Change escalation processes and complex adaptive systems: from incremental reconfigurations to discontinuous restructuring

Article

Accepted Version

Girod, S. J. G. and Whittington, R. (2015) Change escalation processes and complex adaptive systems: from incremental reconfigurations to discontinuous restructuring. Organization Science, 26 (5). pp. 1520-1535. ISSN 1526-5455 doi: https://doi.org/10.1287/orsc.2015.0993 Available at https://centaur.reading.ac.uk/43542/

To link to this article DOI: http://dx.doi.org/10.1287/orsc.2015.0993

Publisher: INFORMS Open Option

Change Escalation Processes and Complex Adaptive Systems: From Incremental Reconfigurations to Discontinuous Restructuring

Stéphane J.G. Girod (corresponding author)
Henley Business School
University of Reading
Henley-on-Thames RG9 3AU
United Kingdom
s.girod@henley.ac.uk

Richard Whittington
Saïd Business School
University of Oxford
Park End Street
Oxford OX1 1HP
United Kingdom
Richard.whittington@sbs.ox.ac.uk

Abstract

This study examines when 'incremental' change is likely to trigger 'discontinuous' change, using the lens of complex adaptive systems theory. Going beyond the simulations and case studies through which complex adaptive systems have been approached so far, we study the relationship between incremental organizational reconfigurations and discontinuous organizational restructurings using a large-scale database of U.S. Fortune 50 industrial corporations. We develop two types of escalation process in organizations: accumulation and perturbation. Under ordinary conditions, it is perturbation rather than the accumulation that is more likely to trigger subsequent discontinuous change. However, organizations are more sensitive to both accumulation and perturbation in conditions of heightened disequilibrium. Contrary to expectations, highly interconnected organizations are not more liable to discontinuous change. We conclude with implications for further research, especially the need to attend to the potential role of managerial design and coping when transferring complex adaptive systems theory from natural systems to organizational systems.

Key words: Complex adaptive systems; organizational restructuring; reconfigurations

Acknowledgments: The authors are grateful to the Economic and Social Research Council, the Millman Foundation and Accenture for their financial support. They would also like to thank the three anonymous reviewers and Rich Burton for their invaluable guidance during the review process.

Change Escalation Processes and Complex Adaptive Systems: from Incremental Reconfigurations to Discontinuous Restructuring

Introduction

Organization theorists often discuss change in terms of contrasting types, with different levels of impact: for example, evolutionary change and revolutionary change (Greenwood & Hinings, 1996); continuous and episodic change (Weick & Quinn, 1999); and incremental and discontinuous change (Nadler & Tushman, 1995). The contrasts are useful in highlighting the distinct managerial implications of each type of change. However, the types are not necessarily discrete and well-insulated alternatives: one type of change can lead to another. Weick and Quinn (1999: 378) invoke complex adaptive systems theory: under certain conditions 'small changes do not stay small... Small changes can be decisive if they occur at the edge of chaos.'

This article explores how organizations may tip over the edge from incremental to discontinuous change (Nadler & Tushman, 1995). We adopt the lens of complex adaptive systems theory, associated with the edge of chaos (Brown and Eisenhardt, 1998). Originally developed in the natural sciences to describe the behavior of phenomena ranging from weather patterns to biological populations, complex adaptive systems theory points to how natural systems tend to balance on a dynamic edge between inertia and 'chaotic' change. This edge is characterized by ongoing adaptive change. But beyond a threshold, otherwise adaptive changes can tip systems beyond continuity into radical change. In this sense, small changes have disproportionate - 'nonlinear' - effects (Miller & Page, 2007).

We adopt the lens of complex adaptive systems theory as a coherent metaphorical framework by which to detect and interpret nonlinear effects in organizations equivalent to those in nature (Richardson, 2011). Taking a complex adaptive systems lens alerts us to the potential for incremental change to escalate to discontinuous change. Moreover, it points us to two distinct types of change escalation process: i. *accumulation*, where escalation is a result of progressively building pressures; and ii. *perturbation*, where escalation is the result of discrete system shocks. Complex adaptive systems theorists are beginning to study nonlinear change in organizations using simulations (Carroll & Burton, 2000; Davis, Eisenhardt, & Bingham, 2009) and individual case studies (e.g., Chiles, Meyer, & Hench, 2004; Burgelman & Grove, 2007; Plowman, Baker, Beck, Kulkarni, Thomas-Solansky, & Villareal-Travis, 2007). However, empirical studies of complex adaptive systems effects in organizations are still rare (Andriani & McKelvey, 2009; Eoyang, 2011). In particular, we do not have large scale cross-industry research on how incremental change may escalate into discontinuous change. As a result, we lack systematic evidence about organizations' susceptibility to escalation and when it is more likely.

Accordingly, this study explores the relationship between incremental change and discontinuous change in a large sample of U.S. Fortune 50 industrial corporations between 1989 and 2004. We focus on organizational restructuring as a form of discontinuous change and organizational reconfiguration as a form of incremental change. By organizational restructuring, we mean change in basic structural principles, for example change in the type of structural axes or the number of organizational layers (Bowman, Singh, Useem, & Bhadury, 1999). By reconfiguration, we mean changes affecting particular structural units, for instance mergers or splits, but which leave the overall organization structure basically intact (Eisenhardt & Brown, 1999; Karim, 2006). Reconfigurations are thus incremental in Nadler and Tushman's (1995) sense of being consistent with existing structural principles, while restructuring is discontinuous in that it involves change in structural principles.

