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Changing Organizational Designs and Performance Frontiers

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This paper develops and tests a multilevel organizational contingency theory for designing headquarters–subsidiary relations. We use frontier analysis to overcome problems that have hampered advancements in organizational contingency theory in general and headquarters–subsidiary relationships in particular. Based on a longitudinal study of a large medical group practice of 32 local community clinics, we compute the relative distance of clinics from a best-performance frontier, determine what proportions of changes in clinic performance are due to factors that are endogenous or exogenous to the clinics, and examine the organizational factors that may explain these performance changes. We find that uniform headquarters policies have differing effects on the performance of subsidiary units, benefiting some and hindering others through no fault of their own. We also find significant performance volatility with different types of unit designs, suggesting the need to examine the risks of changing organization designs.

Key words: organization design; adaptation; frontier analysis
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Introduction

Striking a balance between corporate-wide policies and subsidiary unit autonomy is an ongoing challenge of multisite organizations that have many geographically dispersed units, such as manufacturing plants, service outlets, and retail stores (Child 2005, Dooms and van Oijen 2008). On the one hand, organization-wide policies and procedures are necessary to achieve economies of scale and scope, and they create reliable and branded products from all of the organization's stores, factories, or service centers regardless of their location. On the other hand, each dispersed unit requires some autonomy and flexibility so that it is able to respond to its particular environmental task demands.

Most of the research on headquarters–subsidiary relations has been in multibusiness and multinational firms and has focused on the mechanisms used by headquarters to control their subsidiaries and the mechanisms subsidiaries use to manage their fit within their local environment (Birkinshaw 2008). This research has mainly been concerned with the degree to which corporate control mechanisms should be tailored to allow subsidiaries to maintain the requisite autonomy to manage their relationship with the local institutional conditions and the degree to which such control mechanisms should be standardized to take advantage of economies of scale and scope (Ghoshal and Nohria 1989, Nohria and Ghoshal 1994). Researchers have also examined the variations of such control mechanisms across subsidiaries (e.g., Dooms and van Oijen 2008).

Although this research has uncovered mechanisms of corporate control over subsidiaries and has shown how subsidiary performance is contingent on the fit between corporate control and the local environment, it has not examined the multilevel effects of macro-headquarter policies and microunit efforts on subsidiary performance. We argue and show that an understanding of the design of headquarters–subsidiary relations requires a systematic way of distinguishing between the exogenous parts of subsidiary performance that are due to macro-corporate policies and the endogenous parts that are due to the micromanagement efforts of individual subsidiaries. Without unpacking the corporate and subsidiary components of subsidiary performance, we have no evidence for assessing the relative contributions and relationships among macro and micro levels of organizations. In addition, organization design researchers have not discriminated between the relative effects of corporate and subsidiary control mechanisms on endogenous and exogenous unit performance. Hence, our research question focuses on how corporate (macro) and subsidiary (micro) organizational control mechanisms affect subsidiary performance.

Probably the most commonly used theoretical framework to examine headquarters–subsidiary relations is contingency theory (Donaldson 2001, Doz and Prahalad 1991). In this context, the basic contingency theory proposition is that *organizational performance increases when subsidiary units are designed to differentially fit their local environmental demands subject to macro-organizational constraints of the headquarters* (Drazin and Van de Ven 1985, Meyer et al. 1993, Nohria and Ghoshal 1994, Birkinshaw 2008). Donaldson (2001) and Child (2005) review the research on this proposition and suggest that it represents the most widely accepted view of our current state of knowledge on designing headquarters–subsidiary relationships. Although intuitively straightforward, this abstract proposition glosses over three thorny problems that limit advancing organizational contingency theory in general and understanding headquarters–subsidiary relationships in particular.

First, the contingency theory proposition assumes that organization design is a strategic choice (Child 1972, Donaldson 2001) that can be made in a purposeful and rational manner by top managers. In reality, organization design reflects some joint deliberate decisions and some emergent actions, especially when multiple stakeholders with conflicting interests are involved (Pfeffer and Salancik 1978). Designing headquarters–subsidiary relations involves some centralized coordination and some local autonomy, which can lead to unanticipated conflicts between central administration and local units (Blau 1964, Astley and Van de Ven 1983). In addition, most organizations face multiple and often conflicting environmental demands, structural arrangements, and performance criteria at macro- and micro-organizational levels (Thompson 1967, Lewin and Minton 1986). Achieving fitness with local environmental demands and with corporate strategies often conflict (Child 1975, Khandwalla 1973), and it forces making trade-offs between purposeful and emergent goals at micro- and macro-organizational levels (Miller 1993, Sinha and Van de Ven 2005). These complexities make it difficult to specify in concrete terms the relationships among abstract notions of organization environment, configuration, and performance in contingency theory.

To move beyond the limits of armchair theorizing, we propose taking an empirical approach using methods of frontier analysis to advance our understanding of designing headquarters–subsidiary relationships. This approach provides a systematic way to assess the relative overall performance of organizational subsidiaries facing comparable resource and environmental constraints and to unpack the trade-offs between micro- and macro-organizational factors that might have a differential impact on subsidiary unit performance.

Second, the contingency theory proposition treats corporate policy as a uniform constraint on all subsidiary units when corporate policy should, in fact, be treated as a variable that differentially affects subunits. As a constraint, it is generally assumed that headquarters' policies are implemented in a uniform way in all subsidiaries. Yet, as the concept of "affordance" (Gibson 1979, Norman 1988) suggests, any rule or policy is open to many action possibilities depending on what one makes of it. These action possibilities depend not only on the literal policy prescriptions but also on the actor's goals, plans, values, beliefs, and past experiences. The same constraint (or policy) may or may not limit a subsidiary. It has been shown that macro policies can also enable productive pathways for subsidiary units to perform tasks (Nelson and Sampat 2001). In other words, macro-organizational rules and policies both enable and constrain behavior (Adler and Borys 1996). If that is the case, then macro-organizational policies may increase or decrease micro-organizational performance variations, depending on how the policies are interpreted and implemented. Thus, Nelson (2008, p. 8) observes, "Over the years empirical studies have consistently shown large differences in productivity between establishments of the same corporation producing the same things and using the same production machinery (perhaps the best of these studies remains the old one by Pratten 1976)."

These different connections between headquarters' policies and subsidiary units' behaviors have not been studied because it is very difficult to get reliable evidence for assessing the relative performance of subsidiary units and for determining what parts of subsidiary units' performance are due to subsidiary-specific (or endogenous) factors within the control of organizational units and what parts can be attributed to headquarters-specific (or exogenous) macro-organizational policies. Using frontier analysis, we disentangle the endogenous subsidiary-specific components and the exogenous headquarters-specific components of a subsidiary unit's performance. This makes it possible to examine how macro-organizational policies that impose uniformities across dispersed subsidiary units may have differential impacts on subsidiary performance. The same policies may advantage some units but disadvantage others in unknown and unintended ways.

Third, the concept of fit in contingency theory has been criticized for being too static and unable to capture the changing processes of organizational adaptation within an organization's local environments and within other organizational levels (Anderson et al. 1999). Responding to these criticisms, Donaldson (2001) points out that even some of the classic contingency theories made the point that organizations adapt over time by moving from misfit to fit and that what constitutes a fit changes as the contingencies change. Our longitudinal research provides an empirical way to go beyond this comparative-statics analysis of fit and misfit. Conceptually, it requires a shift in thinking of organization–environment relations from one of fit to one of adaptation. This shift is central to the organizational complexity perspective of Levinthal (1997), McKelvey (1999), and Siggelkow (2001) and their discussions of organizational adaptation on a metaphorical changing landscape over time. In the results section, we show that uniform headquarters' policies shift the best-performance frontier differently for various types of subsidiary units on this metaphorical landscape. The image of actors "dancing" across a fitness landscape over time is apropos, as actors adapt to each others' steps as well as to moving frontiers. Through this process, some improve and others fall behind, reflecting "Red Queen" dynamics (Barnett and Sorenson 2002, Derfus et al. 2008).

The next section of this paper proposes a multilevel organizational contingency theory of headquarters–subsidiary relations. We describe the method of frontier analysis that was used to empirically assess the relative performance of different types of subsidiary units, and we determine what parts of unit performance are attributable to the efforts of individual units and what parts are due to macro-organizational policies. Our empirical findings are based on a longitudinal study of a sample of 32 local community clinics that are all part of a large medical group practice. With longitudinal data, we construct a changing adaptiveness landscape for these organizational units and determine what proportions of changes in clinic performance are due to endogenous or exogenous factors of the clinics. We identify several organizational characteristics that differentially influence these endogenous and exogenous sources of clinic performance. We conclude with a discussion of how this research advances organizational contingency theory in general and headquarters–subsidiary relationships in particular.

Our paper makes at least four contributions. First and foremost, we advance a multilevel organizational contingency theory that takes into account the different impact of headquarters' policies and subsidiary managerial efforts on subsidiary performance. Second, we show that frontier analysis provides a systematic way to discriminate endogenous from exogenous components of subsidiary performance, which provides a first step in examining headquarters–subsidiary relations. Whereas many studies have examined headquarters–subsidiary relations (Ghoshal and Nohria 1989, Nohria and Ghoshal 1994), we distinguish between two types of performance sources that might provide a more accurate assessment of subsidiary performance, especially as subsidiaries are differentially affected by headquarters' policies. Third, we show that macro- and micro-organizational control mechanisms have different performance effects. Endogenous subsidiary performance is a function of micro-subsidiary control mechanisms (autonomy and interactions), whereas exogenous performance is a function of macro-corporate control mechanisms (standardization and integration). Our results show that corporate control mechanisms (standardization and integration) that are expected to have a consistent effect on subsidiary performance have differential effects on exogenous subsidiary performance and unexpected effects on endogenous subsidiary performance. Fourth, using frontier analysis, we provide a new way of examining dynamic fit, or adaptation, by identifying the best-performing subsidiaries and assessing their relative distance from other subsidiaries subject to the same input and environmental conditions. This provides a more cogent test of contingency theory's arguments and avoids the pitfalls of assessing performance based on mean-level regression-based models. Our empirical findings also suggest that an important area for future study is in the examination of the different levels of risk associated with changing organizational designs.

