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The Relationship Between Change Across Multiple Organizational Domains and the Incidence of Latent Errors

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Abstract

The authors examined the relationship between types of organizational change (i.e., changes across multiple domains, e.g., employees, structure, and technology) and the incidence of latent errors (i.e., potentially consequential deviations from rules and procedures), using data from internal audit reports and interviews with managers in 80 business units in a large financial institution. Consistent with their premise that latent errors result from the increased demands on organizational attention associated with organizational change, the authors found that changes in multiple organizational domains was positively related to the frequency of latent errors. Moreover, this relationship was only observed for changes that had an adverse impact on managerial time, expertise, and/or work coordination. Implications for research on organizational change and latent errors, as well as for managers, are discussed.

Keywords

errors, organizational change, attention

This article investigates the relationship between organizational change and latent errors. Latent errors refer to deviations from rules and standard operating procedures that can potentially result in adverse outcomes of organizational significance (Dekker, 2005;

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Hofmann & Frese, 2011; Reason, 1998). For example, the accumulation of latent errors—failure to detect trading transactions that exceeded prespecified value and volume limits—contributed to \$2.3 billion in losses at the Swiss bank UBS (Murphy, Burgess, Jones, & Simonian, 2011). The effective prevention, detection, and correction of such errors are increasingly seen as critical organizational capabilities in a wide range of organizational settings such as nuclear power plants, hospitals, and financial institutions (Reason, 2008). In other words, the incidence of latent errors represents an important indicator of an organization's potential vulnerability to major adverse outcomes (Ramanujam & Goodman, 2011). The current study examines the effects of change in multiple organizational domains (e.g., personnel, structure, and technology) on the incidence of latent errors.

Research interest in understanding the organizational antecedents of errors can be traced back to several seminal studies of accidents and organizational reliability (e.g., Perrow, 1984; Roberts, 1993). These studies advanced the premise that accidents and their precursors—such as latent errors—warrant research in their own right as organizationally produced outcomes (Vaughan, 1999). Subsequent studies identified various organizational antecedents of errors such as characteristics of technology (e.g., complexity; Perrow, 1984), structure (e.g., flexible hierarchy; Roberts, 1993), and culture (e.g., Sagan, 1993). More recently, studies examined other antecedents of errors such as safety climate, that is, organizational members' shared perceptions about the priority of safety relative to productivity (e.g., Hofmann & Mark, 2006; Zohar, 2008); the role of middle managers (Roe & Schulman, 2008); decision-making processes (Starbuck & Farjoun, 2005); and mindful organizing—that is, the collective capacity for enacting mindfulness characterized by various tendencies such as preoccupation with failure, reluctance to simplify interpretation, and sensitivity to operations (Vogus & Sutcliffe, 2007).

Despite the growing number of organizational studies of errors, however, few studies to date have examined organizational change as a potential antecedent of latent errors (Ramanujam & Goodman, 2011). This is surprising for several reasons. First, insofar as the interest of organizational researchers is motivated by a desire to understand the organizational causes of errors and organizational change represents a fundamental process in organizations (Goodman et al., 2011), the absence of studies that examine the plausible link between change and errors represents an important gap in our understanding of what makes errors organizational. Second, theoretical accounts have frequently suggested that change plays a central role in the occurrence of errors. For instance, organizational analyses of the collapse of the investment management firm Barings suggest that the initial changes in the organizational structure, in combination with other subsequent changes, contributed to deviant trades and failure to monitor trading operations (i.e., latent errors) as required by internal policies and external regulations (Goodman, 2000; Hannan, Polos, & Carroll, 2003). Consistent with this idea, one of the defining characteristics of high-reliability organizing is the collective ability to function reliably in the presence of fluctuations in the operating environment (Weick, Sutcliffe, & Obstfeld, 1999). That is, dynamic variations in the

work environment, such as those occasioned by organizational change, pose major challenges for error-free operations and therefore what distinguishes high-reliability organizations is the ability to maintain nearly error-free operations in the presence of such challenges (Weick & Sutcliffe, 2007). In other words, the core premise about high-reliability organizing rests on a plausible but untested assumption.

The absence of prior studies about the link between change and errors is also surprising from the viewpoint of research on organizational change, where the general notion that change can be disruptive is well established (Armenakis & Bedian, 1999). For instance, organizations that initiate change experience “the liability of newness”—that is, the costs of establishing new structures and procedures; attracting, training, and retaining new employees; and building a reputation for quality and reliability (Stinchcombe, 1965). Although several studies of liability of newness have verified this effect in terms of organizational-level outcomes such as organizational failure and financial losses, few studies have examined whether organizations that implement more changes (i.e., changes in multiple domains) experience more errors in their routine operations than organizations that implement fewer changes.

Similarly, even in the broader literature about the consequences of organizational change, few studies have examined latent errors as a consequence of change (see Armenakis & Bedian, 1999; Barnett & Carroll, 1995). Several studies in this tradition examine the effects of change on organizational-level outcomes such as performance (e.g., Gibson, 2004), mortality (e.g., Haveman, 1992), and effectiveness (e.g., Lawler & Worley, 2006). For example, a recent study examined the adverse effects of downsizing, a type of organizational change, on corporate reputation (Love & Kratz, 2009). Several other studies have examined the employee-level consequences of change—that is, the effects of change on employee’s psychological contracts (Freese, Schalk, & Croon, 2011), emotional states (Kiefer, 2005), commitment (Fedor, Caldwell, & Herold, 2006), and coping (e.g., Fugate, Kinicki, & Prussia, 2008). For instance, these studies suggest that employees are more likely to react negatively to change if they view the change as hindering their chances to achieve goals (Huy, 2001) and undermining the significance of their distinctive skills (Kraatz & Zajac, 2001). Yet, in comparison, few studies have systematically examined the potential effects of change on the incidence of latent errors. The only study to examine this relationship reported that change across multiple organizational domains was positively associated with the frequency of latent errors in routine operations (Ramanujam, 2003). However, this study used archival data, and it left unanswered several questions about the processes that link organizational change and errors.

