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First-order Economizing: Organizational Adaptation and the Elimination of Waste in the U.S. Pharmaceutical Industry*

Bryan D. Key
Boehringer Ingelheim Research Fellow in Pharmaceutical Economics
Washington State University

Richard Reed
Professor of Management and Operations
Huber Chair in Entrepreneurial Studies
Washington State University

David A. Sclar
Boeing Distinguished Professor of Health Policy & Administration
Washington State University

Since the seminal work of Lawrence and Lorsch (1969), it has been acknowledged that one of the key explanatory variables of performance is the relationship between the firm and its environment. The issue is of such import that more than 30 years later journal editors continue to accept manuscripts dealing with organizational responses to environmental pressure and change. For example, among numerous other pieces on environment and performance that have been published in this journal, there has recently appeared research on industry deregulation, firm strategy, and performance (Kim and McIntosh, 1999), the strategies firms adopt in discontinuously changing environments and their impact on firm performance (Arbaugh and Sexton, 1997), and how firms control strategy in "dynamic versus stable environments" (Fiegner, 1997). Our research is of the same genre and sheds light on how firms economize in the face of environmental pressure, and what are the associated performance effects.

Williamson observed that economizing has received inadequate re-

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search attention: "first-order economizing—effective adaptation and the elimination of waste—has been neglected" (1994: 364). Although there exists a substantial body of research on adaptation in the form of asset restructuring as "a popular means for organizations to respond to threats and opportunities in their business environment" (Hoskisson *et al.*, 2004: 525), work specifically addressing restructuring as a means of economizing is most conspicuous by its absence. Similarly, there is a dearth of empirical research looking at the benefits of eliminating waste. We therefore raise and address the fundamental questions: how do managers economize in the face of environmental pressure, and what are the performance consequences of different approaches to economizing? The answers not only have implications for practice but are also important for management theory.

We start by arguing that the neoclassical treatment of allocative efficiency adapted to the level of the firm by IO economics, in combination with the non-allocative efficiency arguments found in both IO economics and X-efficiency theory, offer utility toward examining the role of efficiency gains consistent with first-order economizing. We then synthesize these arguments with ideas from resource-based theory to provide a theoretical foundation for a subsequent empirical analysis that explores economizing in the U.S. pharmaceutical industry.

EFFICIENCY AND ECONOMIZING

Although the charters of strategic management and economics are radically different—the former aims to maximize firm profits while the latter seeks to maximize consumer welfare—strategy scholars have assumed that they are not mutually exclusive and have grounded strategy theory in the longer-established economic theory. We continue that tradition by examining the economic perspective on efficiency and then relating it to the strategy of economizing.

An Economics Perspective on Efficiency

The efficiency literature falls principally under two headings: allocative and non-allocative. Allocative efficiency is grounded in classical/neoclassical economics where, compelled by cost and demand alone, firms behave in a rational manner and make efficient decisions on output. Within this "black box" treatment of firms, it is a given that all firms are rational utility maximizers that continuously operate on their production frontier. Consequently, a firm is allocatively efficient when it adopts the optimum combination of inputs. The question of what constitutes optimum is one that is receiving increasing research attention; for example, see Wang *et al.*'s (2003) examination of resources allocated among security firm branches, Hartman *et al.*'s (2001) analysis of resources within branch banks, or Maniadakis and Thanossoulis' (2000) work on resource allocation in acute-care hospitals. The reverse scenario of allocative *in*efficiency from suboptimal allocation of resources and poor budgeting was observed by Lee and Menon (2000) in their study of the use of information technology in hospitals.