Conceptual Framework

Headquarters–Subsidiary Relations

The study of headquarters–subsidiary relationships has a long and rich history in organization and management literature dealing with the division of labor, departmentation, and control (Filley et al. 1976, Galbraith 1977, Walker and Lorsch 1968). Work in organizations can be divided in a number of ways (e.g., by geography, product, function, or goal) and assigned to subsidiaries, departments, divisions, or other units. Filley et al. (1976, p. 360) note that early writers focused on the efficiencies of alternative forms of departmentation and the degrees of headquarters' control over subsidiary units. Little consideration was given to unique conditions facing individual subsidiary units and their relative influence on headquarters–subsidiary relations. During the past 30 years, much has been learned from studies of headquarters–subsidiary relations, mostly in multinational corporations (MNCs) (see reviews by Egelhoff 1988, Gupta and Govindarajan 1991, Prahalad and Doz 1987, Ghoshal and Nohria 1989, Birkinshaw 2008). Most MNC researchers adopted an organizational contingency theory to examine headquarters–subsidiary relations. In this context, the core contingency theory proposition is that organization performance increases when subsidiary units are designed to differentially fit their local environmental demands subject to corporate-wide constraints of the headquarters (Donaldson 2001, Child 2005).

Implicit in this proposition is a multilevel view of subsidiary performance. It states that the performance of a subsidiary is a function, in part, on the behavior of managers and employees within the subsidiary and, in part, on the effectiveness of macro-organizational policies that subsidiaries are required to implement. Determining the relative contributions of macro-organizational policies and micro-organizational behavior on subsidiary performance is an important first step for empirically understanding headquarters–subsidiary relations. A basic assumption in designing headquarters–subsidiary relations is that these macro and micro contributions are complementary, or positively correlated. In other words, macro-organizational policies are intended to support the performance of most or all subsidiaries, and the managers of subsidiaries are expected to adapt and implement these macro policies in constructive ways. We test this assumption in our first hypothesis.

Hypothesis 1. *There is a positive correlation between the components of subsidiary performance that are attributable to endogenous micro-subsidiary efforts and to exogenous macro-organizational policies.*

In addition to examining the relative contributions of micro and macro levels of organization, a contingency theory of headquarters–subsidiary relations requires the study of how organizational units adapt to their local environments. In a study of 54 MNCs, Nohria and Ghoshal (1994) find support for this proposition. Headquarters–subsidiary relations that were differentiated to fit their local contexts were associated with higher performance of the MNC as a whole. They measured two dimensions of subsidiary context (the complexity of local environment and the amount of subsidiary resources) and three dimensions of structural control by headquarters over its subsidiaries through centralization, formalization, and normative integration (an informal cultural dimension of shared values). They found that in high-performing MNCs, greater environmental complexity was associated with lower formalization, moderate centralization, and higher shared values. In addition, subsidiary resources were negatively related to centralization, and shared norms were positively associated with the formalization of the headquarters–subsidiary relations.

Dooms and van Oijen (2008) use variables similar to Nohria and Ghoshal (1994) to examine the relative balance between subsidiary autonomy (tailored control) and headquarters-standardized control. They distinguished between formal and informal dimensions of tailored control (subsidiary autonomy and communications, respectively) and formal and informal dimensions of corporate standardized control (formalization and integration or shared values, respectively). No measures of organization performance were reported. Based on a study of 100 subsidiaries of 23 corporations, they found that firms adopt a balanced combination of subsidiary autonomy and corporate standardization. Dooms and van Oijen (2008, p. 250) report that the findings were more complicated than expected. They found no corporate effect on subsidiary autonomy but found that integration, formalization, and communication are subject to corporate influences. However, these corporate effects did not diminish the large variations that were still explained by the subsidiary level.

Building on these studies, we identify four dimensions for studying headquarters–subsidiary relations: subsidiary autonomy, subsidiary interactions, corporate standardization, and headquarters–subsidiary integration. These four dimensions are related, as illustrated in Table 1, and moderated by environmental complexity. Subsidiary autonomy (i.e., decentralization of decision making) and corporate standardization (i.e., formalization of policies and procedures) reflect formal structural mechanisms of controlling activities at the subsidiary and headquarters levels of organization. Subsidiary interactions (interdependence and communications with headquarters) and headquarters–subsidiary integration (shared norms) refer to informal control mechanisms. These informal dimensions reflect the view that organizational culture (Martin 1992) and interactions (Homans 1961) minimize divergent interests and can serve as substitutes for structural controls (Durkheim 1964, Gouldner 1954). Following Nohria and Ghoshal (1994) and Dooms and van Oijen (2008), we expect these formal and informal control mechanisms to compensate and complement each other.

Donaldson (2001) points out that these dimensions also reflect different levels of organizational differentiation and integration. Unlike Lawrence and Lorsch (1967), who view differentiation and integration at a single organizational level, Nohria and Ghoshal (1994) distinguish them at micro and macro levels of organization. Differentiation focuses on the subsidiary level and refers to the structural autonomy and interactions of each subsidiary unit with headquarters. Integration applies to the corporate level and refers to the control achieved by headquarters through standardized policies and procedures, as well as cultural views of headquarters–subsidiary integration. Subsidiary differentiation and headquarters integration need not be correlated: "Differentiation here is the difference between subsidiaries that may or may not need to be integrated at the corporate level" (Donaldson 2001, p. 85). Thus, integration also refers to corporate policies and strategies that apply to all subunits regardless of their differentiation.

These dimensions of micro-organizational differentiation and macro-organizational integration have important implications for designing headquarters–subsidiary relations. Dooms and van Oijen (2008, p. 245) point out that unit autonomy and communications are "tailor-made" to each subsidiary and differentiated throughout the organization. In contrast, corporate-wide factors, such as standardization and culture, involve controls that apply uniformly across organizational subsidiaries. This leads us to expect, as Table 1 illustrates, that subsidiary autonomy and interactions most directly influence the component of subsidiary performance that is endogenous

Table 1 Formal and Informal Dimensions of Headquarters–Subsidiary Relations

	Formal dimensions	Informal dimensions	Environmental complexity	Expected performance effects
Unit differentiation	Autonomy —Decentralization	Interactions —Interdependence —Communications		Endogenous —That part of unit performance that is due to unit's own action
Corporate integration	Standardization —Standardization	Integration —Shared norms —Culture		Exogenous —That part of unit performance that is due to corporate policies

or within the control of subsidiaries, whereas corporate standardization and headquarters–subsidiary integration directly predict the exogenous component of subsidiary performance that is attributable to macro-organizational structure. Specifically, we hypothesize the following.

Hypothesis 2. *Micro-subsidiary control mechanisms of autonomy and interactions have a positive effect on endogenous performance and no effect on exogenous performance.*

Hypothesis 3. *Macro-corporate control mechanisms of standardization and integration have a positive effect on exogenous performance and no effect on endogenous performance.*

Finally, we expect that the complexity of the local environment served by the subsidiary will moderate these relationships. Studies of organizational contingency theory show that environmental complexity increases the need for unit autonomy to adapt flexibly to heterogeneous demands (see the review by Donaldson 2001) and that uniform corporate policies tend to be too coarse-grained for adapting to diverse, particular needs (Nohria and Ghoshal 1994, Sinha and Van de Ven 2005). Conversely, as Thompson's (1967) concept of coordination by programming emphasizes, organizational rationality and efficiency increase when uniform rules, policies, and procedures can be applied to stable and homogeneous situations. Hence, the less complex a subsidiary's environment, the less the need for exercising autonomy and the greater the performance benefits of standardized policies and procedures. Therefore, we propose the following.

Hypothesis 4. *Local environmental complexity enhances Hypothesis* 2 *and dampens Hypothesis* 3.

In the next section, we discuss operational procedures for distinguishing between the endogenous and exogenous parts of subsidiary performance with a method of frontier analysis.

Methodology

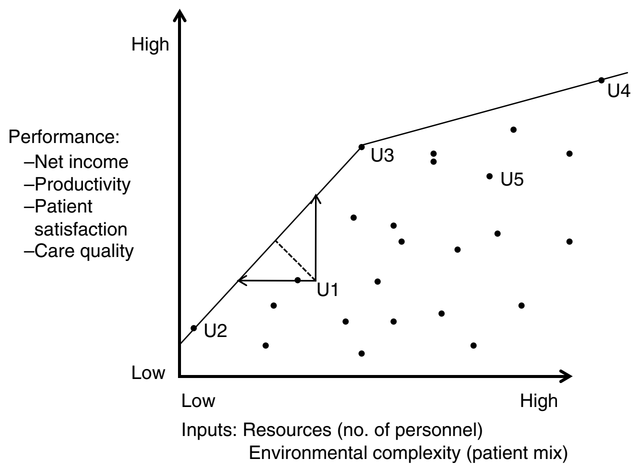
Frontier Analysis

The empirical study of organizational fitness or adaptiveness involves two steps: (1) in a sample, identify the most efficient organizations that best achieve performance outcomes subject to their particular resource and environmental constraints; and (2) analyze their design configurations with those of less efficient, comparable organizations facing similar resource and environmental constraints (Donaldson 2001, Meyer et al. 1993). The first step entails a constrained maximization problem of calculating the maximum performance outputs of organizational units in a sample subject to different resource and environmental input constraints. Organizational design factors are not part of this first step. The second step treats this calculated result from the first step as the dependent variable whose variance is explained in terms of a set of organizational design factors using a standard regression model.

To perform the first step of the analysis, we chose a method of frontier analysis to avoid a logical problem with regression-based models used in prior studies of organizational contingency theory (e.g., Drazin and Van de Ven 1985, Doty et al. 1993). As Bryce et al. (2000, p. 511) discuss, regression is designed to explain variance in average behavior; for example, $Y = f(X)$ estimates variations in average outputs, Y, from a set of independent variables, (X). In contrast, frontier analysis mathematically calculates the outlying ideal-type organization that maximizes desired performance outputs subject to its particular input constraints (Lewin and Minton 1986). This latter estimate, at least intuitively, provides an appropriate measure of the relative efficiency of organizational units facing comparable constraints. Frontier analysis provides a more direct method of empirically identifying these most adaptive outliers in a sample of organizations than do regression methods that examine the distance of residuals from the center of a least squares line.