Escalation from reconfiguration to restructuring may have significant implications. Whereas reconfigurations are the kinds of change that can become relatively routinized in organizations (Eisenhardt & Brown, 1999), discontinuous change is typically more episodic and requires different managerial skills (Weick and Quinn, 1999). Discontinuous change can be painful, risky and difficult (Tushman, Newman and Romanelli, 1986; Tushman and O'Reilly, 1996). In particular, restructurings are associated with performance penalties, at least in the short-term (Lamont, Robert, & Hoffman, 1994). Moreover, especially from a repetitive momentum perspective (Amburgey and Miner, 1992), escalation may be unexpected. Given the potential for trauma and surprise, organizations need to know more about whether and when incremental change may escalate to a higher level.

Our study makes several contributions. Above all, we show for the first time in a large group of organizations that incremental change in the form of reconfigurations does predict subsequent discontinuous change in the form of restructuring, in line with complex adaptive systems theory. Change produces greater change. Further, we find that perturbations rather than accumulations of incremental change are more likely to trigger discontinuous change. We identify a point where the rate of incremental change is markedly more likely to produce discontinuous change, and indicate conditions where such escalation is more likely. We find that organizations in disequilibrium are more sensitive to the triggering effects of incremental change, and that this applies to accumulation as well as perturbation. But, contrary to expectations from complex adaptive systems theory, we do not find that greater interconnectedness in organizations increases the likelihood of discontinuous restructuring following reconfigurations. We suggest that human organizations may differ from natural systems in two respects therefore: their apparent ability to cope with the ordinary accumulation of incremental change and their lack of sensitivity to interconnectedness. In these respects, our results support McLean & McIntosh (2011) in pointing to the possible role of management in mediating the effects of complex adaptive systems in organizations.

Theory and Hypotheses

This section introduces restructuring and reconfiguration as types of, respectively, discontinuous and incremental change. We continue by examining theoretical and case study treatments of change from a complex adaptive systems perspective, and the conditions under which they suggest escalation from incremental to discontinuous change is more likely.

Discontinuous restructuring and incremental reconfiguration

Weick and Quinn (1999) take as an example of discontinuous change the occasional 'revolutions' of punctuated equilibrium theory, characterized by changes in organizational leadership, strategy and structure (Romanelli & Tushman, 1994). Discontinuity involves a qualitative change of state and is typically infrequent. We follow Nadler and Tushman (1995) in taking restructuring as our focal type of 'discontinuous' change: organizations move from one basic organization structure to another. Restructurings involve change in the number of organizational layers and/or change in the number or type of structural axes, for instance from functional to divisional axes (Bowman, Singh, Useem, & Bhadury, 1999). Examples from our data include Compaq's removal of a whole layer of executive vice presidents in 2000 and ExxonMobil's 1999 shift from a geographic divisional structure to a global divisional structure. Thus restructurings are discontinuous in that the basic structure of reporting relationships is fundamentally changed organization-wide. Such restructurings are generally occasional:

strategy-structure misfits often endure a decade or more (Aupperle, Acar and Mukherjee, 2013). Even if necessary, discontinuous restructurings can be highly disruptive and ‘painful’ (Tushman and O’Reilly, 1996). In punctuated equilibrium theory, restructurings are typically accompanied by radical and traumatic changes in strategy and leadership as well (Romanelli and Tushman, 1994). Restructurings may also incur short-term performance penalties, as in adoptions of the M-form structure (Lamont, Robert, & Hoffman, 1994).

Weick and Quinn (1999) contrast such discontinuous change with the ongoing incremental change found in Brown and Eisenhardt’s (1997) fast-evolving computer companies, which Eisenhardt later describes as reconfigurations (Eisenhardt & Brown, 1999; Galunic & Eisenhardt, 2001). Reconfigurations involve small adjustments within the same basic structure, namely the adding, splitting, transferring, merging or deleting of particular organizational units. Changes in reporting relationships are localized rather than organization-wide. Eisenhardt and Brown (1999) give the example of Dell’s regular divisional splits, which reconfigure particular businesses while leaving the company's basic customer-division structure intact. Reconfigurations are increasingly recognized as important for dynamic capabilities (Galunic and Eisenhardt, 2001), learning and innovation (Karim, 2009), the divestment and retention of activities (Karim, 2012), and the flow of knowledge within firms (Karim and Williams, 2012). These reconfigurations entail more limited adjustments than restructurings and, because of their frequency, can become fluent organizational routines (Eisenhardt and Brown, 1999). Such reconfigurations are often what Tushman et al (1986: 587) term figuratively ‘ten percent changes,’ expected and potentially welcomed even in conservative organizations.