Hence, by examining the theoretical and empirical link between organizational change and latent errors, we seek to make several contributions. First, we aim to extend our understanding of whether and how a fundamental organizational process—change—is related to an outcome of growing theoretical as well as practical significance—latent errors. By elaborating on the understudied roles of change as an antecedent of errors and errors as an unintended consequence of change, we seek to contribute to the organizational literatures on errors as well as change. Second, by

linking the mostly separate organizational literatures on errors and change, we wish to respond to the frequent critique of the research on errors that it is too specialized and insufficiently integrated to the mainstream organizational literature (e.g., Scott, 2002).

Third, we seek to demonstrate the feasibility of investigating errors using a research design that avoids the problems associated with most prior studies of errors (Sagan, 1993). With some recent exceptions, most organizational studies of errors and error-related outcomes have been subject to recurring set of criticisms about their methodology: small sample size (typically one organization) that does not permit formal hypothesis testing; sampling on the dependent variable (i.e., most studies examine either organizations that experienced accidents or organizations that avoided accidents over a sustained period of time but rarely both), which limits the validity of conclusions; *ex post* analysis that is susceptible to hindsight bias; reliance on data sources such as press accounts of accidents and self-reports of errors, which are prone to self-censoring bias; and extreme settings for research (typically organizations that operate high-hazard technologies, e.g., nuclear power plants and naval aircraft carriers), which potentially limits the generalizability of findings to a broader set of organizations with nonhazardous technologies.

We address these methodological concerns by explaining *ex ante* variations in errors across a large sample of organizational units. That is, rather than explain rare outcomes in a few organizations after the fact, we attempt to explain variations in the frequency of errors in the ongoing operations of multiple organizations. As result, we avoid the problems linked to small sample size, sampling on the dependent variable, and retrospective analysis. Moreover, we measure errors using reports of internal audits of ongoing operations. In other words, we use the same data source that the organizations themselves use to detect and manage errors in their operations. In addition, we interviewed managers in these organizational units to independently obtain information about change in their units. As a result of using different data sources for measuring our independent and dependent variable and using a combination of qualitative and quantitative methods, our research design mitigates the biases associated with alternative data sources such as self-reports and press accounts. Finally, the setting for our study is a large financial institution where errors represent a major source of operational risk but where the technology is not physically hazardous. Hence, by locating our study in this setting that has rarely been used in prior studies of organizational errors, we extend the relevance of organizational research on errors to a wider set of organizations.

Theory and Hypotheses

The general term *change* will be used henceforth to refer to a system of discrete episodic changes in one or more organizational domains such as people, structure, and technology (Romanelli & Tushman, 1994). Such changes tend to be formal, planned, and goal directed, and organizations try to actively manage the processes and outcomes associated with them (Pettigrew, Woodman, & Cameron, 2001). In this study, change

is at the unit level. A unit is a discrete work area focused on a specific task such as “Bond Trading” or “Derivatives Trading.” Each unit has a formal leader and a hierarchy of exempt and nonexempt workers. Each unit has performance goals and is regularly assessed against these goals. Change at the unit level could mean changes in senior managers or a reduction or increase in staff or a change in the structure of the unit (e.g., merging with another unit) or introducing a new information technology to facilitate operations. All of these changes in personnel, organizational structure, or technology affect the unit’s operations. Also, there can be single or multiple changes introduced at the same time.

“Latent errors” in this research refer to deviations from standard operating procedures and rules that can have adverse consequences for the organization. For example, a trading department may have limits on the amount of a trade. Exceeding that limit would be a latent error. It is a clear deviation from a well-publicized standard operating procedure. The specific deviation may not have adverse consequences. But the operating procedure is in place to minimize the risk of adverse consequences such as financial or reputation loss. The Barings case mentioned earlier is an example of accumulations of deviations or latent errors that over time led to bankruptcy. We focus on latent errors at the unit rather than the individual or organizational level. Our basic thesis is that change has a unit-level effect and draws away limited attentional resources. Although latent errors are enacted by individuals, we argue that the attentional demands of changes in an organizational unit can reduce supervision and monitoring. Thus, the conditions for deviations across the unit are increased. We want to understand both quantitatively and qualitatively how organizational change affects the frequency of errors. Latent errors ultimately can lead to actual organizational-level errors, but this connection is beyond the scope of this article (see Goodman, 2000).

We propose that attention plays an important role in linking change and errors. By “attention,” we refer to

the noticing, encoding, interpreting, and focusing of time and effort by organizational decision-makers on both (a) issues; the available repertoire of categories for making sense of the environment; problems, opportunities, and threats; and (b) answers; the available repertoire of action alternatives: proposals, routines, projects, programs, and procedures. (Ocasio, 1997, p. 189)

Organizational attention is limited. That is, each organization has a set of decision makers with a finite amount of time and resources (March & Simon, 1958). Attention is also selective; because of the organization’s inherently limited capacity for attention, decision makers (managers as well as employees) are selective in the issues they attend to, and their day-to-day actions depend on what issues they focus their attention (Ocasio, 1997). In a stable environment, managers of the unit find some equilibrium. That is, they selectively attend to strategic issues, performance goals, and monitoring of day-to-day operations.