Frontier analysis is a method that begins with the outliers in a sample. It empirically identifies the most adapted or best-performing units on the outlying frontier in the sample and then provides a way to examine the relative distance of other units in the sample from their comparable cohorts on the frontier. Frontier analysis directly addresses the constrained optimization problem in contingency theory that is central to configuration and complexity perspectives (Sinha and Van de Ven 2005). The best-performance frontier consists of organizational units that maximize desired output criteria

Figure 1 Geometric Portrayal of Frontier with DEA



subject to input resource and environmental constraints in comparison with others examined in the sample.

Figure 1 provides a geometric representation of how Data Envelopment Analysis (DEA) works. The appendix presents a technical description of DEA calculations. DEA searches for the weights that optimize outcome performance measures (the Y axis) subject to a set of input factors (on the X axis) for organizational units being investigated. After scores are calculated, as described in the appendix, a best-performance frontier can be identified from which other units can be compared. A best-performance frontier refers to the maximum output that can be attained given a set of input conditions for a sample of units that use a similar transformation process to convert inputs into outputs (Jayanthi et al. 1996). Instead of trying to fit a regression plane through the center of the data, DEA floats a piecewise-linear surface to rest on top of the most extreme observations in a sample of organizational units (i.e., DEA envelops the observations—hence, its name).

Compared with other frontier estimation methods, the features of DEA that make it particularly appropriate for our research objective are that it (1) can handle multiple input and output variables, where each variable may be measured in different scales; (2) does not require that functional relationships be specified between the input and output variables; and (3) allows for a nonlinear shape to the frontier. We also show how longitudinal observations of a sample of organizations can be analyzed with DEA to determine, over time, the changes in performance frontiers and the relative adaptiveness of organizational units on and off of the shifting frontier.

Exemplary applications of DEA in organizational studies have been made by Lewin and Minton (1986), Chilingerian (1995), Cooper et al. (1996), and Johnson et al. (1996). DEA has also been used in several health-care settings; it has been used to evaluate the efficiency of U.S. health maintenance organizations (HMOs) from 1985 to 1994 (Wholey and Bryce 1997), physician efficiency in hospitals (Chilingerian 1995), primary health care in England (Salinas-Jiménez and Smith 1996), primary care physicians of a large HMO in the eastern United States (Chilingerian and Sherman 1996), and case workers in home health-care services (Johnson et al. 2002). With the exception of the Wholey and Bryce (1997) study, all others used DEA to examine cross-sectional data. It is important to note that our objective and method in using the DEA frontier analysis differs from these applications. Past studies have used DEA results as the final deterministic criterion to evaluate and prescribe interventions for the specific organizations being investigated. Our objective is to draw inferences of study findings that go beyond the immediate sample in order to advance a more general multilevel contingency theory of designing headquarters–subsidiary relations.

Field Research Setting

This research is part of a larger longitudinal study of organizational integration in a large midwestern managed health-care system (hereafter, Midwestern) in the United States. This system emerged as a vertically integrated health-care provider (with 20,000 employees and $2 billion in revenues) through a merger in 1994 of 15 hospitals, about 50 primary care clinics, a variety of home care and ancillary services, and several health insurance plans that cover over approximately one million people. From 1994 to 2002, our study tracked the formation and integration of the system's medical group of primary care clinics.

This group practice was founded in 1994 with 20 clinics that were owned by Midwestern's parent hospitals at the time of the merger. During its first few years, the group grew rapidly by acquiring 30 additional primary care clinics to provide geographical coverage of the regions served by the group's sister health plan, whereas others were acquired to provide primary care and patient referrals to Midwestern's hospitals. During this acquisition period, the group experienced rising costs as it struggled with integrating its new clinics. By the end of 1996, the group's management attention shifted from growth by acquisition to organizational integration of its now 50 clinics with 450 physicians and more than 3,000 employees. From 1997 to 1999, group top managers focused on introducing standardized clinic operating procedures, increasing clinic financial performance through various cost reduction and revenue-generating initiatives, improving clinical quality and patient satisfaction as well as strengthening employee morale.

The group developed and implemented many policy and procedural changes in all of its clinics during the study period examined in this report. They included uniform and consolidated patient billing, supply purchasing, equipment maintenance, laboratory services, and other related administrative functions. These changes required clinics to sever some old vendor relationships and develop new ones; the clinics sometimes had to let staff go who had provided them with these functions within the clinics. With extensive physician input, several clinical groupwide initiatives were also undertaken, such as clinical care quality improvement, drug formularies, and risk management programs. Clinic managers and physicians were charged with developing new documentation and data collection systems and modifying previous practices to comply with new clinical quality and risk management standards. To promote equity in compensation and improve productivity in all clinics, a uniform compensation system for all clinic employees was adopted, and a standardized physician productivity metric was implemented based on an industry standard of relative value per unit of care (RVU). Managers in the clinics had to adjust their previous human resource practices to match new groupwide standards, and physicians had to adjust to a different kind of performance measurement and compensation system than they had experienced before. Group managers consolidated some previously stand-alone clinics to decrease operating expenses, requiring clinic staff and physicians to accommodate to new locations and new working relationships. The group also adopted some new operating procedures designed to improve patient satisfaction and care quality, such as a system allowing same-day scheduling for patients and an automated electronic medical record. Clinics were charged with assembling teams to implement these new initiatives. Finally, the group practice negotiated a uniform payment reimbursement contract with health insurance companies that treated all clinics as one provider. This represented a major change from the previous procedure where individual (and more-or-less powerful) clinics negotiated their own reimbursement contracts with health plans. These are just a few of a myriad of changes that the medical group and its clinics implemented between 1997 and 1999.

This field setting provides an ideal opportunity to examine whether and how these group-level policy changes are related to the organization and performance of subsidiary clinics that are serving diverse patients in local communities. This report examines the two-year time period (1997 and 1999) when most of the group integration initiatives mentioned above began and concluded. Of course, we cannot measure the influence of each of these macro-policy changes on clinics. Instead, we view the cumulative effects of all macro-group policies as producing the total change observed in the group performance frontier for all the clinics during the two-year study period. We then examine how this group frontier change differentially affects clinic performance.

Data Collection

Data on the clinic variables were collected in the fall of 1997 and again in the fall of 1999. In each wave, the data came from three different sources. First, we were given access to patient satisfaction surveys that were conducted in 1997 (7,700 in total); the surveys taken in 1999 were completed by 8,000 patients who were served by the primary care clinics. The group practice contracted with an independent health-care survey organization to conduct the patient satisfaction surveys. After cleansing the data of any patient identification information, the vendor provided us with a copy of the patient satisfaction surveys for each clinic. Second, data on clinic environmental characteristics and economic performance were obtained from organizational records. Third, we designed and conducted questionnaire surveys and obtained responses from about 1,000 employees from all clinics in 1997 and 1999; our surveys included measures of the perceived quality of health care and the other variables in our model of headquarters–subsidiary relations in Table 1.

The specific sample of organizational units examined in this study consists of 32 primary care clinics[1] that are owned by the large managed care organization. Given the relatively small number of clinics for statistical analysis, we had to restrict the scope of our data analysis and model by selecting the fewest number of clinic input and outcome variables in our DEA model.

DEA Model Variables

Specifying an empirical DEA model of key clinic inputs and performance outcomes is the first and perhaps most important step in the research process. Model misspecification results in selecting the wrong organizational units on and off the frontier and irrelevant findings for theory and practice. To decrease this likelihood, we collaborated with managers and lead clinicians of the medical group practice to develop an empirical model of clinic input and outcome variables that the managers used to evaluate clinic performance. This involved a series of meetings, including about three with the top managers of the group practice, another meeting with the district managers and medical directors, and a review session with the clinic managers. The DEA model that the managers and researchers jointly developed to assess the performance of clinics is the following:

> Maximize: Business Care (clinic productivity and net income) and Patient Care (patient satisfaction and care quality) subject to clinic resources (size), and for different levels of environmental complexity (patient mix).

These clinic input and performance measures are now described.

Clinic Input Conditions. Clinic resources (the size or number of employees) was chosen as the key input factor in the DEA model for clinics serving a broad and focused mix of patients (our indicator of environmental complexity). Clinic size was selected as the major resource input factor because labor costs account for approximately 80% of annual clinic operating costs. Using size as the input variable, the DEA analysis identifies the relative performance of clinics in terms of those that accomplish the most with the resources they have. In addition, studies over the years indicate that size is perhaps one of the best overall predictors of organization structure (Tosi and Patt 1967, Kimberly 1976, Cullen and Baker 1984, Bluedorn 1993, Camisón-Zornoza et al. 2004).

With regard to environmental complexity, clinic managers and physicians emphasized the importance of the mix of patients served by different clinics. An internal organizational study found that there were large differences in demands on clinics that served a broad versus narrow mix of patients. The study characterized patients of broad or heterogeneous clinics as "option seekers" (where 58% of all patients are shoppers, basing decisions on urgency, convenience, and cost). In contrast, the patients served in more focused or homogeneous clinics were referred to as "relationship seekers" (42% want long-term relationships). Medical group managers observed that smaller clinics appear more efficient and effective, but that may be because they serve a more homogeneous set of patients. Larger clinics that serve a greater proportion of option seekers stay open longer hours (resulting in higher overhead and staffing costs), provide urgent care and more diverse services, and deal with patients who are not easy to keep satisfied. With the assistance of the group practice managers and physicians, we classified the environmental complexity of primary care clinics in this sample into two groups based on whether they serve a broad or focused mix of patients.

Clinic Outcome Performance. Medical group managers and physicians selected two composite measures of clinic performance: patient care and business care. As Table 2 indicates, patient care is the average of patient satisfaction and staff courtesy (measured with eight and four items, respectively, in a patient survey conducted by an independent research firm) and clinical quality care (measured with five items in a survey completed by clinic health-care providers). Business care is the average of clinic productivity (measured from organizational records as the number of standardized clinical services (RVUs) per clinic provider) and clinic net income (measured as net revenue per clinic provider from organizational records). Group practice managers confirmed the relevance of these performance measures. They reported using these measures in their performance appraisals of clinics and physicians within the clinics.