While the literatures on both restructuring and reconfiguration are well-developed in themselves, potential relationships between these two forms of organizational change have not been considered. This disarticulation appears also in more general treatments of types of change in organization theory. In punctuated equilibrium theory, for example, equilibria are typically punctuated by occasional episodes of radical, brief and pervasive transformations (Romanelli and Tushman, 1994). Small organizational changes do not accumulate to generate larger transformations therefore. Similarly, in the organizational momentum perspective, one type of change typically does not unfreeze the organization as a whole, but only unfreezes the same type of change (Kelly and Amburgey, 1991: 606). Institutionalization and routinization processes ensure that the more frequent a particular kind of change, the more probable is its reoccurrence (Amburgey et al, 1993): there is repetitive momentum in firms' choices of alliance partners, for example (Gulati, 1995). Momentum implies that changes repeat rather than escalate to another level. A still stronger view on the relationship between episodes of change is that successful adaptation in one part of an organization can even reduce pressure for adaptations elsewhere (Levinthal and March, 1993). This safety-valve effect suggests that incremental change may actually diminish the chance of more change. Ilinitch et al (1996: 218) propose that ongoing adaptive (incremental) change may substitute for major episodic change. Thus, from several points of view, reconfiguration is thought unlikely to lead to subsequent restructuring. Complex adaptive systems theory suggests the reverse: reconfigurations can trigger restructuring.

Complex adaptive systems theory and change

Organization theorists drawing on complex adaptive systems theory are particularly sensitive to how feedback processes can amplify small change into larger change (Van de Ven and Poole, 1995; Weick & Quinn, 1999). Many systems operate on a dynamic but precarious 'edge of chaos', neither inert nor wholly disordered (Brown and Eisenhardt, 1998; Carroll and Burton, 2000). This edge of chaos involves a typically fragile balance between different kinds of feedback, positive and negative. Positive feedback amplifies change, as when panic spreads through a herd to cause a stampede. Negative feedback dampens change, as when the release of insulin corrects excesses of glucose in the human body. Where positive feedback exceeds some critical threshold value, equivalent to a 'tipping point' (Neptstad et al, 2008), systems are pushed beyond the ordinarily dynamic edge of chaos and into the chaotic zone of heightened instability. Thus otherwise innocuous small events may trigger so-called 'large events', phenomena of an altogether different scale and character to what preceded them (Miller & Page, 2007).

We can draw from complex adaptive systems theory two distinct processes for such nonlinear change, differing according to the pattern of preceding events and the timing of outcomes. The first escalation process is one of progressive accumulation, by which the build-up of small changes finally creates insupportable pressures that explode into a greater event. The initial pattern of change may be incremental and slow, but, when positive feedback finally overwhelms restraining forces, the outcome is large and sudden. In complex adaptive systems theory, this process is the kind of avalanche event that eventually results from the repeated dropping of individual grains of sand on a sand-pile (Bak and Paczuski, 1995). Even if the pattern is steady and incremental, just one extra grain of sand can finally push the sand-pile over the edge with disproportionately explosive results - an avalanche. As illustration, Plowman et al's (2007: 536) case study of turnaround within a church describes 'an accumulation of small changes that ultimately became radical': positive feedback amplified a series of small volunteer initiatives over several years into unforeseen and fundamental change.

The second escalation process is set off by discrete perturbation rather than progressive accumulation. Here a quite small event may trigger knock-on effects that reverberate throughout the system with growing amplitude until eventually precipitating major change. Each part of the system transmits the initial perturbation to the next part, generating increasing waves of positive feedback to a point where damping by negative feedback is no longer enough to constrain large-scale repercussions. In complex adaptive systems theory, an extreme example of this kind of perturbation is the famous butterfly effect: here the flap of a butterfly's wings in Brazil can notionally set off a chain of events leading to a tornado in Texas (Lorenz, 1993). Thus one kind of event, even small and remote, can spark other events that lead to an outcome of much larger scale and far distant from the original. Characterized by bursts of activity, the perturbation process has a more uneven preceding pattern of change than the accumulation process, and the gap between trigger and outcomes is longer. Case studies illustrate this uneven and lagged perturbation process too. Thus Chiles et al (2004: 502) describe how Branson, Missouri's development process was one of occasional perturbatory events (e.g. the improvement of the railroad), where 'evolution proceeds from one punctuated emergence to the next'. Each perturbation opened up mindsets, unleashing waves of new initiatives which eventually consolidated into new orders for the growing town. The sequence from initial perturbation to consolidation would typically take several years. At Intel, Burgelman and Grove (2007: 278) point to a similar two-step process summarized by the aphorism: 'Let chaos reign, then rein in chaos'. The process begins with initial perturbatory bursts of 'autonomous' local initiatives in middle management layers and the periphery. Only after a period of analysis and debate would top management take the second step, and scale up the most promising local initiatives into coordinated programs of major 'induced' change.

While such case studies of a church, a town and a technology leader can illustrate nonlinear escalation processes, they provide insecure grounds for generalization. Moreover, these cases differ in the weights given to progressive accumulation and discrete perturbation. Our initial hypotheses therefore follow complex adaptive systems logic by using a large sample to test the extent to which incremental reconfigurations may have nonlinear effects in the form of discontinuous restructurings. The hypotheses distinguish between the two escalation processes, accumulation and perturbation:

Hypothesis 1a: The greater the accumulated incremental change (reconfigurations) since a previous discontinuous change (restructuring), the higher the likelihood of subsequent discontinuous change (restructurings).