Leibenstein (1966) became disenchanted with the neoclassical treatment of firms and developed an alternate view—X-efficiency theory—that recognized that firms can operate behind the production frontier and be inefficient for non-allocative reasons such as poor decision making and not eliminating waste from time wasting by employees, absenteeism, poor quality output, and the like. His work immediately created a wave of opposition from economists due to its denigration of "*homo economicus*" and the logical consequences upon individual (hence firm) behavior. X-efficiency theory also meant abandoning two key assumptions. First, the assumption of rationality, even boundedly so, was relaxed. Leibenstein adopted a selective-rationality view in which organization members select the extent to which they deviate from maximizing behavior. Second, the utility maximization assumption collapses without the strength of the rationality assumption to support it.

The underlying assumptions of X-efficiency theory are: (1) only individuals think and act, so they are the appropriate level of analysis by which firm behavior should be analyzed, (2) humans are selectively rational—their behavior may include both rational and non-rational elements, (3) the interests of principal and agent may not coincide, (4) human behavior is not immediately responsive to changes in the environment—some level of inertia exists, and (5) because labor contracts are incomplete some level of behavioral discretion exists. Based on these assumptions, it is argued that rationality is not constant. Instead, it is a continuous variable that depends on the level of internal and external pressure on an individual regarding the consequences of their decision making. Decision making itself is a process and is therefore subject to various levels of performance. Because individuals' levels of effort are discretionary, the effort (or lack of it) expended in the firm determines the amount of non-maximizing behavior. Thus, as external pressure and the consequent need for performance increase, greater rationality is utilized, resulting in better decision making. The outcome is an increase in intra-firm effort leading to less X-inefficient (non-maximizing) behavior and higher productivity.

Economizing

First-order economizing eliminates "bloat" (Williamson, 1994)—wasteful practices, poor organization, and excessive organizational slack. For a given level of output, first-order economizing is the difference in cost between inefficient and efficient production. It is not to be confused with second-order economizing that reflects increased output as prices are reduced in line with improvements in efficiency. Williamson also points out that gains from first-order economizing, which arise from *effective adaptation* and the *elimination of waste*, are in the order of ten times greater than those from second-order economizing. He goes on to argue that economists have typically assumed away first-order gains and focused on second-order gains—first-order gains accrue directly to the firm whereas second-order gains produce social benefits.

Effective Adaptation. Adaptation to environmental pressures equates directly to organizational change (Gersick, 1991; Haverman, 1992; Hrebiniak and Joyce, 1985), which Barnett and Carroll (1995) classified in terms of process and content. Theories of organizational change that focus on process are primarily concerned with internal operations and systems that serve as a catalyst for change (Barnett and Pratt, 2000; Gersick, 1991; Wong-MingJi and Millette, 2002), while those that focus on content are concerned with the features of the organization that are being modified (Tushman and Romanelli, 1985). Ruef (1997) observed that the process view is anchored in determinism and structural inertia, while the content view is grounded in strategic-choice arguments. The latter is commensurate with thinking in strategy, but strategy researchers have had negligible empirical success in defending the position that firms can adapt to environmental influences in a meaningful and timely fashion because the continuous nature of evolutionary change is difficult to measure. For example, with gradual change in the operating environment, firms will respond tactically and make structural adjustments to the input mix of resources to capitalize on emerging opportunities and minimize new threats. Ruef points out that: (1) basic activities, such as adapting the input mix of resources, "are precisely those that many strategic-management theorists consider to be most salient" (1997: 838), and (2) any empirical discussion of organizational-change content must address the class of organizational characteristics being modified along with the environmental criteria for evaluating their merit.

From resource-based theory we can deduce that a firm's resource mix is likely to be a unique organizational characteristic. For example, Penrose claims that "It is the heterogeneity . . . of the productive services available or potentially available from its resources that gives each firm its unique character" (1959: 75), Wernerfelt (1984) argues that strategic relevance lies in identifying a firm's "resource-position," and Mahoney and Pandian (1992) argue that the unique structure of the firm's resources extends beyond their simple composition to include their apportionment. We can thus deduce that firms will respond to their environment by changing their resource mix—a position adopted by Castanias and Helfat (2001) in their analysis of managerial rents—which means that they also change their structural characteristics. Consequently it is also fair to believe that there will be an impact on the firm's allocative efficiency. This resource-based treatment of adaptation not only speaks to the issue of economizing but remains consistent with IO economic views on efficiency.