Measures of the Clinic–Group Relations Model

As Table 2 shows, we measured four dimensions of clinic–group relations: clinic autonomy, clinic–group interactions, group work standardization, and headquarters–subsidiary integration. These dimensions were defined and measured as follows.

1. *Clinic autonomy*: This measure is defined as the extent to which clinic employees (physicians, nurses, and staff) perceive that they exercise discretion or influence decisions about what work to perform, how work is performed, and the development of work policies or procedures. Survey questions for measuring these three decisions were adapted from Van de Ven and Ferry (1980).

2. *Work standardization*: As noted above, during the period of study, group practice management introduced a variety of policies and procedures that all clinics were to follow. Our measure of standardization captures the combined effects of how these group policy changes influenced the formalized structuring of work in clinics. As Table 2 indicates, work standardization was measured with four survey questions dealing with the clarity, degree, number, and enabling of work rules and procedures. Three of these items come from Van de Ven and Ferry (1980).

3. *Clinic–group interactions*: This is a measure of informal clinic–group relations that is tailored to individual clinics and not specified by group policies (Dooms and van Oijen 2008, p. 247). It was measured as the degree of perceived interdependence and communications between individual clinics and group headquarters with the five survey items outline in Table 2.

4. *Headquarters–subsidiary integration*: Creating an integrated medical group practice out of many previously independent clinics was a major objective of group managers. Nearly biweekly meetings and semiannual retreats of clinical and managerial employees occurred during the study period; these featured discussions of group culture, shared norms, and integrative synergies. These meetings provided an informal mechanism for group coordination and integration. The survey included 10 questions, outlined in Table 2, that measure the perceived degree of headquarters–subsidiary integration.

The right column of Table 2 shows the interitem reliabilities (coefficient α), the intraclass correlations (ICC(1)) (Bliese 2000), and the within-clinic interrater reliabilities (r_{wg}) (James et al. 1984) for the four organizational dimensions. The α values for the four constructs range from 0.68 to 0.86, providing good evidence of reliabilities among items used for measuring the four constructs. In addition, the interrater reliability estimates with r_{wg} among all informants within clinics are clearly in an acceptable range from 0.73 to 0.94. Moreover, the ICC(1) values (ranging from 0.42 to 0.46) are significant and comparable to the median ICC(1) values of aggregated constructs reported in the organizational literature (see Bliese 2000, Zellmer-Bruhn and Gibson 2006).

Table 3 presents the results of a confirmatory factor analysis of the 21 survey items that were used to measure the four organizational dimensions. The table shows

Table 2 Measurement of Variables

Variable	Measures	α, ICC, r_{wg}
Clinic resources (size)	Number of full-time equivalent positions based on organization records	
Clinic environmental complexity	Mix of patients served by a clinic, coded by group managers as a broad (heterogeneous) or focused (homogeneous) mix of patients	
Clinic productivity	The number of RVUs of care per provider. The RVU is an industry standard established by Medicare to measure the units of patient care delivered by health-care providers	
Clinic net income	Net revenue per provider based on organization records	
Patient satisfaction as perceived by patients served by clinic	Mean of eight items in a patient survey conducted by an independent research firm contracted by the medical group practice: 1. Chance to explain the reason for the visit 2. Provider listened 3. Received answers to questions 4. Trust in provider 5. Treated with respect 6. Involved in treatment decisions 7. Sufficient time with provider 8. Provider courtesy	$\alpha = 0.84$
Patients' perceptions of clinic staff courtesy	Mean of four items in a patient survey conducted by an independent research firm contracted by the medical group practice: 1. Courtesy of appointment maker 2. Courtesy of office staff 3. Courtesy of telephone advice staff 4. Rating of telephone advice received	$\alpha = 0.86$
Patient care quality	Mean of five items in an employee survey about the extent of agreement on following process indicators of quality of care provided to patients: 1. Patients see the same physician 2. Clinicians meet to discuss patient care 3. Patient information is available when needed 4. Follow-up phone calls are made 5. Patients are reminded when they need additional care	$\alpha = 0.74$
Clinic autonomy	Mean of three items in an employee survey about the amount of influence in making decisions about 1. What work is performed 2. How work is performed 3. Work policies and procedures	$\alpha = 0.80$ ICC(1) $= 0.43^*$ $r_{wg} = 0.73$
Work standardization	Mean of four items in an employee survey about the extent to which 1. Work is clearly defined 2. Work requires following rules and procedures 3. Number of rules and procedures to follow 4. Rules make work easier	$\alpha = 0.68$ ICC(1) $= 0.41^*$ $r_{wg} = 0.85$
Clinic–group interactions	Mean of five items in an employee survey about 1. Clinic's dependence on the group 2. Group's dependence on the clinic 3. Frequency of communications with people in the group 4. How often one works with people in the group 5. Frequency of meetings with people in the group	$\alpha = 0.84$ ICC(1) $= 0.46^*$ $r_{wg} = 0.74$
Headquarters–subsidiary integration	Mean of 10 items in an employee survey about the extent to which the medical clinics and group 1. Complement each other 2. Consider each other in their actions 3. Share a primary focus on patient care 4. Respect each other's views and values 5. Go out of their way to help each other 6. Get in each other's way (reverse scored) 7. Believe that their future is tied to one another 8. Feel they have a better chance of succeeding together 9. Share information that is helpful 10. Have incentives that are aligned	$\alpha = 0.86$ ICC(1) $= 0.42^*$ $r_{wg} = 0.94$

$^*p < 0.001$.

Table 3 Confirmatory Factor Analysis on Clinic–Group Relations Measures

	Headquarters–subsidiary integration 1	*Clinic–group interactions* 2	*Clinic autonomy* 3	*Work standardization* 4
Work standardization				
Work is clearly defined	0.24	−0.13	−0.27	**0.42**
Degree that rules are followed	0.18	−0.13	0.12	**0.83**
Number of rules	0.11	−0.07	0.16	**0.83**
Rules enable work	0.36	−0.07	−0.11	**0.71**
Clinic autonomy				
Decide what work to perform	0.00	0.20	**−0.88**	−0.10
Decide how to perform work	0.00	0.16	**−0.83**	−0.03
Decide on work policies and procedures	0.00	0.19	**−0.77**	−0.06
Clinic–group interactions				
Clinic depends on group	−0.01	**0.73**	−0.12	−0.12
Group depends on clinic	0.00	**0.64**	−0.04	0.05
Communication frequency	−0.03	**0.85**	−0.20	−0.14
Work frequency	−0.04	**0.87**	−0.18	−0.11
Meeting frequency	−0.06	**0.78**	−0.24	−0.23
Headquarters–subsidiary integration				
Complement each other	**0.70**	−0.04	−0.04	0.24
Consider each other	**0.80**	−0.09	0.01	0.19
Share a primary focus	**0.75**	0.05	−0.15	0.21
Respect each other	**0.84**	−0.01	−0.08	0.23
Help each other	**0.82**	−0.05	−0.05	0.24
Get in each other's way (reverse scored)	**−0.46**	0.20	−0.07	−0.31
Future is tied together	**0.68**	0.04	−0.04	0.10
Succeed together	**0.75**	0.03	0.00	0.13
Share helpful information	**0.78**	−0.09	−0.05	0.21
Have aligned incentives	**0.77**	−0.08	−0.02	0.21
Eigenvalues	5.84	3.51	1.91	1.79
Cumulative % common variance	26.50	42.50	51.20	59.30

Notes. $n = 1{,}205$ respondents. Extraction method: principal component analysis. Rotation method: oblimin with Kaiser normalization.

the structure matrix produced by a principal components analysis using an oblimin rotation procedure with Kaiser normalization. The results show strong evidence of convergent and discriminant validities. All items intended to measure one of the four organizational constructs (in bold) converge with high loadings on a single factor and clearly discriminate by having low loadings on all other factors. The four factors explain about 60% of the common variance, and each factor contributes a substantial percentage to this cumulative common variance.

DEA Performance Analysis

DEA was performed on the sample of clinics measured in 1997 and then again on data collected in 1999. As explained in the appendix, DEA computes the efficiency of clinics (called decision-making units, or DMUs, in the DEA literature) with the following equation:

$$\text{Maximize } E_u = \frac{\sum_{r=1}^{s} y_{ru} O_{ru}}{\sum_{i=1}^{m} x_{iu} I_{iu}}, \qquad (1)$$

where u represents the units of DMU; E represents performance efficiency; I and O represent all inputs and outputs, respectively, for each DMU; and x and y represent the weights assigned to each input and output. These weights are chosen in such a way that the DEA efficiency ratio is maximized for each DMU in the interval $[0, 1]$. As Figure 1 illustrates, this frontier bounds ("envelops") the remaining data points from above, and the interior observations of DMUs below the frontier receive nonnegative scores less than 1 based on their proximity to the frontier (Bryce et al. 2000, p. 513).

As noted previously, we follow two methodological procedures to analyze the DEA model and the clinic–group design model. First, we use the DEA procedure to identify the organizational units on a best-performance frontier as discussed in the appendix. Applied to our longitudinal data, we compute a Malmquist Index (MI) developed by Färe et al. (1994) to determine what parts of changes in unit DEA productivity are due to endogenous efforts of organizational units (often called "managerial" efficiency) and exogenous shifts in the environment or macro-organization (also called "policy" efficiency by Thanassoulis 2001). We subsequently use these DEA results as the dependent variables to analyze the clinic–group relations model using a standard regression-based model and to examine how organizational units adapt over time in their relative positions on or off the best-performance frontier; we also examine how this frontier changes over time to produce Red Queen dynamics.

Findings

Descriptive Statistics

Table 4 shows the correlations among clinic performance measures of business and patient care. As expected, the two measures of business care are significantly correlated, as are the three indicators of patient care. The table also shows very low correlations between the measures of patient and business care. This latter finding was gratifying to clinic physicians and managers who feared that clinic cost-cutting efforts were compromising patient care quality. They indicate that clinic business care and patient care are independent; advancing one outcome does not decrease or increase attaining the other desired outcome in this sample of clinics.