Hypothesis 1b: The more incremental change (reconfigurations) is concentrated in short periods of time, the higher the likelihood of subsequent discontinuous change (restructurings).

Moderating effects of disequilibrium and interconnectedness

Complex adaptive systems theory also proposes two conditions under which incremental change is more likely to lead to discontinuous change: internal disequilibrium and system interconnectedness. These conditions are already recognized within organization theory as having a role in change, but complex adaptive systems integrates them within a single frame.

Prigogine (1978) observes that physical systems tend to behave differently as they move from equilibrium (or close to equilibrium) to disequilibrium. Beyond a critical value, damping processes are likely to be overwhelmed by additional disturbances from which new kinds of order may emerge. If pressures are already high or rising in the system, any particular change is more liable to breach the critical threshold beyond which large events become likely (Andriani & McKelvey, 2009). In other words, systems operating in a state of heightened disequilibrium are closer to the chaotic state where they are exposed to discontinuous change.

Within organization theory, Plowman et al (2007) take the complex adaptive systems lens to highlight two disequilibriating factors that precipitated transformation at their church: change in leadership and performance decline. Organization theorists from other traditions recognize the importance of similar factors for significant organizational change. Thus, researchers on CEO succession observe that new leaders, especially outsiders, are more likely to institute radical change (Miller, 1993). Similarly, both absolute and relative performance decline increases the pressure for organizational change (Boeker & Goodstein, 1993; Barker & Duhaime, 1997). Downturns in organizational growth are especially likely to prompt changes in organization form (Huber, Sutcliffe, Miller, & Glick, 1995). In short, both top management change and performance decline appear to create conditions where firms are easily pushed beyond the ordinary dynamism characteristic of the edge of chaos into the more extreme chaotic conditions from which discontinuous change may emerge. To test the effects of disequilibrium on accumulation and perturbation, we therefore hypothesize:

Hypothesis 2a: The more an organization is characterized by organizational decline, the more cumulated incremental change (reconfigurations) will be associated with subsequent discontinuous change (restructurings).

Hypothesis 2b: The more an organization is characterized by organizational decline, the more concentrated bursts of incremental change (reconfigurations) will be associated with subsequent discontinuous change (restructurings).

Hypothesis 3a: The more an organization is characterized by top management change, the more cumulated incremental change (reconfigurations) will be associated with subsequent discontinuous change (restructurings).

Hypothesis 3b: The more an organization is characterized by top management change, the more concentrated bursts of incremental change (reconfigurations) will be associated with subsequent discontinuous change (restructurings).

A second condition exacerbating susceptibility to discontinuous change is internal connectedness. Complex adaptive systems theory highlights how natural systems are more fragile when highly interconnected internally (Kauffman, 1993). Connections allow surges in positive feedback to be easily transmitted throughout the whole system, with low buffering between individual parts. The multiplier effects of change increase with growing interconnectedness (Dooley, 1997). From within organization theory, Weick's (1976) notion of loose-coupling supports the advantage of limited interconnectedness within organizations. Loose-coupling promotes flexibility and buffers the impact of organizational shocks; tight-coupling restricts flexibility and allows local shocks to reverberate throughout the whole system. Similarly, in both configuration theory (Miller, 1982) and complementarities theory (Whittington, Pettigrew, Peck, Fenton, & Conyon, 1999), tight interconnectedness transmits the impact of localized incremental changes much more widely through the organization. Isolated changes and repairs can violate organizational complementarities and unravel the whole bundle of mutually-supporting elements (Zenger, 2002).

Organizational interconnectedness varies by strategy. Unrelated conglomerate strategies leave each business unit operating in distinct markets and managed independently: units are well-insulated from shocks to any particular one (Kay, 2000). In conglomerates, interconnectedness is low and change can be localized. In undiversified or related-diversified firms, by contrast, resource-sharing and market-adjacencies are higher, creating more links across organizational units through which shocks can be transmitted organization-wide (Rumelt, 1974). The more related a firm's strategy, therefore, the more prone it should be to nonlinear change. These arguments about strategic interconnectedness lead to the following hypotheses:

Hypothesis 4a: The more highly interconnected organizations are strategically, the more cumulated incremental change (reconfigurations) will be associated with subsequent discontinuous change (restructurings).

Hypothesis 4b: The more highly interconnected organizations are strategically, the more concentrated bursts of incremental change (reconfigurations) will be associated with subsequent discontinuous change (restructurings).

Research Methodology

We focus on reconfigurations and restructurings because these offer two standard and comparable forms of organizational change that are distinct in nature and scope, while lending themselves to quantitative measurement. We illustrate incremental reconfiguration and discontinuous restructuring by particular reference to Ford, a company in which we interviewed and whose products are widely familiar.

Sample and study period

We take as our sample the top 50 publicly-listed industrial firms ranked in 1985 in the U.S. Fortune 500, tracking them through until 2004 (13 dropped from the sample due to takeover). These firms are of similar size to Intel, the major existing case study of complex adaptive change in a large-scale corporate context (Burgelman and Grove, 2007). They are also large enough to receive extensive media coverage, thereby enabling the comparison of multiple sources of information. The timeframe allows us to track firms through multiple iterations of change, with extended lags. All data are assigned by financial year.