Change represents a demand on the unit's limited attention because its design and implementation requires time, people, and other resources (Tushman & Anderson, 2004). One needs to attend to the fit between the design of the proposed change and the characteristics of the unit. Implementing the change represents an additional type of demand. All changes experience some resistance and redesign efforts. Also, another challenge is making the change sustainable. All of these activities draw on limited attentional resources. Organizational leaders switch from managing day-to-day operations and refocus their attention on managing the change processes (Peteraf & Reed, 2007). Given this reduced attention to routine activities, organizational members may look for shortcuts or choose to not perform some activities (Reason, 1998; Tucker, Edmondson, & Spear, 2002), often resulting in deviations from rules and regulations. Hence, latent errors are more likely to happen following a change.

We additionally note the following to conclude this theoretical position. First, there are different types of system changes. We have identified three—people, organizational structure, and technology. These are consistent with the literature and also were prevalent forms of change in this organization. We chose these types of change because they are different and should represent different potential benefits and costs to the organization. They also are different in the sense of affecting different constituencies in a given unit. Our basic argument is that change draws on limited attentional resources, which increases the likelihood of latent errors. However, the increase in different types of change should increase the demand on attentional resources because the different forms of change have different demands (Rerup, 2009). Managing changes in people, structure, and technology places greater demands on the attentional resources in the unit, and, as a result, potentially decreases vigilance, signals a lowered priority for error-reduction, and increases the propensity for errors. This leads to Hypothesis 1.

Hypothesis 1: Increase in different types of change leads to an increase in the frequency of latent errors.

The above hypothesis refers to change in general and does not take into account the fact that change can have different effects on the availability of attentional resources, which, in turn, can have differential effects on latent errors and performance. In the course of implementing large-scale changes, we would expect an immediate effect of increasing attentional demands, thereby making errors more likely. After the change is in place, we want to understand how the features of the change affect attentional demands. Does the change increase or decrease time demands on managers of units? Does the change increase or decrease the level of expertise in the unit? These are just two examples of features that may enhance or reduce available attentional resources.

Our task is to understand not only the effect of multiple system interventions on errors but also how change itself increases or decreases attentional demands. In a case where change helps the organization to respond more effectively to ongoing issues by reducing attentional demands, change should have a positive impact and reduce the

frequency of latent errors. On the other hand, if change increases attentional demands, there will be fewer resources for monitoring and a greater propensity for errors.

To sharpen the meaning of positive and negative change, a few examples might be helpful. One manager in our study who experienced a significant organizational change said, "This gave me more time to focus on strategic issues. I could delegate more and also, I had fewer teams to deal with directly." This quote indicates that after the change was in place, he had more attentional resources for managing his unit—a positive change. On the other hand, a manager said, "When this person (a senior manager) left, a lot of knowledge left with her. It took a while for the next person to get it right." In this case, it is the ineffectiveness of the new senior manager over time, which increased the attentional demands of other managers. The basic themes in this section are that (a) in general, change by itself places demands on the limited attention resources, and these demands, which intensify with the number of different types of changes, create conditions for more latent errors; and (b) specifically, each change can have either a positive or a negative impact on the attentional resources.

This suggests that our previously hypothesized effects of change, which treated all changes alike regardless of their specific impact, must be modified to take into account the differences between changes that have a positive impact and changes that have a negative impact on attentional resources. Specifically, changes with negative impact are more likely to an increase in latent errors because, in addition to the general increase in attentional demands associated with any change, these changes place specific additional demands on attentional resources. By contrast, changes with positive impact may not lead to a similar increase in latent errors because their specific impact leads to an augmentation of attentional resources. Therefore, the relationship between change and latent errors will be stronger for changes that have a negative impact. Hence, we modify our earlier hypothesis as follows.

Hypothesis 2: Increase in different types of changes that have a negative impact on attentional resources leads to a greater increase in the frequency of latent errors than does an increase in different types of changes that have a positive impact on attentional resources.

A variation of this hypothesis is the following: Changes can have both positive as well negative effects. The combined effect of these changes will depend on the extent to which the changes deplete or augment the attentional resources in a unit. For instance, consistent with Hypothesis 2, we would expect changes with negative impact to lead to more latent errors. However, if these changes are accompanied by other changes that have a positive impact (e.g., reducing the unit manager's workload, enhancing the quality of intra-unit coordination), then we would expect the link between changes with negative impact and the incidence of latent errors to be weaker.

Hypothesis 3: The incidence of latent errors will be lower in units where changes with negative impact are accompanied by a higher number of changes with

positive impact than in units where changes with negative impact are accompanied by fewer changes with positive impact.

Method

Setting

The study was carried out in North American Financial Institution (NAFI), a large financial institution comprising several business units in consumer banking, private banking, corporate banking, investment banking, and insurance. Data came from interviews with managers of these units and the auditors who led the teams that audited the units' operations as well as from content analysis of the audit reports.

Financial institutions represent an appropriate setting for this study because of the growing prevalence and increasingly dire consequences of errors in their routine operations. For instance, failure to comply with the established rules for verifying the identity of new high-net worth customers resulted in Bank of New York agreeing to a \$38 million settlement with regulatory agencies in a money-laundering case (Kirchgaessner, 2005). As a result of this and other similar situations, the management of "operational risk" has emerged as a major priority in this industry (Flores, Bónson-Ponte, & Escobar-Rodríguez, 2006). In response, financial institutions continue to develop various means to assess operational risk, and foremost among them is internal audits of their operations.