Table 5 presents a comparison of the clinics serving a broad (heterogeneous) versus focused (homogeneous) mix of patients. The table shows that the two groups of clinics are significantly different in terms of size, patient care, and group frontier change, but not in terms of organizational design, business care, and clinic DEA performance change over time. (These DEA performance measures are discussed in the next section.) On average, clinics with a more complex heterogeneous mix of patients are larger (staffed with about 58 clinicians) than clinics serving a less complex and homogeneous mix of patients (with 27 employees). The more focused mix of patients in these clinics tend to provide OB/GYN services for expectant families, treat patients with diabetes and other chronic diseases, or serve more acute

Table 4 Correlations Among Clinic Performance Measures

	Patient care				Business care		
	Patient care composite	Patient satisfaction	Staff courtesy	Patient care quality	Business care composite	Productivity RVUs per provider	Net revenue per provider
Patient care							
Patient care composite	1						
Patient satisfaction	0.89**	1					
Staff courtesy	0.68**	0.41**	1				
Patient care quality	0.17**	−0.05*	0.61*	1			
Business care							
Business care composite	−0.10	−0.04	−0.10	0.05	1		
RVUs per provider	−0.03	0.005	−0.13	0.001	0.72**	1	
Net revenue per provider	−0.14	−0.12	−0.02	0.15	0.79**	0.18**	1

*$p < 0.05$; **$p < 0.01$.

Table 5 Clinics Serving Broad and Focused Mixes of Patients

	Broad (heterogeneous) mix		Focused (homogeneous) mix		Group differences
Number of clinics	18		14		
	Mean	Std. dev.	Mean	Std. dev.	Significance
Resources (no. of personnel)	57.73	28.28	26.95	20.25	**
Organization design					
Autonomy	3.16	0.30	3.22	0.45	
Standardization	3.65	0.18	3.68	0.30	
Interactions	2.43	0.38	2.58	0.42	
Integration	3.19	0.17	3.06	0.31	
Clinic performance					
Business care composite	2.08	0.36	1.95	1.00	
RVU productivity/provider	6,403.93	1,245.83	6,855.58	3,650.32	
Net income/provider ($)	−31,502.33	27,239.39	−49,180.07	55,792.70	
Patient care composite	1.48	0.48	2.56	0.76	**
Patient satisfaction	2.79	0.04	2.85	0.04	**
Staff courtesy	3.87	0.15	4.05	0.15	**
Perceived care quality	3.48	0.20	3.84	0.38	**
DEA performance[a]					
Clinic performance change	0.93	0.29	0.81	0.35	
Group frontier change	1.03	0.03	1.13	0.01	**

[a]Refer to Table 6.
**$p < 0.01$.

needs of elderly patients. In addition to these kinds of patients, the broad clinics also serve a more heterogeneous array of patients and families seeking less acute and chronic health-care services such as vaccinations; medical checkups; the treatment of colds, flus, cuts, and scrapes; and drug prescriptions. Because they have medical conditions requiring long and repeated care, a greater proportion of patients in focused clinics seek a long-term relationship with their "own" doctor, whereas more patients of broad clinics seek immediate, competent, and comprehensive health-care services when it is convenient for their busy work and family schedules.

Clinic site visits by the researchers revealed that the more complex broad (compared with focused) clinics were not only larger but also much busier, with full waiting rooms and a constant buzz of clinicians and patients going in all directions. Given these different patient expectations and practices, the findings in Table 5 are not surprising: patients served by less complex focused clinics are more satisfied with their care and perceive clinic staff as more courteous, and staff perceive that they provide a higher quality of health care than broad clinics. The insignificant statistical differences between broad and focused clinics on organizational and business care dimensions may be due to the much greater standard deviations in these dimensions among focused clinics than among broad clinics. When reporting these findings, managers of the clinic group practice stated that the cost structure of focused clinics was lower than broad clinics. They referred to an internal study by the health insurance plan (a sister division of the Midwestern system) that found that the per-member per-month cost of the average patient served in the broad-mix clinics was \$153 and was \$98 in the focused-mix clinics. These observed differences between the two types of primary care clinics provide an ideal natural field setting to examine how uniform macro-organizational policies might have differential effects on the performance of subsidiary clinics depending on their type.

DEA Analyses Results

Following Thanassoulis (2001), we evaluated clinics' efficiency in two DEA steps. The results of these two steps, repeated in each time period (1997 and 1999), are reported in the columns labeled "Step 1" and "Step 2" in Table 6. Step 1 evaluates each clinic's efficiency compared to clinics serving the same type of patient mix (i.e., either broad or focused). Step 2 reports each clinic's efficiency compared to all types of clinics in the sample. In terms of an adaptiveness landscape metaphor, Step 1 compares the relative performance among clinics on their own design hill, whereas Step 2 compares the relative performance among clinics on all (both broad and focused) hills.

As the Step 1 columns show for both time periods, each design group has its own best-performing clinics. Clinics with DEA efficiency ratings of 100% in Table 6 are on the best-performance frontier for this sample, whereas the scores of clinics with DEA efficiency ratings lower than 100% indicate how far the clinics are off the frontier (relative to their best-performing peers). In 1997 (Time 1), clinics C23, C24, and C31 were on the frontier among broad clinics; C17, C32, C41, and C57 were on the frontier among focused clinics in that year. Two years later (Time 2), clinics C14 and C31 were on the frontier among broad clinics, and C17, C32, C42, and C60 were on the frontier among focused clinics in that year. Only clinic C31 among broad patient care clinics and clinics C17 and C32 remained on the frontier in both years, whereas other clinics came on and fell off the frontier relative to their cohorts.

The relative performance efficiency of broad and focused clinics operating in complex and simple environments (respectively) in each year is indicated in the Step 2 columns of Table 6. The table shows that focused clinics have higher DEA efficiency scores than the clinics serving a broad mix of patients. In fact, not one broad clinic has a DEA efficiency score that exceeds the lowest-performing focused clinic. This is shown in Figure 2, which plots the clinics based on their Step 2 scores in 1997 and 1999. As the figure shows, there are dramatic DEA performance differences between broad and focused clinics in both time periods. Equally clear from the figure is the close clustering among broad clinics in the low DEA efficiency range and the even closer clustering among focused clinics in the high-performance range in 1997 and 1999. The correlation between the DEA efficiency in 1997 and 1999 for all clinics is 0.97 (statistically significant), whereas it is only 0.33 among clinics within each design type.

As these data suggest, although there is some shifting in DEA performance among clinic peers of each type, the relative performance of all clinics remained the same during the study period. Focused and broad types of clinics are located on different organization design hills in our metaphorical landscape, with the focused design hill much higher in performance than the broad clinic design hills. In terms of Red Queen competitive dynamics (Barnett and Sorenson 2002, Derfus et al. 2008), the clinic managers may have run as fast as they could for two years, and then found their performance relatively unchanged. As we examine in the next section, this may be a result of the endogenous efforts and capabilities of clinic managers, and/or it may be due to exogenous policy or environmental reasons that are beyond the immediate control of clinic managers.

Findings on Endogenous and Exogenous Components of Clinic Performance

The last three columns of Table 6 report the values of the Malmquist Index in terms of changes over time in each clinic's productivity that are attributable to the

Table 6 Frontier Analysis of Clinics, 1997 and 1999

		1997 DEA		1999 DEA		MI		
Clinic ID	Macro policy type	Within type (Step 1)	Between types (Step 2)	Within type (Step 1)	Between types (Step 2)	Clinic change (C)	Frontier change (F)	Total productivity change (T) ($T = C * F$)
C16	Broad	71.28	73.68	84.42	86.27	0.42[a]	0.02	0.45
C14	Broad	87.18	70.78	100.00	86.08	0.32	0.06	0.41
C15	Broad	64.69	74.49	82.76	84.03	0.18	0.03	0.22
C8	Broad	61.53	76.41	79.59	86.08	0.2	−0.01	0.19
C61	Broad	76.43	79.11	79.62	85.10	0.14	−0.01	0.14
C59	Broad	73.21	79.11	94.30	84.90	0.12	−0.01	0.12
C31	Broad	100.00	68.83	100.00	84.03	0	0.08	0.08
C19	Broad	91.38	72.87	87.88	86.08	0.04	0.04	0.08
C44	Broad	67.27	69.48	41.38	84.03	−0.1	0.11	−0.01
C50	Broad	94.54	71.66	91.95	83.73	−0.05	0.02	−0.03
C23	Broad	100.00	79.11	94.36	85.29	−0.09	−0.01	−0.09
C5	Broad	86.79	79.11	75.87	83.73	−0.18	0.01	−0.17
C45	Broad	84.64	79.11	51.72	84.03	−0.2	0.02	−0.19
C33	Broad	94.75	71.66	69.70	86.08	−0.26	0.04	−0.23
C38	Broad	97.31	71.32	83.95	85.29	−0.25	0.02	−0.24
C24	Broad	100.00	69.45	74.84	84.03	−0.27	−0.01	−0.27
C58	Broad	81.70	68.83	51.54	84.90	−0.61	0.05	−0.59
C51	Broad	84.72	70.13	54.55	86.08	−0.65	0.05	−0.63
C22	Focused	65.86	98.41	72.37	99.25	0.36	0.12	0.52
C52	Focused	56.85	98.74	73.68	100.00	0.26	0.13	0.4
C11	Focused	60.27	100.00	82.94	99.00	0.23	0.12	0.37
C6	Focused	56.85	98.70	68.58	99.72	0.02	0.14	0.16
C32	Focused	100.00	100.00	100.00	100.00	0	0.13	0.13
C42	Focused	90.16	100.00	100.00	100.00	0.01	0.12	0.13
C17	Focused	100.00	100.00	100.00	100.00	−0.06	0.14	0.06
C60	Focused	84.62	100.00	100.00	100.00	−0.26	0.14	−0.17
C37	Focused	75.13	100.00	63.17	99.61	−0.33	0.13	−0.25
C48	Focused	60.18	98.70	65.05	100.00	−0.45	0.14	−0.37
C1	Focused	67.78	100.00	43.00	99.50	−0.53	0.13	−0.47
C34	Focused	91.07	98.30	69.51	99.00	−0.57	0.12	−0.52
C57	Focused	100.00	100.00	47.37	100.00	−0.64	0.13	−0.59
C41	Focused	100.00	100.00	83.44	99.58	−0.68	0.11	−0.65