Dependent variable: organizational restructuring

Consistent with past research (Chandler, 1962; Blau & Schoenherr, 1971), we define restructuring as involving change in the core principles of organizational structure, i.e. change in number of layers (vertical restructuring) or number and type of structural axes (horizontal restructuring) that affect the whole company (corporate level). Our measure of restructuring relies on annual report data, as in Romanelli and Tushman (1994) and Barkema and Schijven (2008). Following Romanelli and Tushman (1994), we computed a structural change ratio based on senior executive title changes. Romanelli and Tushman (1994) found a high level of correspondence between their ratio and more qualitative measures of restructuring.

To create our structural change ratio, we coded all top managerial titles into categories to reflect the horizontal principles of structure: business area; geography; functional; customers; and technology. CEO, President and COO titles were coded General Managers. Likewise, we coded all titles to a maximum of four levels: Level 1 is the CEO level; Level 2 is the COO or President, if present; Levels 3 and 4 are operational (e.g., a business unit, a geography, etc.) and functional (e.g. marketing, finance, etc.). Consistent with findings that many COOs are appointed to prepare them for promotion to CEO (Hambrick & Cannella, 2004), we excluded heir-apparent COOs in order to avoid inflating the structural change ratio.

The three steps for calculating the change ratio can be illustrated byFord's restructuring in 1999, when the company introduced a geographic axis to its structure (see Figure 1). First, we computed for each firm and year the proportion of titles in each category by dividing the number in each category by the total number of titles coded. Since each title is counted twice, once for the horizontal dimension and once for the vertical dimension of structure, we divided each proportion by two to obtain a sum of proportions adding to 1 (or 100 percent), a figure easier to grasp. In the Ford example, the number of geographic titles increased from zero in 1998 to three in 1999: the proportion in this category (after dividing by two) became 0.14. Meanwhile, the proportion of business area titles dropped from 0.17 to 0.045. Next we subtracted the value of each title category from its corresponding value in the previous year, taking the absolute value difference. Finally, we obtained the structural change ratio by summing each difference for a given firm-year. The sum of all the various differences gives Ford a 1999 structural change ratio of 0.63. In our dataset, the change ratio varies between 0 and 0.97.

[Figure 1 here]

In order to focus on discontinuous change, we established a threshold excluding minor changes. As in Romanelli and Tushman (1994), we converted the structural change ratio into a dummy variable "restructuring," coded 1 above a 0.30 cut-off. In establishing this cut-off, we were guided by both interview and documentary sources. We interviewed fourteen senior executives at twelve of our firms regarding all changes above 0.20 on our ratio; for two more firms we interviewed the client partners of a large international consulting company. Our interviewees confirmed all changes above 0.30 as restructurings, but were more ambivalent about those below: these often reflected simple reconfigurations or *ad hominen* changes. In Ford's case, a vice president explained: 'while the 1995 reorganization was a centralizing move that reduced the role of the regions, in 1999, top management decided that it was better to give some autonomy to the regions again. They said the company was becoming too bureaucratic.' We also read all sampled companies' annual reports for mentions of significant structural change, and searched the Lexis-Nexis database, using the key terms 'restructuring', 'reorganizations', 'appointments' and 'executive moves'. In Ford's case, CEO Nasser wrote in Ford's 1999 annual report (p.9): 'We've taken the next evolutionary step in organization structure and realigned our worldwide operations into Consumer Business Groups centered around regions.' Dicken (2003: 379) described Ford's 1999 change as 'yet another major reorganization of its global management structure'. Accordingly we coded as 1 the restructuring variable for Ford in 1999.

Changes below 0.30 were not as clearly transformative of corporate structure. For example, in 2003, Ford's change ratio was 0.24 due to the addition of two functional titles to the two existing ones, and the recombination of Latin American and North American operations into a new Americas Group. These changes reinforced the existing structure rather than transformed it. Secondary material did not indicate substantial restructuring either. Accordingly, Ford's 2003 restructuring variable was coded 0. While both interview and documentary material tend to confirm the 0.30 cut-off, our robustness checks will include variations around that level.

Explanatory variables

In measuring *reconfigurations*, we count additions, mergers, transfers, splits and deletions of organizational units (Brown and Eisenhardt, 1998; Karim, 2006). Reflecting the diversity of our firms, we use a wide range of data-sources, including annual reports, SEC 10Ks and press announcements from the Lexis-Nexis database (under the standard key terms 'reorganization', 'restructuring', 'appointments', 'executive moves', 'mergers and acquisitions', 'demergers' and 'spin-offs'). Where two or more units are involved, we count the process as a single reconfiguration. Thus Ford's 2003 merger of its Latin American and North American operations into a new Americas Group counts as one reconfiguration. Other examples of reconfigurations include Ford's creation of the Automotive Consumer Services division in its North American Group in 2000 (addition); Ford's transfer of its Direct Market business into its Automotive Operations division in 1987; its 1996 split of the Automotive Components division from its Automotive Operations division to form a stand-alone division; and its 1992 closure of the Diversified Products Group (deletion).