Waste. Attempts to defend the assumption that firms are efficient profit maximizers produced arguments of managerial utility (Williamson, 1964), leisure as output (Stigler, 1976), and rent-seeking behavior (Tullock, 1980), among others. Organization economics made a significant step toward treating "man as he is" (Coase, 1988) with the move from neoclassical economic man as a perfectly rational utility maximizer to man as intendedly rational but limitedly so (Simon, 1947). This change is reflected in Williamson's later work where he argued that "waste, bureaucracy, slack and the like . . . are principally due to inferior organization and maladapted operations" (1994: 366). We believe that this structural view of waste does not go far enough, and we agree with Leibenstein (1966) whose simple observation of human decision-making behavior suggested that other factors were present. As we have already pointed out, X-efficiency theory adopts a "selective" rationality perspective in which decision making can include both rational and non-rational elements. In other words, under conditions where there is reduced constraint concern, individuals within the organization elect to operate less efficiently. Waste, which arises from both structural and non-maximizing behavior, thus has implications for both allocative efficiency (effective adaptation) and non-allocative efficiency (elimination of waste).

From the above arguments, and following the standard strategic management model of strategy intervening between environment and performance, we assume that first-order economizing is a mediator of the relationship between environmental pressure and firm performance. This leads to our central hypothesis:

H1. Firms respond to environmental pressure by increasing both allocative and non-allocative efficiency which, in turn, improves performance.

Mauri and Michaels (1998) found that competing firms tend to develop homogenous strategies over time through convergent behavior, but that variation in performance was predominately accounted for by firm effects. They explain this influence of industry-level effects on strategy and firm-level effects on performance in terms of complementarity between IO theory and strategic management's resource-based theory. Hence, the appropriate level of analysis for examining the influence of external pressure on firm-level strategic behavior (economizing) is that of the industry. Because of its identifiable change in environmental pressure, we have elected to test our thesis with data from the pharmaceutical industry. There are, of course, always questions of generalizability with sectoral studies, but the benefit of being able to control for industry heterogeneity is sufficiently meaningful for the approach to have been widely adopted. For example, see studies examining efficiency in the banking industry by Byrnes and Freeman (1999), Casu and Molyneux (2003), Luo (2003), and Hartman *et al.* (2001), in health-care by Lee and Menon (2000), and Maniadakis and Thanassoulis (2000), in hospitality by Reynolds (2003), and in securities trading by Wang *et al.* (2003).

THE U.S. PHARMACEUTICAL INDUSTRY

The 1962 Kefauver-Harris Amendments to the 1938 Food, Drug and Cosmetics Act extended the mandate and control of the FDA. That year also signaled the start of increased attention to the competitive structure of the ethical drug industry and its persistently high rate of profits. Numerous studies were conducted, but there was a great deal of variance in findings (see, for example, Cocks, 1975; Comanor, 1964, 1966; Costello, 1968; Schifrin, 1967; Steele, 1962, 1964; Telser *et al.*, 1975). The source of that variance appears to be chiefly derived from competing views on competition—the Mason/Bain (Bain, 1956, 1968; Mason, 1939) model of structure, conduct, and performance, or the Schumpeterian (Schumpeter, 1950) view of dynamic competition (Grabowski and Vernon, 1979). That aside, it was generally accepted that rivalry existed in the pharmaceutical industry (Cool *et al.*, 1999).