A key feature of this research setting was its large professional audit operation. A major challenge in studying errors *ex ante* is an appropriate measurement system. Features of NAFI's internal audit process make it particularly suitable for this study. First, the audit operation functions independently and reports directly to the board of directors. In other words, it does not report to the businesses it audits, thereby avoiding potential conflict or biases in reporting errors. Second, the audits are driven by a set of standard processes applied uniformly across the organization, with the findings reported in a standard format. Because of this uniformity, audit findings and conclusions across different business units are easily compared. Third, audits are performed by teams of auditors whose leadership and composition differ from audit to audit. As a result, the potential for any single auditor's bias influencing the findings is reduced. Fourth, the goal of these audits is to review the operations of the unit with a view to identifying potentially serious weaknesses, that is, "material" errors of omission and commission. Compared with other studies in this literature, which have used self-reports or questionable company record systems, this measure represents an important contribution.

Sample

Our sample consisted of 80 business units located in northeastern United States that were audited during 2001. We excluded new business units (i.e., units set up within the past year) and units outside North America.

Data came from multiple sources. First, we used the audit reports for each unit to identify errors. Second, where possible, we interviewed the manager in each unit who was responsible for ensuring that the operations conformed to rules and regulations. Managers provided data about change in their units during the 12 months preceding the audit of their units and about the perceived impact of these changes on their jobs as well as on their units' operations. We were able to meet with unit managers for 67 of the 80 units sampled. For the remaining 13 units, information about change was obtained from audit team leaders. Comparing units where data were obtained from unit managers with those where data came from lead auditors, we confirmed that they did not differ significantly in size, $F(12, 67) = 1.21, p < .30$; past performance, $F(12, 67) = 0.52, p < .91$; change level, $F(12, 67) = 1.5, p < .15$; and errors, $F(12, 67) = 0.83, p < .64$.

Third, for each of the 80 units, we interviewed the leader of its audit team. These interviews, conducted prior to the audit's commencement, provided information about unit characteristics such as past audit performance, work-inherent risk, and size (see below for details). It may be recalled that NAFI's audit process involved regular change in the leadership and composition of audit teams. In all, there were 73 different lead auditors with 69 of them serving as the lead auditor only once and 5 of them serving as the lead auditor two or more times (4 auditors served as team leader for 2 audits, and 1 auditor served as a team leader for 3 audits).

Measures

Latent errors. The prevalence of latent errors was measured using the internal audit reports. As reported earlier, these reports had a standardized format and always contained a section where the main findings were described. Each segment of this section that described a deviation from procedures and policies was coded as a deviation. Examples included a failure to carry out a monthly reconciliation of accounts as required by corporate policy or a failure to comply with certain customer service regulations. The authors content-analyzed the reports and identified deviations. To verify interrater reliability of this coding, 20 randomly chosen reports (representing 25% of the sample) were content-analyzed by an independent rater. The interrater agreement (Cohen's $\kappa = .87$) was at levels deemed acceptable (Krippendorff, 2004). In addition to describing the findings, the audit reports also flagged some findings as being especially significant, allowing us to classify certain errors as "major."

We measured the total number of errors in each unit in two ways. First, we used a simple count of the deviations coded from the unit's audit report. Second, we used a weighted sum assigning major errors a higher weight (5:1). This was done to take into account the greater potential for major errors to lead to adverse consequences. Our subsequent analyses were performed separately for the weighted and unweighted error measures. However, because the findings were very similar, we report only findings from the weighted count of errors.

Change. As noted above, change was measured for each unit using data from interviews with business managers and audit team leaders. During their interviews, managers

were asked to respond to questions about unit changes pertaining to the following five domains: managers, nonexempt staff, the unit's internal organizational structure (e.g., consolidation of previously separate activities, changes in reporting relationships), the unit's position in the overall organizational structure (i.e., its relationship to other units and entities within NAFI), and technology (e.g., implementation of new hardware or software). These domains were chosen because preliminary interviews indicated that changes in these domains were frequent and significant at NAFI. Moreover, these domains are consistent with those commonly identified in past studies of organizational change (e.g., Romanelli & Tushman, 1994).

For each of the five domains, we used the interview protocol provided in the appendix to obtain information about whether that type of change took place and, if it did, the nature of the change (i.e., positive or negative) and the extent of its perceived impact on the unit manager's job and the unit's operations. Using this information, we computed the impact of change in each domain on the unit's managers and operations separately on a 5-point scale ranging from -2 (very high negative impact) to +2 (very high positive impact). Given limitations on interview time, we were not able to get detailed information on each of the changes.

We derived several aggregate measures of change in each unit. First, we counted the number of changes that had some impact (positive or negative) on the manager's job and the unit's operations. For example, if a manager indicated that each of the five types of changes had some degree of impact on his or her job and that each type of change also affected the unit's operations, the number of changes for that unit was counted as 10. Second, we also measured change separately based on the impact on manager and on the operations. Third, we considered only major changes—that is, changes that were rated as having a “very high impact,” either positive or negative, on the unit manager's job or the unit's operations. We also separately examined the changes that had a major impact on the unit manager's job and changes that had a major impact on the unit's operations. We carried out our analysis using these alternative measures of different types of change. However, because the results did not vary significantly for these different measures, here we report results for the analysis that used the first measure of change reported above—that is, the number of changes that had some impact (positive or negative) on the manager's job and the unit's operations.

Perceived impact of change. This was computed using the managers' responses about the impact that each change that they identified had had on their own job as well as on the unit's operations. For example, consider a unit where the manager identified changes in three domains. In response to our follow-up questions about the impact of each of these changes, the manager indicated that two of these changes had a positive impact on her job but had no impact on the unit's operations and that the third change had no impact on her job but had a negative impact on the unit's operations. These responses were coded at the unit level as two changes with perceived positive impact and one change with perceived negative impact.

