extensive information sources and to learn of innovations more quickly than others (Becker, 1970; Coleman et al., 1966). They are more likely to adopt innovations (and adopt them quickly) not because of their technical or competitive advantages, but rather because they confer status and prestige, elicit normative approval, and achieve other noneconomic ends (Granovetter, 1985).

It is impossible to discern the precise motives for decisions to adopt matrix management. Are those motives technical and competitive or nontechnical and normative? A more elaborate design that specified not only the actions of network members and the spread of information but also an organization's interpretation of this information might disentangle the two sets of effects. Several bits of evidence suggest, however, that nontechnical motives are largely responsible for adoptions. As Figure 1 illustrates, the diffusion of matrix programs occurred quickly within a few years' time, exhibiting the classic contagion curve. Moreover, the regional force of adoption exerted a consistent effect across all of the regression models we estimated. The geographic locus of this effect suggests there was more normative cue-taking than strategic response to the actions of local competitors. Finally, the pattern of emulation reflects the prestige ordering of organizations, with low-prestige hospitals following the lead of high-prestige hospitals in their own networks. There is no indication that hospitals responded to network members that were structurally equivalent.

Our results have important implications for two other organizational issues concerning adoption. First, the significant effects of diversity found here contrast with Burns's (1989) finding that organizational diversity is unrelated to the complexity of the matrix program adopted. Combined, these findings suggest that although hospitals adopted matrix management to meet problems of increased diversity and scale, as Lawrence and Lorsch (1967) and Galbraith (1972, 1973) argued, political considerations shaped the particular matrix program adopted in each case (Burns, 1989: 364). In professional-dominated organizations such as hospitals, various forces appear to influence program initiation and implementation decisions. Nurses and administrators may agree that technical exigencies call for a new structure to coordinate work but disagree over whose "sphere of action" (Thompson, 1967) will be enhanced or diminished by it.

Second, the estimates for two measures, outpatient diversity and regional force of adoption, indicate that the adoption and abandonment processes are somewhat symmetrical (Hypothesis 10). A diverse mix of inpatients and outpatients promotes adoption, and low diversity promotes abandonment. Moreover, it is the level of inpatient-outpatient diversity, rather than the change in diversity over time, that shapes adoption and abandonment. Given that matrix programs typically administer both inpatient and outpatient areas (Burns, 1989), level of patient diversity appears to be a critical determinant of whether or not a hospital uses such a program at all. The proportion of hospitals in a region initiating or abandoning matrix management by a given year also influenced the subsequent adoption (abandonment) process. Among large teaching hospitals, regional examples provided important cues for implementing and terminating new programs.

The remaining network factors affected only the adoption process. One explanation for these findings is that, prior to adoption, organizations have little experiential knowledge about matrix management. They therefore turn to their environments for information or normative support. In the abandonment process, an organization can evaluate the matrix on the basis of its own experience. We suggest that the differing effects of the local and regional forces of adoption reflect the number of cues available for hospitals considering initiating or terminating a program.

Overall, however, our adoption models exhibit weak explanatory power, as measured by pseudo R^2. We offer two reasons for these results. First, this statistic reflects the percentage improvement in a model's fit over a constant-rate model. With only 346 discrete events (adoptions) occurring in 14,183 hospital-years (the number of hospitals times the number of years observed), a constant-rate model correctly predicts nonadoption for 97.5 percent of the cases. The low proportion of all hospitals adopting matrix management (27.7 percent) and the use of event-history methods to study adoptions over a 17-year period thus limit the explanatory power of our models. Given the low rate of adoption in any given year, our models are remarkable for identifying significant determinants that are consistent with theoretical predictions. The chi-square statistics show that each estimated model was significant. Second, our models fail to specify other potential determinants of adoption. Future research should consider the effects of competing environmental demands and technological uncertainty noted in prior discussions of matrix management (cf. Davis & Lawrence, 1977).

The models for abandonment exhibit even less explanatory power. Although the adoption decision is a function of network influences, and, to some extent, organizational diversity, the abandonment decision seems to be based on information peculiar to an institution's direct experience with the matrix program. Qualitative information provided by the hospitals that terminated programs suggested that such issues as financing problems, turnover and staffing problems, and conflict between physicians and nurses caused abandonment (Burns, 1982). Potential conflicts may also be responsible for structural changes in the matrix programs that survive (cf. Burns, 1989). There is no indication that political processes delay matrix abandonment or prevent structural alterations, however. Future research on abandonment and retention should focus instead on the matrix's contribution to organizational performance as well as its compatibility with the existing structure and culture of an organization.