Since those early studies, the pharmaceutical industry has undergone tremendous change that paralleled changes in the broader health-care industry (Meyer *et al.*, 1990). From the mid 1980s to the early 1990s, there were lower price increases among existing pharmaceutical products, lower introductory prices for new products in existing markets, and larger discounts that buyers were obtaining from the drug manufacturers (Boston Consulting Group (BCG), 1993). The growth of the generic drug market intensified competition via new drug development, and arrival of the managed-care industry redefined the nature of price competition inside the ethical drug industry. Further, pharmaceutical research was transformed by biotechnology (e.g., genetic engineering and monoclonal antibodies) and, predictably, the cost of R&D per new-drug-marketed rose from $54 million in 1976 to well over $300 million by the early 1990s (BCG, 1993).

In the face of such changes, it is reasonable to believe that economizing took on a new importance in the industry. And, with the advent of these new competitive pressures over the 1980s and 1990s, the novel-drug industry constitutes precisely what Leibenstein (1987) described as an ideal setting in which to evaluate X-efficiency.

RESEARCH METHODS

We used a cross-sectional, repeated-measure design in which panel data were collected for the period of 1980-97 for U.S. manufacturers of novel pharmaceuticals. Criteria for inclusion in the sample were: (1) a firm must have developed and marketed a novel-pharmaceutical product by 1980, (2) it had to be incorporated in the U.S. and be publicly traded throughout the study period, and (3) it also had to maintain a continued presence in the novel-pharmaceutical industry. We divided the study period into six three-year intervals. Three years was chosen as a compromise between providing sufficient time for discrete changes in market pressure and offering sufficient periods for covariate analysis. Data were averaged within each firm across each three-year period, and were then used in the calculation of the metrics below.

Dependent Variable (Performance)

Firm performance was calculated by multiplying the number of common shares outstanding by their closing price. Financial data were obtained from COMPUSTAT; original SEC filings were used for missing values or verification needs. All market values were discounted back to 1980 dollars. Market valuation was chosen primarily on the merits of the arguments of Lubatkin and Shrieves (1986)—stock price is able to "see through" accounting figures (absent the recent accounting scandals, such as Enron, which occurred after our study period). Stock price reflects long-term strategies that may have a short-term deleterious effect on accounting measures of performance, which is particularly true in an R&D-intensive industry.

Independent Variable (Pressure)

In the early 1980s, the managed-care industry started using cost-reduction incentives, such as generic substitution, restrictive formularies, therapeutic substitution and drug utilization reviews to apply pressure upon manufacturers to both keep prices down and increase innovative product development (BCG, 1993). The market penetration of managed care thus provides a sound metric for pressure, calculated as the total enrollment in HMOs (source: SMG Marketing Group) divided by the total population (source: U.S. Census Bureau) per year.

Intervening Variable (First-order Economizing)

Adaptation to environmental pressure, in the form of resource-(re)allocation, was captured by allocative efficiency, while non-allocative efficiency was identified as reduced non-maximizing behavior (X-efficiency). These metrics are generated by data envelopment analysis (DEA), an analytical technique that is gaining prominence in research on organization efficiency (e.g., Byrnes and Freeman, 1999; Casu and Molyneux, 2003; Luo, 2003; Reynolds, 2003; Zenios *et al.*, 1999) because it creates a piece-wise linear frontier from the "best-practice" firms that sets a standard for comparing other firms.

Another property of DEA is that it is suitable for estimating non-allocative efficiency because it admits input and output measures of different units and forms which, as Leibenstein and Maital point out, permits "the partitioning of X-inefficiency among its proximate causes, including those related to the performance of management" (1992: 430) (also see Banker *et al.*, 1984; Charnes *et al.*, 1978, 1981; Sieford and Thrall, 1990). Non-allocative efficiency was calculated by dividing the weighted sum of inputs a firm would be utilizing if it were operating on the best-practice frontier by its actual weighted sum of inputs, while holding its input-mix and outputs constant. For every observation's inputs, weights were assigned that maximized the object firm's efficiency score when compared to all other firms in the set while the same weights were applied to them. A simple examination of the list of weighted sums for each observation's results revealed the lowest figure, representing the best-practice firm for a given observation. Total efficiency could then be calculated by dividing the weighted sum of inputs of the best-practice firm by the object firm's weighted sum of inputs, again holding output constant.