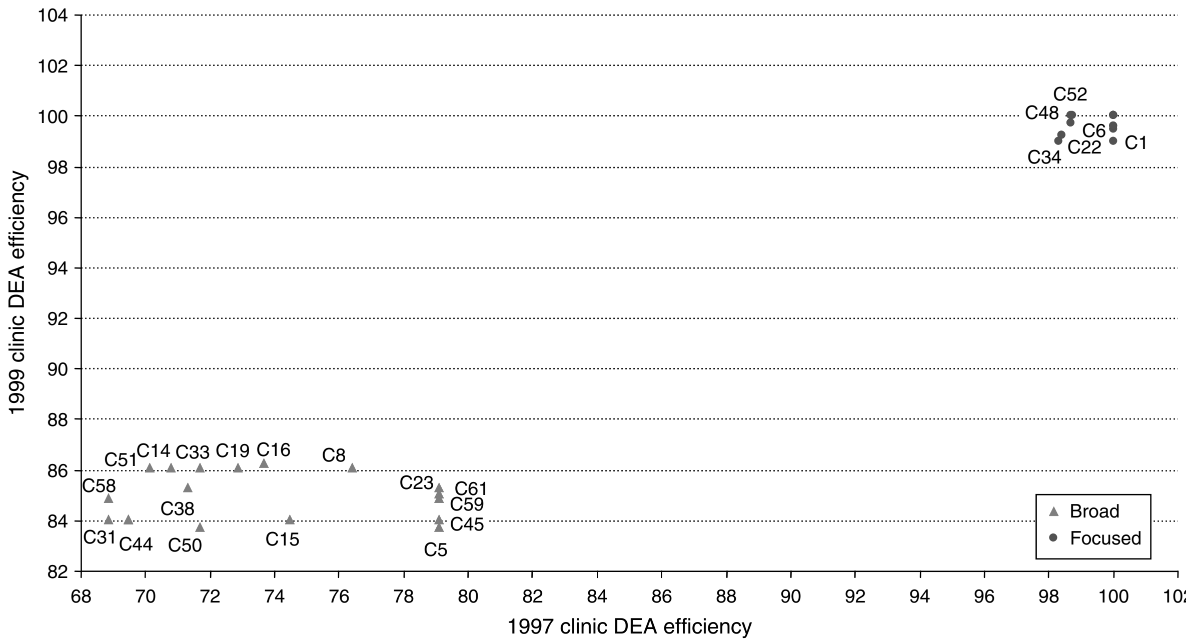
Notes. All values in the table represent relative productivity. The first four columns are presented in terms of percentage, within the range of 0% and 100%, where 100% means maximal efficiency in DEA; other values are productivity relative to 100%. The last three columns are raw values according to the MI computations but have been subtracted by 1. Thus, a positive value means an increase in efficiency, and a negative value means a decrease in efficiency; a value of 0 means no change.

[a]Clinics sorted by type and total productivity change (in descending order).

clinic's endogenous efficiency and its exogenous frontier. The clinic's endogenous efficiency change consists of the change in the clinic's performance with respect to its peers of the same clinic type, whereas the clinic's exogenous efficiency change consists of the change in the clinic's performance with respect to all the clinics in the sample. See the appendix for computations. The correlation between endogenous efficiency change and exogenous frontier change is -0.14, which is statistically insignificant. This finding rejects Hypothesis 1. In this sample of clinics, contrary to expectations, no positive relationship exists between the components of clinic performance that are due to endogenous managerial efforts within the clinics and exogenous macro policies at the group level. Instead, endogenous and exogenous components of clinic performance are unrelated and tend to move in a slightly negative direction. This low correlation may be due to the absence of a relationship between group and clinic performance, or it may be due to a washout effect of group-level policy changes benefiting the performance of some clinics and hurting others.

To examine these possibilities, we plot all clinics in terms of clinic efficiency change, group frontier change, and total productivity changes from 1997 to 1999 (i.e., the right three columns of Table 6) on a three-dimensional (3D) graph (see Figure 3). The graph shows that all of the more complex clinics serving a broad patient mix lie to the left of the line separating the clinics on group frontier change, and all of the less complex focused clinics with a homogeneous mix of patients lie to the right. Figure 3 shows that changes over time in endogenous clinic performance varied from a 40% decrease to a 60% increase among both focused and

Figure 2 Scatterplot of Clinic DEA Efficiency, 1997 and 1999

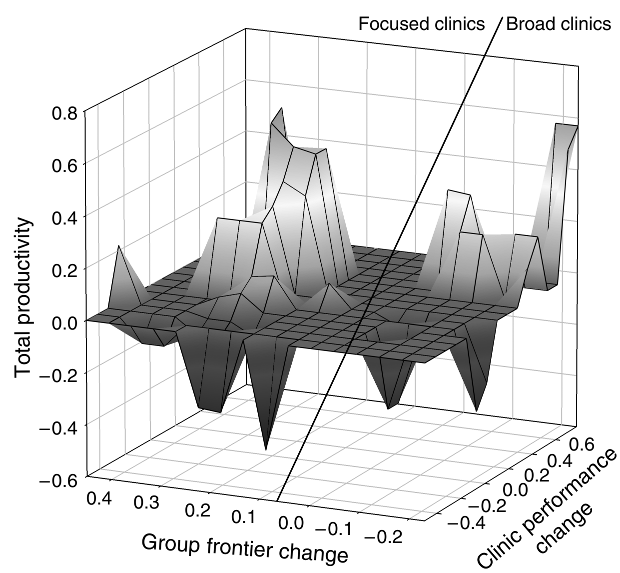


broad clinics. With respect to group frontier changes, however, it is clear that all focused clinics lie along the positive range (from 10% to 40% increases), and all broad clinics are in the negative range (from 0% to 20% decreases). These data show that the focused clinics uniformly benefit much more from exogenous group frontier changes than do their counterparts who serve a broad mix of patients.

These results might lead managers to decide to change the design of their clinics from serving a broad mix of patients to a narrow one. This conclusion, however, does not take into consideration the performance risks in making such design changes. The peaks and troughs in the changing performance landscape of the clinics in Figure 3 suggest that the performance volatility or risk of focused and broad clinics is not the same. Changes in the sizes and locations of performance peaks and troughs of clinics in Figure 3 call attention to such risks. The organizational design of focused clinics reaches a higher performance peak, but it also has a deeper trough of performance declines than that of the broad clinics. In other words, the focused organizational design that has the greatest total productivity gains also has the highest total productivity losses over the same time period and in the same sample of clinics.

The organization design literature has largely ignored the risks associated with changing organizational designs. Organizational ecologists, of course, have highlighted the liabilities of organization change because of inertial forces (Stinchcombe 1965; Hannan and Freeman 1977, 1989). Organizational inertia, however, is different from risk. Whereas inertia focuses on the difficulties or rigidities of changing organizations, risk deals with the likelihood of alternative consequences of changing organizational designs regardless of the difficulties of doing so. Theories of risk are prominent in finance literature (e.g., Gollier 2001), and volatility is the commonly used indicator of risk in this literature. The greater performance volatility of focused versus broad clinics shown in Figure 3 calls for an examination of the risk–return trade-offs of changing organizational designs. Although

Figure 3 Change in Clinic Performance, Group Frontier, and Total Productivity



Notes. This 3D graph uses a negative exponential smoothing technique that applies a Gaussian weight function to the data and a quadratic fit. The diagonal line distinguishes where the broad and focused clinics are plotted in the figure.

switching from broad to focused designs may increase the likelihood of higher total clinic productivity gains, it comes at the risk of experiencing greater productivity loses. As a consequence, the return-to-risk ratio of the broad clinic design may not be inferior to that of the focused clinic design.

The organizational complexity literature (e.g., Levinthal and Warglein 1999, Anderson et al. 1999, Siggelkow 2001) that models organizational adaptiveness on changing landscapes using Kauffman's NKC model (Kauffman 1993) also does not address this risk, for it assumes a base of zero or greater performance to a design hill, and it does not entertain negative valleys or troughs in a performance landscape. In effect, these organizational simulation models right-censure simulation data to zero or greater performance of alternative design hills and thereby forfeit the opportunity to examine the risk–return trade-offs of alternative organizational designs (Elton and Gruber 1997).

One aspect of the literature on organization design that begins to touch on this risk–return trade-off is complementarity theory, which suggests that during organization change, performance may reflect a steep decline for several periods and then improve slowly with time (Milgrom and Roberts 1995, Whittington and Pettigrew 2003). The peaks and troughs in Figure 3 suggest that this curvilinear relationship may be possible if clinics change from the broad type to the focused type. However, as Figure 2 shows, no shifts between broad and focused clinic designs were observed during the study period.

Our study suggests (but does not demonstrate) that a multilevel explanation of the risk–return trade-off is needed. Significant organizational changes may not be within the endogenous capabilities of organizational subsidiaries or subunits. Other studies indicate that exogenous interventions are often needed for organizational units to undertake radical changes (Virany et al. 1992, Van de Ven et al. 1999). This may explain why the clinics in our sample did not change from serving a broad to a focused mix of patients. No exogenous macro-policy decisions and resource investments occurred to make it feasible for the clinics to undertake this transformative change. As a consequence, as we will now see, the broad clinics did the best they could with their endogenous (but limited) resources and capabilities to adapt to changing conditions in serving their heterogeneous mix of patients. Focused clinics did the same and performed better collectively as a result of the performance benefits they received from exogenous group-level frontier changes.