Our conclusions are admittedly based on the analysis of only one program. Consequently, we are unable to replicate our findings using other programs or to study the effects of synergy or the relative advantages of matrix management and other administrative programs. The research design we used sacrifices some generalizability for comprehensive coverage of the diffusion of one administrative change, much as other analyses have done (e.g., Tolbert & Zucker, 1983). Our analyses thus include almost all hospitals at risk of adopting matrix management and encompass the entire period of the program's diffusion.

On the other hand, our research findings have two important implications for team-based approaches to managing quality, such as continuous quality improvement (CQI), currently being implemented in many U.S. industries. First, the matrix adoption models suggest organizations may implement these approaches primarily for nontechnical reasons, including desires to gain prestige, to emulate larger rivals that have already adopted CQI, and to foster the appearance of quality. Like matrix management in hospitals, the adoption of CQI may reflect conformity to institutionalized norms regarding state-of-the-art management methods. Second, the matrix abandonment discussion suggests that CQI efforts may encounter political opposition from vested interests, particularly lower-level managers. The CQI approach transfers to teams much of a plant manager's and first-line supervisor's discretion and places management in the unaccustomed position of working with employee teams and union representatives in collegial, consultative relationships. Managers are likely to resent the loss of power and seek a return to traditional hierarchical arrangements.

Our findings are also based on results from one industry. The hospital industry was an appropriate population in which to test our hypotheses regarding the adoption of matrix management. Matrix arrangements are widely used in hospitals for decision making such as in patient care teams and hospital-wide committees; in addition, both technical and institutional forces strongly influence organizations in the health care industry (Scott, 1983: 102). Other industries with analogous conditions, such as extensive research and development activity and employment of professionals, may offer appropriate settings in which to replicate our findings.

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APPENDIX
Analysis of Survey Error

Following Andersen, Kaspar, Frankel, and associates (1979), we investigated three possible sources of survey error: response, nonresponse, and field bias. First, we examined whether any bias in reporting program adoption might be introduced by variation in type of informant. We mailed the questionnaire to each hospital's chief administrator, but often it was completed and returned by the nursing director. This was not surprising, given that nursing hierarchies administered most matrix programs (Burns, 1989). There was no evidence that one or the other type of informant was associated with greater likelihood of program adoption. The percentages of administrators and nursing directors reporting adoption and nonadoption were nearly identical.

Second, we found no bias in the pattern of nonresponse associated with hospital size, community size, hospital ownership, and teaching affiliation. The only bias occurred in terms of geographic region, with nonresponse being slightly greater among hospitals in New England, the Southeast, and the South. Among hospitals with the program in 1978, the last point of observation, the regional response rate was not significantly associated with the regional rate of adoption (Spearman rank-order $r = .31$, $N = 9$).

Third, we investigated two components of field bias: failure to report program adoption (underreporting) and incorrect reporting of program adoption (overreporting). Much of the survey data required administrators and nursing directors to recall the histories of their matrix programs. Since many of the programs began in the 1960s, often long before the administrators and nursing directors in office in 1979 assumed their jobs, some degree of reporting error might be expected. On the other hand, the high survival rate and stability of the matrix programs (cf. Burns, 1989) suggests that accurate data on program history might be readily available and thus that the degree of survey error might not be large.

To investigate the extent of underreporting, we used an earlier survey of hospital unit management programs conducted by researchers at the University of Michigan (Jelinek et al., 1971). The Michigan data could only be used to detect instances of underreporting because the sample was restricted to hospitals known to have the program. Those data were also collected in 1969, thus permitting us to verify only the accuracy of reported program adoption by 1969. This verification check was probably the most critical, however, since the incidence of underreporting undoubtedly increases with the length of the recall period.

The Michigan survey identified 155 hospitals as having adopted unit management by 1969.

Prior to verification, 138 hospitals in our study reported adopting the program on or before 1969. Of the 155 hospitals in the Michigan survey, 128 are included in our study and are thus available as a basis of verification. When we compared the Michigan data with the initial responses from our own questionnaire, we discovered 16 hospitals with the program that had failed to report it. The field bias due to underreporting was therefore 16/128, or 12.5 percent. Additional analyses confirmed that underreporting is associated with early program implementation but not with program age or failure. Thus, our data are more likely to underreport early adopters than later adopters or "disadopters." However, if underreporting decreases over time, the incidence of underreporting adoption across the entire panel period is likely to be much less than 12.5 percent.

To address the problem of overreporting, we administered a second survey to all hospitals that reported having a unit management program during the 1970s. This survey inquired about the actual structure and function of programs and their personnel (cf. Burns, 1989: 355). In a few instances ($N = 4$), hospitals that initially reported having the program were discovered to have only new clerical personnel, rather than matrix managers, assigned to patient units. We eliminated these hospitals from the second study and recoded them as nonadopters in the study presented here. The small magnitude of error suggests that overreporting was not a significant problem.

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