Pharmaceutical manufacturers cannot maintain a product's market share once its patent has expired because of the increasing pressures of managed care, and the resulting industry-wide response has been to focus more heavily on new drug research (BCG, 1993). Hence, the logical output of this industry is the discovery, development and market introduction of innovative pharmaceuticals. The question becomes, what metric captures this innovation most effectively? One possibility is the number of product introductions, but this approach is problematic. Variations in the level of innovation between new products, poor correlation between specific inputs and product introductions, due in part to the long lag between discovery and introduction, and the inconsistent rate of product introductions all contribute toward a poor metric. At the other end of the product pipeline is the number of patents for new chemical entities. Yet the high rate of attrition between patent and market introduction results in poor correlations with innovation. Indeed, research examining the number of patents in the pharmaceutical industry with firm performance found no association (DeCarolis and Deeds, 1999).

A theoretical problem with the preceding considerations is that they focus on product stocks (e.g., patents, new drug applications, investigational new drugs, product introductions), which tend to be fixed (Dierickx and Cool, 1989). Extending this resource-based perspective, the consideration of changes in asset flows is more consistent with examining timely adaptation and thus, logically, becomes the output variable of choice. Since drug discovery and development is the output, the obvious inflow impacting this asset stock is annual R&D expenditures. Yeoh and Roth (1999) found a positive effect of R&D on both radical innovation and drug approval success in the pharmaceutical industry. Other research supports the relationship between continuous R&D and firm performance (e.g., Griliches, 1981; Chakravarthy, 1986), particularly in industries characterized by technological change.

With R&D acting as a proxy for drug discovery and development output, matching inputs are required. Yeoh and Roth (1999) found a direct and positive relationship between sales-force costs and the number of new drugs brought to market, arguing that the sales force provides market information and direction throughout the value-creation process. Sales-force efforts create awareness and preferences about products in the approval pipeline (SRI International, 1989) and directly influence approval success and radical innovation. Hence, the annual selling, general and administrative (SGA) expenses, of which sales-force cost is a substantial component for pharmaceutical companies, was adopted as an input measure. Our second measure of input focuses on production. Technological advances in production have allowed some products to reach the market that were previously too expensive, or otherwise impossible to develop. Moreover, firms have patented the development processes of novel technology. Because such production-specific knowledge leads to product innovation, the associated production expenditures (i.e., annual cost of goods sold—COGS) are also an acceptable proxy for input.

Controls

Given that R&D expenditures are usually driven by cash flow, and given the effects of economies of scale on the cost of goods sold, we control for firm size. Controlling for size (number of employees) also means that growth from mergers and acquisitions can be handled by combining the resources of both firms at the time of merger. Our methodology explores the influence of the industry-level variable of pressure upon firm-level variables via within-subject (repeated-measure) analysis-of-variance methodology. The advantage of this approach is the ability to economize on the data since the influence of the subject main-effect is removed from the error term, thus increasing the power to detect treatment effects (Maxwell and Delaney, 1989). Put differently, subjects serve as their own control, a necessary tactic in this analysis given the relatively small number of pharmaceutical firms that survived between 1980 and 1997.

Analysis

Since the original formulation of DEA, a number of variations have been developed that differ in both how the frontier is created and how the efficiency scores (distances to the frontier) are measured. The model chosen depends on the assumptions made by the researcher, the nature of the data, and the particular efficiency measure sought. The Banker, Charnes and Cooper (1984) formulation allows for varying returns to scale and factors them out in their calculation, providing a pure non-allocative measure. Consequently, we used that model to account for changes in scale from firm growth (e.g., mergers and acquisitions) over time. Calculation of the DEA scores required the use of linear-programming software (PCx version 1.1© 1997 from the University of Chicago). The statistical methods used for analysis were ANOVA and ANCOVA.