Reconfigurations and restructurings are normally distinct. Figure 2 illustrates the distinctiveness of the two types of change by comparing Ford's peaks of reconfigurations and restructurings between 1985 and 2004. Restructurings are sometimes associated with high levels of reconfiguration (1995 and 1999) as the dotted lines show, and sometimes with low level of reconfigurations (zero in 1993 and 2001). Conversely, Ford had several peaks of reconfiguration (notably 1996 and 2003) that were not associated with simultaneous restructurings. Ford's experience confirms that restructurings are not simply intense episodes of reconfiguration. Our interest is specifically in the relationship between reconfigurations as types of incremental change and restructurings as types of discontinuous change. Since the reconfigurations that occur in the same year as restructurings, i.e. those indicated by the dotted lines in Figure 2, are parts of discontinuous change, we exclude them from our analysis.

[Figure 2 here]

To test the effect of accumulated reconfigurations over time on organizational restructuring, we sum the annual number of reconfigurations between two occurrences of restructuring, resetting the cumulative count to zero after each new restructuring. To test the impact of discrete perturbations on organizational restructuring, we examine the amount of reconfigurations in a single year, identifying relatively intense bursts of activity. Because we have little theoretical guidance on the likely delay between a discrete perturbation and its outcome, we tested a range of lags up to four years before a restructuring.

We operationalize the hypotheses related to disequilibrium in the following ways. With regard to *organizational decline*, we focus on consecutive absolute performance declines. Past research highlights the pressures for structural change exerted by prolonged absolute performance decline, rather than decline versus industry (Donaldson, 1987): poor performance and the consequent squeeze on resources will increase the perceived need for discontinuous change whether or not it is shared by peers. To capture the multi-dimensional nature of economic performance, we retain two accounting based measures (Return on Assets and sales) and one stock-market based measure (Tobin's q), in each case using the standard formulae of the strategy literature (Keats & Hitt, 1988; Kor & Mahoney, 2005). We compute a moving percentage change of the ROA/Sales/Tobin's q value between two consecutive years. To test the gradual accumulation effect in the context of decline (H2a), we count the number of ROA, Sales or Tobin's q declines between two restructurings, resetting the clock to zero after each new restructuring: these measures range from 0 to 12. To test the discrete perturbation effect in the context of decline (H2b), we count the consecutive number of years of ROA, Sales or Tobin's q decline over four years; these measures range from 0 to 4. Both measures aim to capture the effect of prolonged performance declines. The data for these ratios are all from Compustat.

With regard to Hypotheses 3a and 3b on the disequilibriating impact of top management instability, particularly from outsiders, we focus on the appointment of an *external CEO* (Miller, 1993). External CEO change is a dummy variable, coded 1 when the new CEO does not come from the company (Karaevli, 2007). To test H3a, we use a one-year lag of external CEO change so that interactions correspond with the last year of accumulated incremental change. Since theory is less explicit on timing in the perturbation process (H3b), we tried multiple lags of the measure. The data come from annual reports.

Finally, with regard to Hypotheses 4a and 4b, we measure *strategic interconnectedness*, by the extent of related diversification (Hambrick & Cannella, 2004). We measure related diversification using an entropy index (Palepu, 1985) based on a firm's dispersion of sales across four-digit industry SIC codes (the less dispersed a firm's four-digit SIC codes across higher-level two-digit SIC codes, the more related-diversified a firm is held to be, with more interdependence across business divisions). To test H4a, we use a one-year lag of strategic interconnectedness so that interactions correspond with the last year of accumulated incremental change. For H4b, due to the lack of theoretical guidance on the timing of the relationship, we again tried multiple lags of the measure. The data are from the Compustat Business-Segment Reports.

Control variables

Our control variables all rely on Compustat data unless otherwise indicated. First, to control for *momentum* effects in restructuring (Amburgey and Miner, 1992), we introduce a one year-lagged measure of restructuring. To control for the effects of *environmental dynamism* on the pace of structural changes (McKinley and Scherer, 2000), we use a one-year lag of Dess and Beard's (1984) industry-based 'environmental dynamism' measure. Dynamism is the volatility of the rate of change of annual industry sales, i.e. the standard error of the rate of change of annual industry sales at the four-digit SIC code level for each of the 60 primary industries present in the sample. We control for two types of strategy change. First, one year-lagged *diversification change* follows Chandler's (1962) classic explanation of structural change. Diversification change in t -1 is the absolute percentage change of the total diversification measure (the entropy measure described above) between t -2 and t -1 (Wiersema, 1992). Second, we include one year-lagged *multinationality change* as also likely to affect organizational restructuring (Stopford & Wells, 1972). Multinationality is measured yearly as a firm's ratio of foreign sales over total sales (FSTS) (Rugman & Verbeke, 2004). Multinationality change in t -1 is the absolute percentage change of the FSTS ratio between t -2 and t -1.

Consistent with contingency theory, we also control for *changing size* using the absolute percentage change in the number of employees between t -2 and t -1 (Cullen, Anderson, & Baker, 1986). We also control for *absolute size* (log transformed number of employees lagged by one year) reflecting the inhibiting effect that size may have on the propensity to change (Hannan & Freeman, 1984). Finally, we include a one-year lag of performance change (using the moving percentage change measures described above) and, to allow for exogenous shocks, we include time dummies (year).