To better understand what the managers meant by positive and negative impact, we transcribed and content-analyzed the explanations provided by managers for rating the impact of any given change as positive or negative (see Table 1). Across changes in different domains, managers consistently explained their ratings, positive as well as negative, in terms of the impact of change on *their time*, the level of employee *expertise* in the unit, and *coordination* of work. Changes rated as having a positive impact were seen as freeing up time that the managers previously spent on some activity, increasing the level of work-related expertise in the unit, or facilitating organizational coordination.

As an example, one manager who reported a favorable impact of a change in organizational structure in his unit (the introduction of another level in the unit's structure) said, "This gave me more time to focus on strategic issues. I could delegate more and also, I had fewer teams to deal with directly." In contrast, another manager who reported an unfavorable impact of a change in the structure of his unit (combining two previously separate subunits) said, "This took up a lot of time as I had to be personally involved in making sure that the integration went off smoothly." Both of these are examples of managers describing the impact of change in terms of how it affected the demands on their time.

The impact of changes in the management team was often described in terms of their impact on the level of expertise in the unit. For instance, in one unit where three new managers joined the unit and two older managers left, the unit manager rated the impact of this change as positive and explained, "The new people brought in good experience and knowledge of the business whereas the people we lost were ones who were less knowledgeable." By contrast, in another unit where the impact of the changes in the management team was rated negatively, the unit manager said, "When this person left, a lot of knowledge left with her. It took while for the next person to get it right. To some extent, I have been hurt by having one person in a job for too long."

The impact of changes in organizational structure was typically described in terms of their effect on the ease of coordination of work. For instance, in one unit, the unit manager pointed to "reduced decision cycle times" following a restructuring as the reason for viewing this change favorably. Another manager, however, referred to the challenges associated with "there is the lack of clarity in the roles and responsibilities of key managers" as the reason for viewing a change negatively.

Control variables. Because we were sampling across different units in the same organizations, we needed to control for unit-specific factors, such as potential differences across unit size, past performance, and the degree of risk each unit typically faced. Since there had been a major merger several years prior to the study, a dummy code distinguished units that originally belonged to the "parent company" from those from other companies that had merged with the parent. Organizational size was measured as the number of employees in each unit. Past audit performance was measured with information provided by lead auditors, using the same 3-point scale as the one used to assess the unit's overall performance in the current audit (1 = *unsatisfactory*, 2 = *needs*

Table 1. Positive and Negative Impact of Change: Examples of Reasons Provided by Managers in Interviews

| Change domain | Category | Positive impact | Negative impact |
|--------------------------|--------------|---|---|
| Managers | Time | I was able to pass on some of my work to the new managers and focus more on business development. | I had to spend a lot of time on finding people, defining new roles, and identifying roles that could be combined. |
| | Expertise | The new people brought in good experience, and the people who left were generally the less efficient ones. | I would say my job suffered because the persons who left had been around for a long time and had a solid understanding of the business. It will be a while before the new managers get to that level. |
| | Coordination | Two years ago we started restructuring. With these new managers, all the pieces are now in place. We are really fine-tuning this year. | The New York operation is driving me crazy. We are not staffed properly, and these changes have meant that my managers are as confused as I am about who is doing what. |
| Nonexempt staff | Time | Previously we were understaffed. The new people have eased the load for everyone. | A lot of time was spent on training people and bringing them up to speed. |
| | Expertise | | There was some level of brain drain because people with useful experience left. This affected customer satisfaction. |
| | Coordination | We lost them willingly based on the need for efficiency. | Our operations are quite complicated, and it takes a while for new staff to come up to speed and learn to work with others. |
| Organizational structure | Time | The new team structure made it easier for me to delegate day-to-day work and focus on my priorities. Also, I now deal with fewer managers on a daily basis. | Although switching to a regional structure made business sense, I did not anticipate the amount of time I had to spend making sure that the transition was smooth. |

(continued)

Table 1. (continued)

| Change domain | Category | Positive impact | Negative impact |
|------------------------|--------------|--|--|
| External relationships | Expertise | Additional management talent came into the entity as a result of the change. | ^a |
| | Coordination | I like the new structure because it has reduced the span of control, increased leadership focus, reduced decision cycle times, and increased organizational performance. | The implementation of the matrix structure has made it difficult to enforce accountability because of the confusion over roles and responsibilities. |
| | Time | I suddenly had access to resources in other businesses and in the corporate office. I could now tap into these resources directly rather than waste time as I used to trying to tackle problems on my own. | Parts of my business are now overseen by a newly formed corporate group. I find myself spending a lot of time on the phone explaining our business to them. |
| | Coordination | ^a | We have had lots of crossed wires. I am still unsure about when I am expected to get the other business involved in my planning and when I should avoid loading them with information. |
| Technology | Time | We had five systems that we consolidated into one system. As a result I can now monitor risk from my desk more easily. It also takes less time to train people to use one system rather than five different systems. | The new platform turned out to have lots of glitches. We could not trust its accuracy and so ended up cross-checking our reports. |
| | Coordination | The new Internet-based system made it easier for brokers to communicate with the clients. Communication was faster as well as less prone to errors. | The new system shut down so many times that we had to maintain manual records in parallel. It was not easy to ensure that everyone was working off the same system. |

a. No corresponding excerpts were identified from the interview transcripts.