RESULTS

Thirteen pharmaceutical companies met the criteria for inclusion in the study. Efficiency scores were calculated for all thirteen firms for each of the six three-year periods. A mathematical outcome of DEA is the artificial assignment of 1, or perfect efficiency, for all subjects that include extremal data points (i.e., endpoints on the production frontier), and so the inputs and output were examined to identify the smallest and the largest values of each parameter. The firms that included these data points were then removed from the subsequent analysis, which reduced the sample size from 13 to 11.

To first test whether or not there was a treatment effect from environmental pressure on strategy, efficiency was assigned as a dependent variable. Per DEA methodology, contrasts were generated from the pressure variable whereby the first treatment served as the control and each successive treatment value was calculated from the averaged pressure score within that treatment. The averaged percent of U.S. lives covered by HMOs within each treatment (4.4%, 7.6%, 12.5%, 15.0%, 19.2%, 29.4%) produced the symmetrical contrast of -1, 0.09, 0.15, 0.18, 0.23, 0.35. The results of two-factor, within-subject analyses of variance show, as expected, that firms do economize in response to pressure (see Table 1). The measure of first-order economizing, total efficiency, and both of its components, allocative and non-allocative efficiency, all show a significant treatment effect consistent with environmental pressure.

To ensure that the first-order economizing changes were not consequences of changing firm size, the ANOVAs were rerun with firm size as a covariate. Using size as a covariate presupposes that it is independent of treatment effect (Maxwell and Delaney, 1989). This assumption was tested using an ANOVA across the treatments, with size being dependant. No significant treatment effect ($p = 0.3380$) validates its use in this fashion. In the resulting three ANCOVAs, the inclusion of size as a covariate did not remove the treatment effect upon the efficiency scores, nor did firm size reach significance as a covariate (data not shown). Therefore, we can conclude that the treatment effect of pressure upon all three measures of first-order economizing is independent of firm size.

Controlling for exogenous time-dependent threats to internal validity

TABLE 1. ANOVA Test of Treatment Effect on First-order Economizing with Market Pressure as Contrast.

(a) Dependent Variable: Total Efficiency

Source of Variation	SS	Df	MS	F Value	P Value
Companies	1.677	10	0.168	22.5	0.0001
Treatments					
Managed Care	0.508	1	0.508	68.3	0.0001
Error	0.372	50	0.007		

R-Sqr = 0.869

(b) Dependent Variable: Allocative Efficiency

Source of Variation	SS	Df	MS	F Value	P Value
Companies	1.926	10	0.193	32.3	0.0001
Treatments					
Managed Care	0.133	1	0.133	22.3	0.0001
Error	0.298	50	0.006		

R-Sqr = 0.874

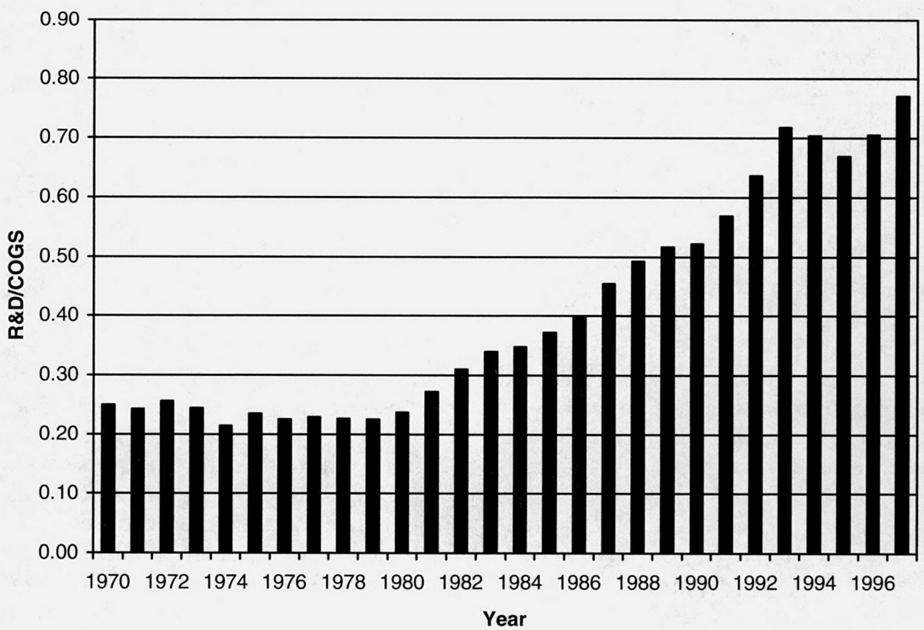
(c) Dependent Variable: Non-allocative Efficiency