Findings on the Model of Headquarters–Subsidiary Relations

Finally, we examine Hypotheses 2–4 in our multilevel contingency model of headquarters–subsidiary design. As discussed previously and illustrated in Table 1, we expected the unit differentiation dimensions (clinic autonomy and clinic–group interactions) to influence the endogenous component of clinic performance that is attributable to clinic managerial efforts and the group integration dimensions (standardization and headquarters–subsidiary integration) to influence the exogenous component of clinic performance that is attributable to changes in group frontier. Table 7 shows the results of two regression analyses of these organizational dimensions on the endogenous and exogenous components of clinic performance changes. The equations also include a control variable for patient mix (broad or focused) to capture the influence of environmental complexity that featured prominently in the preceding DEA analysis.

The first regression equation in Table 7 examines the effects of unit differentiation dimensions (clinic autonomy and clinic–group interactions) and group integration dimensions (standardization and headquarters–subsidiary integration) on the endogenous change in clinic performance. Partially supporting Hypothesis 2, the results suggest that increases in clinic autonomy have a significantly positive effect on the endogenous change in clinic performance, whereas group integration dimensions (standardization and headquarters–subsidiary integration) have no significant effect on the endogenous change in clinic performance. Contrary to Hypothesis 2, however, the results suggest that clinic–group interactions have a significantly negative effect on endogenous change in clinic performance. As an indicator of

Table 7 Regression Results on Clinic Performance Change and Group Frontier Change

	Clinic performance endogenous change		Group frontier exogenous change	
	Beta	*P*-value	Beta	*P*-value
Unit differentiation dimensions				
Clinic autonomy	0.42	0.05	0.02	0.80
Clinic–group interactions	−0.65	0.01	−0.27	0.02
Group integration dimensions				
Standardization	−0.40	0.08	−0.13	0.21
Headquarters–subsidiary integration	0.15	0.53	0.26	0.03
Local environment complexity				
Patient mix (heterogeneous–homogeneous)	−0.07	0.71	0.96	0.00
R^2	0.36		0.85	
F-statistic	2.32	0.07	23.47	0.00

informal clinic–group coordination, we expected clinic–group interactions to be a mechanism for tailoring headquarters–subsidiary relations to serve the particular needs of local clinics, as Dooms and van Oijen (2008) found. Instead, the data suggest that these clinic–group interactions hampered clinics' efforts to achieve the highest performance changes given their resources.

The second regression in Table 7 examines the effects of unit differentiation dimensions (clinic autonomy and clinic–group interactions) and group integration dimensions (standardization and headquarters–subsidiary integration) on the exogenous change in clinic performance or group frontier change. Partially supporting Hypothesis 3, the results suggest that increases in headquarters–subsidiary integration have a significant, positive effect on the exogenous change in clinic performance, whereas clinic autonomy has no significant effect on the exogenous change in clinic performance. Contrary to Hypothesis 3, the results suggest that clinic–group interactions have a significant, negative effect on the exogenous change in clinic performance, whereas standardization has no effect on the exogenous change in clinic performance.

Hypothesis 4 predicted that clinic environmental complexity moderates these relationships. Unfortunately, we do not have sufficient degrees of freedom to add interaction terms to our regression equations to test this hypothesis. As an alternative, we examined the simple correlations for clinics serving a simple (focused) versus complex (broad) mix of patients. Table 8 shows the correlations among clinic autonomy (a dimension of subsidiary differentiation) and standardization (a dimension of headquarters integration) with endogenous and exogenous changes in clinic performance. The correlations are in the directions hypothesized by our multilevel contingency model. As expected, clinic autonomy is positively correlated with the endogenous change in clinic performance and negatively correlated with the exogenous change in clinic performance or group frontier change for complex clinics, but it is uncorrelated for simple clinics. Conversely, group standardization is strongly correlated with both endogenous and exogenous performance changes for simple clinics, whereas these correlations are very low for complex clinics.

Table 8 Correlations of Clinic and Group Design and Performance Measures

	Clinic performance endogenous change		Group frontier exogenous change	
	Complex (broad)	Simple (focused)	Complex (broad)	Simple (focused)
Clinic autonomy	0.34	−0.002	−0.34	0.07
Standardization	−0.13	0.44	−0.01	0.35

These results remind us of the principle of opposite part–whole relationships (Simmel 1955, Dahrendorf 1979, Astley and Van de Ven 1983). Many organization design problems and relationships manifest themselves in different and contradictory ways at different organizational levels. At the micro level, the focus is on the particularistic needs of patients served by local community clinics and on the autonomous discretion of clinicians to decide how best to enable this. This clinic autonomy does not necessarily advance macro group-level objectives where the focus is on strategic policies, structural arrangements, and building an integrative culture. Moreover, the substantive effects of clinic design factors can be different for different kinds of clinics, depending on their structure and patient mix.

Concluding Discussion

This paper advances a multilevel organizational contingency theory that takes into account the different impact of headquarters policies and subsidiary managerial efforts on subsidiary performance. Our paper builds on the contingency theory view of designing headquarters–subsidiary relations by proposing that organization performance increases when subsidiary units are designed to differentially fit their local environments subject to corporate constraints. An important contribution of this research is that it addresses three thorny problems with this contingency theory proposition: (1) satisfying multiple and often conflicting dimensions of organizational context, design, and performance at micro and macro levels; (2) disentangling what parts of the performance of organizational units are attributable to endogenous and exogenous factors; and (3) examining dynamic patterns of organizational adaptation on changing fitness landscapes over time. These problems have hampered advancements in organizational contingency theory in general and headquarters–subsidiary relationships in particular. To move beyond the limits of armchair theorizing, we take an empirical approach, using frontier analysis, to deal with these challenges.

Based on our longitudinal study of a large medical group practice of 32 local community clinics, we used data envelopment analysis to determine the clinics that best achieve a set of desired performance criteria subject to their resource constraints and environmental complexity. This provides an analytical way to address the first problem of identifying comparable organizational units and determining how well they satisfy multiple and often conflicting environmental demands and performance criteria. It also provides a direct way to empirically identify the best-fit ideal-type units that are necessary for testing contingency theory. DEA does this by identifying the outlying most adaptive or fit units in a sample that define the contours of a best-performance frontier and from which the relative distance of other less adaptive units can be determined.

We show how the DEA method of frontier analysis provides a systematic way to disentangle endogenous and exogenous components of unit performance. This is crucial for addressing the second thorny problem in designing headquarters–subsidiary relations—difficulties in assessing fit across micro and macro levels of organization design. Organization change and performance are simultaneously subject to macro and micro forces that may differ in direction and degree. Without a method of partitioning unit performance into its endogenous and exogenous components, one cannot study the relative influence and interactions of units at different levels in a nested organizational hierarchy. We have shown how the two-step DEA process and the Malmquist Index provide ways of partitioning unit adaptiveness at a given time and performance changes over time into endogenous and exogenous components. This also addresses the third problem of examining the dynamic patterns of organizational adaptation on changing fitness landscapes over time.

This methodology provides the opportunity to make an important substantive contribution of developing and examining a multilevel model of headquarters–subsidiary relations. The model predicted that clinic autonomy and interactions with the group would most directly influence the endogenous component of clinic performance change, whereas group standardization and headquarters–subsidiary integration would predict the exogenous component of clinic performance change. We also hypothesized that local environmental complexity moderates these relationships. The data provided some support for the model. As expected, clinic autonomy was a significant positive predictor of endogenous clinic performance change but was unrelated to exogenous group frontier change. From a macro view, headquarters–subsidiary integration or shared values was a significant positive predictor of exogenous group frontier change but was unrelated to endogenous clinic performance change. Contrary to expectations, however, standardization was not a significant predictor of group frontier change, and clinic–group interactions was a significant, negative predictor of both clinic endogenous and exogenous performance change.

Overall, however, these findings clearly show that different organizational dimensions influence different sources of organizational performance under different environmental conditions. This finding is important, because the literature tends to assume that all organizational design variables must fit together both internally and externally (Donaldson 2001). For example, configuration theory proposes that organizational structure, systems, culture, incentives, and strategies must all be internally coherent and fit environmental demands (Meyer et al. 1993, Nadler and Tushman 1999). Our research findings suggest that a more complex model is needed—one that anticipates how different organizational characteristics are designed to meet different criteria or components of organizational performance.

We found that the correlation between the endogenous component of clinic performance, or efficiency change, and the exogenous component of clinic performance change, or frontier change, was only −0.14. Although not statistically significant, this finding calls into question the commonplace expectation that micro- and macro-organizational performance are positively related in a complementary manner rather than being independent of each other or negatively related such that one level is sacrificed for the other. We found that the small correlation was the result of a cancelling-out effect, where some clinics were helped and others hurt by changes in the group performance frontier over the two-year study period. We observed that performance changes in group frontier only benefited the focused clinics serving a homogeneous mix of patients and not the general clinics serving a heterogeneous mix of patients. The latter gained no performance benefits from macro-policy frontier changes over time. By contrast, focused clinics gained significant productivity benefits from both exogenous frontier and endogenous clinic changes.

This finding has important implications for organizational performance appraisals. Because the benefits and costs of corporate policies on organizational subunits are seldom known or turn out as intended, they also tend to be overlooked in performance assessments of organizational units. This is especially so when it is difficult to attribute what aspects of observed changes in the performance of organizational units are due to macro-organizational policies or unit-specific factors. As a result, the units benefiting from organization-wide policies tend to be unfairly rewarded for performance improvements that are not the result of their own efforts, whereas other units disadvantaged by uniform policies tend to be disproportionately reprimanded for performance declines produced through no fault of their own.

During the study period, we found that clinics with a focused design showed significantly higher and lower performance changes than clinics serving a broad mix of patients. The organizational designs with the highest performance peaks also have the lowest performance declines. This volatility of performance changes is illustrated in Figure 3, from which we drew the inference that some organization designs are riskier than others on a changing performance landscape. This volatility of performance changes calls attention to the risks associated with changing organizational designs. We noted that whereas organizational inertia (i.e., the difficulties of change) has received considerable attention, the risks (i.e., likely performance consequences) of changing organizational designs have been largely ignored.

We think an important future direction in studying organizational change is to incorporate theories of risk in designing organizations.