Table 2. Summary Statistics and Correlations

| Variable | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|--|--------|--------|------|-------|-------|------|-------|--------|-------|---|
| 1. Organizational dummy (1 = parent organization) | 0.25 | 0.44 | 1 | | | | | | | |
| 2. Organizational size | 102.19 | 136.21 | .11 | 1 | | | | | | |
| 3. Past audit performance | 2.83 | 0.41 | .04 | -.23* | 1 | | | | | |
| 4. Work-inherent risk | 5.85 | 1.86 | -.06 | .00 | -.03 | 1 | | | | |
| 5. Total no. of changes | 3.76 | 2.00 | .01 | .23* | -.28* | .18 | 1 | | | |
| 6. No. of changes with positive impact | 2.58 | 1.89 | -.01 | -.04 | -.23* | .20 | .66** | 1 | | |
| 7. No. of changes with negative impact | 1.19 | 1.60 | .02 | .33** | -.08 | -.01 | .46** | -.36** | 1 | |
| 8. Errors | 2.66 | 4.03 | -.06 | .01 | -.21 | .05 | .33** | -.07 | .49** | 1 |

* $p < .05$. ** $p < .001$.

improvement, 3 = satisfactory). Work-inherent risk was measured using data from NAFI's risk management division, which regularly assessed each unit's exposure to 10 different risk families (credit risk, exchange risk, etc.) on a 3-point scale (1 = low, 2 = medium, 3 = high). For this study, we created an index that counted the number of risk families for which the unit had a high level of exposure. A high score on this index suggested a greater use of, or need for, attentional resources because of the large number of distinct and salient risk-related issues that demanded the attention of the unit manager.

Results

Table 2 provides summary statistics and correlations for the study variables. On average, each unit had 2.66 errors. The audit reports did not identify any errors for 23 units in the sample. Eight units had at least one error the audit team considered "major." The average level of change, measured as a count of changes in different domains, was 3.76, with 7 units reporting no change during the year preceding the audit. Overall, more changes were perceived to have a positive (mean = 2.58) rather than a negative impact (mean = 1.19).

Hypotheses

The hypotheses were tested using Tobit regression models to account for the skewed distribution of the dependent variables (because of 23 units having zero errors). Tobit provides a nonparametric alternative to ordinary least squares (OLS) regression for modeling "censored" or skewed dependent variables that violate meet parametric assumptions (McDonald & Moffitt, 1980). The interpretation of Tobit coefficients is

Table 3. Tobit Models With Latent Errors as Dependent Variable

| Variable | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
|---|----------|-------|----------|--------|----------|--------|----------|--------|
| | <i>b</i> | SE | <i>b</i> | SE | <i>b</i> | SE | <i>b</i> | SE |
| Constant | 1.74 | 0.69* | 1.73 | 0.65* | 1.80 | 0.57* | 1.82 | 0.58 |
| Organizational dummy (1 = parent organization) | -0.41 | 1.36 | -0.41 | 1.29 | -0.30 | 1.13 | 0.07 | 1.16* |
| Organizational size | 0.00 | 0.00 | -0.01 | 0.00 | -0.01 | 0.00* | -0.01 | 0.00* |
| Past audit performance | -2.60 | 1.44 | -1.60 | 1.39 | -2.17 | 1.23 | -2.38 | 1.27 |
| Work-inherent risk | 0.23 | 0.32 | 0.08 | 0.31 | 0.16 | 0.27 | 0.14 | 0.28 |
| Total no. of changes | | | 0.92 | 0.30** | | | | |
| No. of changes with positive impact | | | | | 0.34 | 0.29 | 0.39 | 0.30 |
| No. of changes with negative impact | | | | | 1.85 | 0.35** | 1.82 | 0.36** |
| No. of changes with positive impact × no. of changes with negative impact | | | | | | | -0.25 | 0.16 |
| SE | 4.98 | 0.49 | 4.69 | 0.46 | 4.10 | 0.40 | 4.07 | 0.39 |
| -2 Log likelihood | -190.87 | | -186.31 | | -177.85 | | -174.34 | |
| Likelihood ratio χ^2 | 3.96 | | 13.06* | | 30.65** | | 32.82** | |
| Degrees of freedom | 4 | | 5 | | 6 | | 7 | |

* $p < .05$. ** $p < .001$.

similar to that of OLS coefficients. The statistic for evaluating the effects of adding a variable is the difference in the “-2 log likelihood” terms of the original model and the one with the variable; this is analogous to delta R^2 in OLS. Log likelihoods follow a chi-square distribution.

Table 3 provides the results of the Tobit regression analysis. Model 1 included only the control variables (organizational affiliation, size, past audit performance and risk). In Model 2, the total number of changes was added to the control model. In Model 3, the number of changes with positive impact and number of changes with negative impact were added to the control model. None of the control variables had a significant effect. However, the coefficient for past audit performance was marginally significant in all the models ($p = .07$). The negative coefficient for the past audit performance indicates that units performing poorly in past audits (i.e., those that received a low score on the 3-point scale) were likely to have a higher number of errors in the current audit.

Hypothesis 1 indicated that an increase in the types of change is positively related to the number of errors. The coefficient for the number of changes in Model 2 is positive and significant ($t = 3.05, p < .01$), indicating that errors increased with different

types of change. Moreover, the addition of the change term to Model 2 was significant: $\chi^2(1) = 4.56, p < .05$. Therefore, Hypothesis 1 was supported.

Hypothesis 2 stated that the effect of change on errors will be higher for changes that are perceived to have a negative impact than for changes perceived to have a positive impact. In Model 2, the coefficients for both the change terms are in the expected direction. However, only the coefficient for the number of changes with perceived negative impact was significant ($t = 5.34, p < .01$). Also, the reduction in the -2 log likelihood term, following the addition of the change terms to Model 1, was significant: $\chi^2(2) = 13.02, p < .01$. Taken together, this indicates that errors increased only with changes perceived to have a negative impact, not with changes perceived to have a positive impact. Although we had expected to see a significant (but weaker) relationship between errors and changes with positive impact, the overall finding is consistent with what we hypothesized. Therefore, Hypothesis 2 was also supported. Note that we examined the effects of different types of change separately—personnel, organizational relationships, and technology—but did not find any relationship with the frequency of errors.