Source of Variation	SS	Df	MS	F Value	P Value
Companies	2.485	10	.2485	32.3	0.0001
Treatments					
Managed Care	0.286	1	0.286	18.1	0.0001
Error	0.791	50	0.016		

R-Sqr = 0.794

was difficult because of data availability for our sample prior to 1980 and the nearly linear growth of managed care. However, industry-level data were available. Previously, efficiency scores were calculated through DEA using R&D expenditures over the inputs of COGS and SGA expenditures. A proxy for this measure can be generated at the industry level by dividing total R&D by total COGS. To control for variability in the number of firms in the industry, both values were taken as a percent of industry sales. Then, using the rationale that if pressure from managed care was indeed the cause of increased first-order economizing, it may be expected that a plot of the proxy measure against time would be characterized by a piecewise linear slope in which the period 1970-1979 is flat but 1980-1997 has a positive slope. That is, industry efficiency, expressed as R&D relative to COGS, should reflect the advent of HMOs and the environmental pressure they created. The results shown in Figure 1 fit this scenario. (They also fit with Meyer *et al.*'s (1990) conclusions that the hospital

FIGURE I. Industry Level R&D/COGS



industry, which is part of the broader health-care industry, was in a period of adaptation during the 1970s and in revolution during the 1980s.) We can therefore conclude that our findings thus far are valid—environmental pressure leads to first-order economizing.

We next examined the influence of first-order economizing upon firm performance. This analysis focused on the role of first-order economizing as a mediator between environmental pressure and performance. The first step was to run the same two-factor, within-subject ANOVA, but with performance as the dependent variable. Given the likely correlation between firm size and market value, size was included as a covariate. The results (see Table 2) show that, consistent with the increases in environmental pressure, performance varied between treatments ($p < .0001$). Also, as expected, firm size is both a positive and significant ($\beta = 0.47$, $p = 0.0139$) predictor of market value. The second step was to include first-order economizing as a covariate to examine whether or not it eliminated the treatment effects of pressure upon performance, which would be the expected outcome if it does actually intervene between the two variables. As shown in Table 3, such was the case. The treatment effects of pressure lose their significance upon performance ($p = 0.4379$) and total efficiency is a positive ($\beta = 45.3$) and significant ($p = 0.0030$) covariate, thus supporting its mediating role. Interestingly, the results vary for allocative and non-allocative efficiency as independent mediators. Non-allocative efficiency was found to be a positive ($\beta = 28.0$) and significant

TABLE 2. ANCOVA Test of Treatment Effect on Firm Performance

Dependent Variable: Firm Performance Source of Variation	Parameter Estimate	SS	df	MS	F value	P Value
Companies		9873	10	987	11.0	0.0001
Treatments						
Managed Care		1865	1	1865	20.7	0.0001
Size	0.47	587	1	587	6.5	0.0139
Error		4419	49	90		

R-Sqr = 0.856

covariate (p = 0.0338), thus providing support for the hypothesis that eliminating waste leads to increased firm performance. Curiously, allocative efficiency was neither significant (p = 0.1642) nor positive (β = -24.9).