Donaldson (1999) has made an effort in this direction. Drawing on portfolio theory in finance, he proposed that certain environmental factors (e.g., business cycle) and internal organizational characteristics (e.g., diversification) affect the level of performance risk (performance fluctuation) and that a greater level of risk makes an organization more likely to change. Donaldson (1999) also links risk across organizational levels by suggesting that a subsidiary's performance risk, which arises from local industry characteristics, contributes to the risk of the overall organization.

Following Donaldson (1999), we think that designing headquarters–subsidiary relations requires consideration of the different risks and returns of design changes at different organizational levels. For example, we observed no instance of any clinic in our sample changing from serving a broad to a focused mix of patients. In terms of our fitness landscape metaphor, broad and focused clinics occupy different design hills and compete with one another to be the "king or queen of their hill," but they did not engage in hill jumping. This last action represents a major design change that may not be within the endogenous capabilities of organizational units. Clinics may not have changed their designs because no exogenous macro-policy decision or resource investment occurred to make it feasible for the clinics to undertake transformative change. Unlike many organizations where headquarters adopt contingent policies that are implemented differently in selective subsidiaries, the medical group examined here focused on developing and implementing its macro policies uniformly across all of its clinics.[2]

The fact that no clinic-contingent policy interventions were observed, however, does not imply that the medical group had no effects on its clinics or that the observed associations are just random perturbations. The latter, of course, is the null hypotheses that we believe has been rejected by our study data. The Field Research Setting section describes numerous headquarters policies and procedures that the medical group implemented in all of its clinics during the study period. Although we cannot measure the effects of individual group interventions on clinics, we argue that the cumulative effects of all macro-group interventions produced the changes observed in the group performance frontier. Our statistical analysis shows that this group frontier change benefited focused clinics and unintentionally hurt the performance of broad clinics. Moreover, the regression analyses indicate that the clinic–group relationships were not totally random perturbations. Indeed, our measures of clinic–group relations explain 36% and 85% of the variation in clinic endogenous and exogenous performance changes, respectively (shown in Table 7).

Finally, although we believe our study findings generalize to a theory of headquarters–subsidiary relationships, a major limitation is that they are limited to, and cannot be generalized beyond, the sample of organizational units observed. Our sample of medical group clinics may be unique in certain respects (such as the group's uniform treatment of clinics and the different demands on clinics serving a broad versus focused mix of patients). In addition, our small sample of 32 clinics of one group practice limited abilities to systematically examine the organizational design configurations of clinics moving on and off the frontier over time. We think that a limited generality of research findings is a necessary trade-off for developing a more penetrating understanding of organization design in real-world settings. As other studies in different contexts accumulate, meta-analysis projects can provide opportunities for examining the generality of research findings across samples and contexts of organizations.

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Appendix. Computation of DEA Efficiency and Malmquist Index
DEA is a nonparametric frontier estimation method that was developed by Charnes and Cooper (1962), Charnes et al. (1978, 1994), and Banker et al. (1984, 1989). DEA contrasts with stochastic frontier analysis (SFA), which is another major form of frontier analysis. Most importantly, SFA assumes that some random elements in an efficiency analysis follow stochastic distributions and can be specified; DEA is deterministic and does not make this assumption. Thanassoulis (2001) provides an informative introduction to DEA.

DEA computes the performance (or efficiency) of the DMUs (decision-making units) in question with the following equation:

$$\text{Maximize } E_u = \frac{\sum_{r=1}^{s} y_{ru} O_{ru}}{\sum_{i=1}^{m} x_{iu} I_{iu}}, \tag{2}$$

where u represents the units of DMU; E represents performance; I and O represent all inputs and outputs, respectively, for each DMU; and x and y represent the weights assigned to each input and output, respectively.

Two constraints are placed on Equation (1) to allow for optimization and comparison purposes: (a) the assigned weights cannot be negative, and (b) any assigned weight for a specific

DMU can be applied across all DMUs so that it will not lead any DMU to achieve an efficiency ratio greater than 1. These constraints also avoid infinite results stemming from weight assignments. Stated formally,

$$x_{ru} \geq 0, \quad r = 1, \ldots, s, \qquad y_{iu} \geq 0, \quad i = 1, \ldots, m, \tag{3}$$

and

$$\frac{\sum_{r=1}^{s} y_{rk} O_{rk}}{\sum_{i=1}^{m} x_{ik} I_{ik}} \leq 1 \quad \text{for all DMUs.} \tag{4}$$

Given the above constraints, DEA uses a linear programming algorithm to compute x and y (the weights). Specifically, we adopted a nonparametric, deterministic, output-based, variable-returns-to-scale specification of the DEA model.[3] This DEA model enables us to identify the clinics that maximize multiple outcomes (patient and business care) with the least amount of resource inputs (clinic size). The first step of this computed DEA score identifies the efficiency of each clinic relative to its comparable broad or focused cohort. The second DEA step estimates the relative efficiency all clinics together across all cohorts.

The Malmquist Index

Best-performance frontiers are not static; they change over time (Sinha 1996). This implies that the frontier is a moving target and that clinics move on and off the shifting frontier over time. Longitudinal analysis of DMUs (e.g., health-care clinics) involves the use of the Malmquist Index, developed by Färe et al. (1994). The MI assesses productivity change by considering the efficiency of a DMU (in comparison with other DMUs) in two different time periods according to the following equation:

$$\text{MI} = \left[\frac{\text{Efficiency of DMU}_j \text{ at Time}_2 \text{ with respect to Time}_1}{\text{Efficiency of DMU}_j \text{ at Time}_1 \text{ with respect to Time}_1} \times \frac{\text{Efficiency of DMU}_j \text{ at Time}_2 \text{ with respect to Time}_2}{\text{Efficiency of DMU}_j \text{ at Time}_1 \text{ with respect to Time}_2}\right]^{1/2}.$$

This equation computes a geometric mean of the efficiency change of a particular DMU at two different time points. In the above formula, the two terms "Efficiency of DMU_j at Time_1 with respect to Time_1" and "Efficiency of DMU_j at Time_2 with respect to Time_2" are relatively straightforward. In our case, they are simply the DEA scores of a particular clinic in 1997 and 1999.

Methodological requirements of computing the MI assume constant returns to scale. Although this is technically different from Steps 1 and 2 (see the DEA Analyses Results section), it does not affect our analysis substantively. The other two terms "Efficiency of DMU_j at Time_2 with respect to Time_1" and "Efficiency of DMU_j at Time_1 with respect to Time_2" evaluate the efficiency of a focal clinic in one year with respect to all clinics (including the focal clinic itself) in another year.

For an example of how the MI is computed, we examine the productivity change of clinic C1 in our sample. According to the above equation, we conduct four DEA runs and obtain the following four measures regarding clinic C1's efficiency:

Efficiency at 1997 (Time 1) with respect to 1997 (Time 1): 28.50.

Efficiency at 1999 (Time 2) with respect to 1999 (Time 2): 13.50.

Efficiency at 1997 (Time 1) with respect to 1999 (Time 2): 25.10.

Efficiency at 1999 (Time 2) with respect to 1997 (Time 1): 15.10.

The MI for clinic C1 is therefore

$$\sqrt{\frac{15.10}{28.50} \times \frac{13.50}{25.10}} = 0.53.$$

To facilitate interpretations, we subtract 1 from this number. Thus, total productivity change for clinic C1 is now −0.47. The negative sign indicates that clinic C1 experienced a decline in total productivity between 1997 and 1999. We perform this simple transformation for all the clinics in our sample, and the values are presented in the last column of Table 6.

Mathematically, MI can be decomposed into two components (that which is attributable to the DMU's endogenous efficiency change and that attributable to an exogenous frontier policy or environmental change) (Färe et al. 1994). The first component is the ratio between Efficiency of DMU_j at Time_1 and Time_2:

$$\left[\frac{\text{Efficiency of DMU}_j \text{ at Time}_2 \text{ with respect to Time}_2}{\text{Efficiency of DMU}_j \text{ at Time}_1 \text{ with respect to Time}_1}\right] \quad \text{(or clinic efficiency change).}$$

The second component has a form very similar to the MI index, but there is an important difference: the denominator of the first term and the numerator of the second term interchange:

$$\left[\frac{\text{Efficiency of DMU}_j \text{ at Time}_2 \text{ with respect to Time}_1}{\text{Efficiency of DMU}_j \text{ at Time}_2 \text{ with respect to Time}_2} \times \frac{\text{Efficiency of DMU}_j \text{ at Time}_1 \text{ with respect to Time}_1}{\text{Efficiency of DMU}_j \text{ at Time}_1 \text{ with respect to Time}_2}\right]^{1/2} \quad \text{(or frontier change).}$$

The Malmquist Index is equal to the multiplication between these terms: MI = clinic efficiency change × frontier change. In the case of clinic C1, its endogenous efficiency is $13.50/28.50 = 0.47$. Frontier change is $\sqrt{15.10/13.50 \times 28.50/25.10} = 1.13$. Thus its MI is $0.53 = 0.47 * 1.13$. As mentioned previously, we subtract 1 from the original value. Thus, a positive MI value indicates an increase in productivity, and a negative value indicates a decrease in productivity. The last three columns of Table 6 report the values of MI in terms of the total productivity change, the clinic's endogenous efficiency change, and the exogenous frontier change for all clinics.

Endnotes

[1]Because of missing data and combined organizational accounting statements for some clinics, some of the clinics in our initial sample had to be removed from this analysis.

[2]Including such contingent macro policies increases the complexity of correctly specifying a DEA model of headquarters–subsidiary relations. However, the steps in the

DEA methodology would be similar to our treatment of broad and focused clinics in this study.

[3]There are, of course, other ways to compute unit efficiency. Bryce et al. (2000) compare three commonly used approaches: DEA (as described here), stochastic production frontier (see Aigner et al. 1977), and fixed-effects regression. Based on data from 585 HMOs operating from 1985 to 1994, Bryce et al. find that the results from the three methods identify the same industry trends, and those correlations of individual-unit efficiency scores from the three methods vary from 0.67 to 0.79. Although these results show high agreement, Bryce et al. caution that the results are not identical because, indeed, the different methods are designed for different purposes.

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