Analysis

We use dynamic panel data analysis conducted with STATA 11. This technique is appropriate for analyzing a dataset composed of the same firms observed at multiple points in time as it can correct for the risks of autocorrelation between the error terms of the different variables over time (Wooldridge, 2002: 448). For long panels such as ours, liable to unobserved heterogeneity (firm effects) and endogeneity associated with state dependence (presence of a lag of the dependent variable) and initial conditions (restructurings immediately prior to our panel period), Wooldridge (2005) proposes correlated random-effect probit. This dynamic panel data estimation for categorical dependent variables models the distribution of the unobserved effect in function of the value of initial conditions. Wooldridge's estimator computes the longitudinally-averaged exogenous variables for each firm then enters these as additional regressors in the 'xtprobit' specifications. We set 1989 as the year for initial value conditions, introducing the variable "restructuring 1989" in the model, because we test the perturbation effect up to four years before a restructuring event. As a result we focus on a 16-year time window that yields 644 firm-year observations for the test of reconfiguration bursts, and 555 for the test of cumulated reconfigurations. Two firms, taken over before 1989, leave the sample. Our model is:

$$P\ (restructuring_{it} = 1\ |restructuring_{i,t-1}, restructuring_{i0}, x_{it}, \alpha_i)$$
$$= \varphi\ (\beta x_{it} + \gamma y_{i,0,t-1} + \nu_t + \rho_\alpha\, \alpha_i),\ t = 1, \dots, T$$

Where t = 1 corresponds to 1990, t = T corresponds to 2004; $restructuring_{i\,0}$ corresponds to the initial value conditions (events that took place in 1989); x_{it} is a vector of strictly exogenous independent variables; α_i are the time-persistent unobserved individual effects. The parameter vectors to be estimated are β for the exogenous independent variables and their longitudinal averages; γ for the two endogenous variables (restructuring in 1989 and restructuring in t-1), ν_t for unrestricted year intercepts; and ρ_α for the unobserved effect. φ denotes the distribution function.

Descriptive Statistics

Table 1 describes the sampled firms' size, age, sales and strategies. The average firm restructures once every 6 years (an average 0.156 per firm-year). The maximum number of restructurings for any firm over their presence in the sample was five (as at DuPont, Digital Equipment, and Xerox). On the other hand, firms reconfigure much more frequently with an average of 3.182 reconfigurations per firm-year. The maximum number of reconfigurations in a year was 17 (Allied Signal/Honeywell International in 2003).

[Table 1 here]

Table 2 reports the means, standard deviations, minimum, maximum values, and correlations between variables. Restructuring is positively correlated with diversification change ($r = 0.09$, $p < 0.05$), and with changing size in the preceding year ($r = 0.11$, $p < 0.001$). Restructuring is negatively correlated with the cumulated number of reconfigurations between two restructuring occurrences ($r = -0.10$, $p < 0.05$), the number of cumulated Tobin's q declines between two restructurings ($r = -0.09$, $p < 0.05$), and restructuring in the previous year ($r = -0.14$, $p < 0.001$). The only high level of correlation between the independent variables simultaneously present in the models we report below is that between the cumulated count of reconfigurations and the cumulated number of Tobin's q declines between two restructurings ($r = 0.75$, $p < 0.001$). We deal with the resulting potential issue of multicollinearity below.

[Table 2 here]

Results

In Table 3, Models 1 and 2 test Hypothesis 1a by assessing the effect of cumulated reconfigurations between two occurrences of restructuring on organizational restructuring. Hypothesis 1a is not supported in either of the models ($\beta = -0.143$, $p > 0.10$ in M1 and $\beta = -0.313$, $p > 0.10$ in M2). Likelihood Ratio (LR) tests show Model 1 significantly improves on a null model (unreported) containing only the constant and the time dummy variables (Chi^2 statistic = 70.17, $p < 0.01$) and the full Model 2 improves on the nested Model 1 (Chi^2 statistic = 19.90, $p < 0.01$). Given the high correlation between 'Cumulated reconfigurations since previous restructuring' and 'Cumulated Tobin's q declines since previous restructuring,' we also ran Models 1 without the latter and Model 2 without the latter and its corresponding interaction. The coefficient of ‘Cumulated reconfigurations since previous restructuring’ stayed insignificant. This variable’s true value is not affected by multicollinearity.

Models 3 and 4 test Hypothesis 1b regarding the perturbation process, using different lags of reconfiguration intensity.[1] Model 3 shows that the greater the amount of reconfigurations in a given year, the greater and more significant the likelihood of a firm undergoing a restructuring three years later ($\beta = 0.183$, $p < 0.05$). This result is even stronger in Model 4 ($\beta = 0.239$, $p < 0.01$). Moreover, in this model, restructuring also responds to bursts of reconfiguration two and four years earlier, although the significance of these effects is weaker ($\beta = 0.126$, $p < 0.10$ and $\beta = 0.129$, $p < 0.10$ respectively). A first LR test shows these two models significantly improve on a null model (unreported) which contains only the constant and the time dummy variables. A second LR test shows Model 4 significantly improves on the nested Model 3. Models 3 and 4 are consistent with Hypothesis 1b regarding perturbation, i.e. Lorenz’s (1993) butterfly effect. It is concentrated bursts of incremental change that trigger subsequent discontinuous change, rather than accumulation. The most-highly significant length of time between trigger and outcome is three years, half the time between restructuring events ordinarily.