Hypothesis 3 stated that the relationship between change with perceived negative impact and latent errors is moderated the change with perceived positive impact. To explore this, we added the interaction term to Model 3. Although the coefficient of the interaction term in Model 4 was negative as expected, the addition of the interaction term was only marginally significant: $\chi^2(1) = 3.5, p = .06$. Therefore, Hypothesis 3 was not supported. To verify the nature of the marginally significant interaction effect, we plotted the interaction graphically using values for the variables at mean ± 1 standard deviation. The observed pattern of interaction (not presented here) was consistent with our hypothesis. The relationship between change with negative impact and latent errors was stronger in units that had a low number of positive changes than in units that had a high number of positive changes.

Additionally, we ran the models separately for the impact of the change on the unit manager's job and the impact on the unit's operations. As before, only the coefficients for change with perceived negative impact were both significant and positive (again demonstrating that errors increase with negative change). Interestingly, the effects were stronger for the perceived impact on the unit manager's job than on the unit's operations. Although we did not originally propose a difference between the two types of impact, the observed difference is consistent with recent research on safety climate indicating that employees' safety-related behaviors are influenced by their supervisor's priority for safety and his/her actions related to safety (Zohar, 2002). In our study context, this corresponds to employees avoiding potentially consequential latent errors. This suggests that what the supervisor does or does not pay attention to serves as an important signal of what is important (or not important) to the supervisor and thereby can shape employees' perceptions and behaviors. In the study setting, increased demands on unit managers' attention because of changes with negative impact may have caused managers to shift attention away from error management activities (e.g.,

monitoring and reviewing operations, initiating corrective actions), which, in turn, may have suggested to employees that error management was not a high priority.

Furthermore, we reviewed the reasons provided by managers for rating the impact of a change as being positive or negative. As described earlier, we identified several recurring themes. It must be noted that these themes are not mutually exclusive. The same change could be viewed favorably (or unfavorably) for multiple reasons such as increased (decreased) expertise and better (poorer) coordination that, in turn, also serve to reduce (increase) the demands on managerial time. However, with a few exceptions, these themes capture the main reasons provided by the managers in our interviews. These themes also are consistent with the notion of changes in attentional demands that we used to develop our hypotheses about change. Therefore, these analyses provide further evidence to suggest that the effect of change on latent errors may at least in part be because of its impact on managerial attention.

Examining Nonconforming Units

Finally, we examined the organizational units in our sample that did not conform to the proposed hypotheses—that is, units that experienced high levels of change but had few errors and units that underwent little or no change but had a large number of errors. This is an exploratory investigation oriented to find new theoretical insight. Given the exploratory nature of this analysis, we used a simple set of criteria for identifying “low” (change in one or fewer domains) versus “high” levels of change (change in four or more domains) and frequency of latent errors (units with one or fewer errors vs. units with five or more errors). Based on these criteria, we selected 19 units in our sample for further analysis. Of these 19 units, 5 experienced low levels of change but had a large number of latent errors, whereas 14 experienced high change but had a small number of errors.

Of the five units that experienced low change yet had a large number of latent errors, four units reported performance-related problems. Two had scored poorly in previous audits, which had identified a large number of errors. Two other units, which had scored well in prior audits, were behind targets on critical metrics on which their overall performance assessed. The presence of units with performance-related problems in this category appears disproportionately large, as in the overall sample, only 12% of the units reported either poor past audit performance or falling behind key business metrics during the current period. The small number of units in this category precluded more formal analysis of these differences. Meeting performance goals is very important in this organization. From our interviews and observations, falling behind in performance is an undesirable state and one that demands a lot of attentional resources.

Fourteen units in the sample reported a low number of errors despite experiencing high levels of change. Significantly, in 11 of these units, the impact of the changes was rated positively. In other words, consistent with our attention-based explanation, few

of these changes resulted in increased attentional demands. Moreover, 11 of the 12 units in this category performed satisfactorily in the prior audit, and all 12 units met or exceeded their business targets during the current period. Taken together, these patterns suggest that the consequences of change on latent errors can be better understood by taking into account the past and current performance of the units as well as the nature of the impact of change. Both classes of predictors are embedded in the attentional argument.

Discussion

This study brings together two important organizational research literatures. Research on organizational change has not paid much attention to the phenomenon of organizational errors, and the organizational error literature, in turn, has not paid much attention to change. Our findings show the number of different types of organizational change is linked to the frequency of errors. However, the *type* of change seems to be a more important factor than just the *existence* of change. Change that results in negative consequences and increased demand on limited attentional resources has a greater effect on errors. When we analyzed the features underlying negative change, they seemed to increase the time demands on the senior manager; increase coordination efforts decrease the expertise in the unit and so on. We also reported that the effect of the change on the managers' job has a greater impact on errors than when change affected unit operations. There were no differences in errors as a function of whether the changes were in personnel, organizational structure, or technology. Also, there is some evidence (marginal significance) indicating that changes with negative consequences had a lower frequency of errors if the changes included positive consequences as well.

When we examined units that behaved differently from our main hypotheses, a consistent and more differentiated picture emerged. Units with high levels of change, yet infrequent errors, experienced positive change that enhanced their attentional resources. On the other hand, units experiencing frequent errors despite little change had other problems. Some had poor past audit performance that persisted to the time of our study. These units were also struggling with maintaining acceptable unit performance, which draws heavily on attentional resources. The important point in this last case is that there are many factors in addition to change (e.g., performance pressures) that can draw on attentional resources and result in latent errors.