DISCUSSION AND IMPLICATIONS

We quantified first-order economizing in our sample of pharmaceutical companies, and an assessment of non-allocative efficiency allowed us to capture improvements in non-maximizing behavior within firms. Also, by assessing allocative efficiency from a resource-mix perspective, we were able to capture firms' structural adaptations. Our finding of a significant increase in firms' allocative efficiency demonstrates that managers can and do respond to the environment by quickly redirecting resources towards a new strategic goal—it has long been the pursuit of scholars in strategy to develop support for firm-level structural adaptation in response to environmental pressures—but its role in directly increasing firm performance was inconclusive. In a *post hoc* analysis, we found evidence of an indirect effect in the form of an interaction with non-allocative efficiency. The product of the two components, total efficiency, has both a larger regression coefficient and greater explained performance variance than non-allocative efficiency alone, or when allocative efficiency was added to the model.[1] Furthermore, there was a sign change on the regression coefficient of allocative efficiency from negative to positive when non-allocative efficiency was added to the model with allocative efficiency. These findings have important managerial implications insofar as they suggest that effective adaptation has only an indirect impact on performance through its influence on improved non-allocative efficiency. Resource reallocation thus does little to improve performance on its own, but it does enhance gains from reduced waste. In the face of environmental pressures, the first task of management is to eliminate waste and, once that is done, then resources can be reallocated.

Strategy scholars have relied upon the arguments of bounded rationality (March and Simon, 1958) and satisf-

[1] An ANCOVA was run exploring the effect of pressure on performance with firm size (β = 0.39; p = 0.0365), non-allocative efficiency (β = 28.6; p = 0.0270), and allocative efficiency (β = 1.9; p = 0.9272) as covariates.

TABLE 3. ANCOVA Test of Treatment Effect on Firm Performance with First-order Economizing Variables as Covariates.

(a) **Dependent Variable: Firm Performance**

Source of Variation	Parameter Estimate	SS	df	MS	F value	P Value
Companies		8999	10	900	11.8	0.0001
Trt: Pressure		47	1	5	0.6	0.4379
Size	00.55	776	1	78	0.6	0.0025
Total Efficiency	45.30	749	1	749	9.8	0.0030
Error		3670	48	76.5		

R-Sqr = 0.881

(b) **Dependent Variable: Firm Performance**

Source of Variation	Parameter Estimate	SS	df	MS	F value	P Value
Companies		10453	10	1045	13.1	0.0001
Trt: Pressure		627	1	627	7.9	0.0001
Size	00.38	380	1	380	4.8	0.0085
Non-allocative Efficiency	28.00	599	1	599	7.5	0.0338
Error		3820	48	79.6		

R-Sqr = 0.876

(c) **Dependent Variable: Firm Performance**

Source of Variation	Parameter Estimate	SS	df	MS	F value	P Value
Companies		9209	10	921	10.4	0.0001
Trt: Pressure		1841	1	1841	20.8	0.0001
Size	00.40	428	1	428	4.8	0.0326
Allocative Efficiency	-24.90	176	1	176	2.0	0.1642
Error		4243	48	88		

R-Sqr = 0.862

icing (Cyert and March, 1963) as sources of variation in firm behavior to accommodate the arguments of strategic choice (Child, 1972). The implication that emerges from this work is that if rationality increases with environmental pressures, then any behavioral models of the firm should be interpreted in the context of their exposure to that pressure. For example, the utility of the hyper-rational game-theory model likely increases under extreme competitive pressure while "garbage can" models will arguably find more theoretical utility in low-pressure environments.

Some limitations of the study need to be mentioned. First, as already stated, with all sectoral studies, generalizability must be scrutinized. Also, the sample size was relatively small. Even though the use of a repeated-measure design provided sufficient statistical power, it would still be wise to interpret the results with some caution. Finally, our design relied upon a sample of companies that had survived the period from 1980-1997. That means that we under-sampled failure (Denrell, 2003) and some lessons on how not to respond to environmental pressure have therefore been lost.

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