Another contribution of this study is in its innovative research design. We sampled a relatively large number of organizational units, using different, independent methods to collect data. Studies in the error literature often sample on the dependent variable to explain adverse organizational consequences. Many also primarily rely on self-report data.

The following limitations of our study must be noted. First, we did not directly measure the effects of change over time on attentional processes. Our theory indicated that managing the design and implementation of unit-level changes would draw on

limited attentional resources. After the change was in place and institutionalized, the consequences of change would affect attentional resources. If the change was positive, the unit would have more attentional resources and fewer errors. If the change had negative effects, the drain on attentional resources would increase as would errors. To capture these mediating processes, we would need a longitudinal design that tracks changes in attentional resources and errors over time. Given our design included 80 different units in several locations in the Northeast, this kind of data would have required substantial resources in time and money. However, the idea of a longitudinal study is important and intriguing. One strategy might be to select a smaller sample and conduct a more intensive study. Second, although we propose that change causes errors, we cannot establish causality using this study's cross-sectional design. By controlling for past audit performance, we took into account the possibility that errors may lead to change (i.e., a high incidence of errors can itself initiate organizational change in an attempt to improve performance). Also, we collected in most cases the dependent variable—latent errors—well after the change had occurred. So if the audit was in December, we would have collected data for the prior 12 months. Longitudinal studies of the relationship between change and errors are still needed to establish causality.

Third, we measured latent errors but not actual errors. It was not possible to verify our basic assumption that the latent errors identified here posed a significant threat to the NAFI. However, it must be recalled that the audit reports identified only those errors that were viewed as significant or having a high likelihood of causing adverse outcomes. Also, the audit reports were reviewed by the most senior managers of the firm. A final limitation is that our sample came from a single organization. So there is a question about the generalizability of the results. However, the 80 units in our sample functioned in effect as independent organizations because they came from diverse, unconnected businesses (consumer banking, foreign exchange trading, investment banking, etc.). Also, since this organization had a strong independent auditing group, we had stronger measures of errors than are found in most studies, and since the audit process is standardized, we have comparable data across diverse units. Of course, extending our findings to other institutions (e.g., hospitals) would be desirable.

This study raises several questions for future research. First, what are the processes by which the greater attentional demands on managers result in the occurrence of different kinds of errors across the organization? We treated all deviations alike in our analysis. However, latent errors can occur in different kinds of activities. For instance, errors may occur in routine activities or transactions, or they could occur in error management activities (e.g., failure to monitor operations for errors as required); errors also could occur in the design of a unit's infrastructure (e.g., the division of roles and responsibilities might deviate from industry standards). How do different kinds of change affect attentional demands? Does the effect of change on such different types of errors vary? Also, are changes in some domains more likely to cause errors than others? And more generally, what are the processes and conditions that contribute to latent errors becoming actual errors?

Another option is to explore other explanations than attentional demands on errors. For example, change can create losses and procedural injustice for some, which in turn can facilitate errors. More broadly, our focus has been on the *content* rather than the *process* of change. Thus, a new research question is formed about how change across domains and the process of implementation affect the frequency of errors.

In conclusion, the findings from this study point to several managerial implications. Foremost, managers need to recognize that organizational change—especially change that is perceived as negative—can result in an unintended, and often unacknowledged, risk: a buildup of latent errors in operations. They must consider ways to enhance organizational attention and memory during and after the implementation of major change (e.g., arranging for operations to be audited during this period, ensuring that error management activities are not suspended during this period). Moreover, managers should consider using the measurement of latent errors as an additional method to assess the effectiveness of change.

Appendix

Interview Protocol for Obtaining Information About Change

The respondents were asked the following questions:

1. “Were there any major changes in your unit’s internal structure during the past 12 months? By internal structure we refer to such things as changes in reporting relationships, consolidations or segregation of roles and responsibilities of people, etc. By major change, we refer to any change that is unusual or nonroutine.” If any such change was identified, the manager was asked to describe the change so that we could verify that it corresponded to the domain in question. This unit was assigned a score of “1” to indicate that it had experienced at least one major change in this domain.
2. “Change can have a positive impact on your job as the unit’s manager. A positive impact means the change helps you perform your job. A negative impact means the change makes it difficult for you to do so. What was the overall impact of the changes that you just described on your job? Was it positive, negative, or neither?” The manager was asked to explain the response so that we could verify that the manager’s assessment of the impact was consistent with our question. If the overall impact was negative, we assigned the unit a “-1” to indicate the occurrence of a negative change in this domain, that is, unit’s internal structure (a “+1” was used to indicate change with positive impact).
3. If the manager assessed the overall impact as either positive or negative, we said, “The impact of change can vary in strength. Some changes have a slight impact whereas other changes have a strong impact. For the change that you

just describe to what extent did it affect your job (positively/negatively)? Please use the following scale to provide your response (1 = *not at all*, 2 = *a little extent*, 3 = *some extent*, 4 = *a great extent*, and 5 = *a very great extent*).” The score on this scale was combined with the nature of the overall impact (-1 or +1) to provide a score for the impact of the change in this domain on the unit manager’s job.

4. After this information was obtained, Steps 2 and 3 were repeated; but the questions asked were about the impact of change on the unit’s operations. Using the same procedure, we computed a score for the impact of the change in this domain on the unit’s operations. In other words, there were two impact scores for changes in each domain.
5. Steps 1 to 4 were repeated to obtain impact scores for changes in the other domains (managers, nonexempt employees, unit’s position in the overall organizational structure, and technology). Thus, for each of the four types of changes, we were able to assess the presence of change, the nature and extent of its perceived impact on the unit manager’s job as well as the unit’s operations. We compressed these measures to a 5-point scale so that each unit could have an impact score that ranged from -2 to +2.

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Bios

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