We note also that this triggering effect holds after controlling for several factors. In Models 3 and 4, the one-year lagged degree of environmental dynamism significantly decreases the likelihood of a restructuring, which suggests that the more dynamic the environment, the more managers avoid discontinuous change. But in line with contingency theory, the restructuring likelihood significantly increases with diversification change and size change. As expected, an increase of ROA (in Models 3 and 4) and Tobin’s q (in Model 3) in the previous year decreases the likelihood of restructuring (the coefficients of the two later performance measures are significant at the 10% level only). State dependence also plays a strong role (firms are significantly less likely to restructure when they already have restructured in the previous year, $\beta = -1.260$, $p < 0.001$ in Model 4) along with initial conditions (the restructuring in 1989 variable is weakly significant at the 10% level and its coefficient is negative). The ρ coefficient which indicates the percentage of the composite effect due to the unobserved firm effects (the α_i in our model) is reassuringly very small.[2]

[Table 3 here]

We now examine the role of organizational disequilibrium in the escalation of change. While our organizations are not ordinarily sensitive to accumulation, accumulation does tend to play a role in some disequilibrium conditions. With regard to the moderating effect of performance decline, H2a is supported for Tobin's q decline but not for sales or ROA decline. In Models 1 and 2, the coefficient of cumulated Tobin's q declines since the previous restructuring is positive and significant and so is its interaction term with cumulated reconfigurations in Model 2 ($\beta = 0.540$, $p < 0.001$). H2b is supported for sales decline, though not for ROA or Tobin's q decline. We find restructuring is significantly more likely three years after a burst of reconfigurations when coinciding with up to four consecutive years of sales decline. In Model 4, consistent with the hypothesis, the interaction term is positive and highly significant ($\beta = 0.299$, $p < 0.001$). In conditions of disequilibrium associated with prolonged performance decline, organizations are sensitive to both accumulation and perturbation effects.

There is weak support for H3a and H3b examining the disequilibrium following the appointment of new externally-appointed CEOs. In Models 2 and 4, even though the main effect seems to show that new external CEOs in general reduce the likelihood of restructuring in the following year ($\beta = -1.127$, $p < 0.10$ and $\beta = -1.076$, $p < 0.10$ respectively), the interaction terms between cumulated reconfigurations, reconfiguration intensity in t-1 and new externally-appointed CEO in t-1 are positive and weakly significant ($\beta = 1.973$, $p < 0.10$ and $\beta = 0.637$, $p < 0.10$ respectively). Organizations are sensitive to change in leadership; the latter plays a role in both the progressive accumulation and the perturbation effects. For the perturbation effect, the escalation process seems to be hastened from three years (the most significant lag) in the general case to one.

On the other hand, Hypotheses H4a and H4b on the moderating effect of strategic interconnectedness are not supported.[3] In Models 1 and 2, although the main terms of strategic interconnectedness are positive and significant at the five percent level, the interaction is not significant. In Models 3 and 4, although the coefficients of lagged reconfiguration intensity three years earlier are consistently positive and significant, the strategic interconnectedness variable is not significant and neither is the interaction term in Model 4. These results suggest that interconnections in human organizations may not have the same escalating consequences in organizational systems as in natural systems.

We conclude by assessing the direct effects of increasingly intense bursts of reconfigurations (perturbations) on the likelihood of subsequent restructuring. With correlated random effects probit estimations, the size of regression coefficients does not indicate the real impact of each variable because it does not consider the other variables' simultaneous effects. We interpret the regression coefficients by computing the partial effects on mean coefficients, averaged across the distribution of unobservables (Wooldridge, 2005). Figure 3 plots the cumulated probability distribution of restructuring as a function of the annual number of reconfigurations three years earlier conditional upon the average partial effect of the other significant variables in Model 4. We use the real scale of reconfigurations in t-3 to make managerial implications more straightforward

Figure 3 shows an unevenly rising effect of annual incremental change (reconfiguration intensity) on the likelihood of subsequent discontinuous change (restructuring). At three reconfigurations a year (close to the mean rate of reconfiguration, represented by the vertical line in Figure 3), the estimated probability of restructuring three years later is a modest 0.30. But a doubling of this rate to six raises the probability of subsequent restructuring to 0.58. Six is thus the threshold where a subsequent restructuring becomes more likely than not. The probability remains at this level at seven and eight reconfigurations, but a further critical point is reached at nine reconfigurations, where the likelihood of escalation jumps to 0.72. For intense bursts of twelve reconfigurations, the probability is 0.82: restructuring is hard to avoid.

[Figure 3 here]

Discussion and conclusion

In this paper, we drew on complex adaptive systems theory to investigate the relationship between two types of change, incremental and discontinuous. Above all, our findings confirm the proposition derived from complex adaptive systems theory that one type of change can lead to another (Weick and Quinn, 1999; Van de Ven and Poole, 1995). Following various simulations (Carroll & Burton, 2000; Davis et al., 2009) and case studies (Chiles et al., 2004; Burgelman & Grove, 2007; Plowman et al., 2007), we provide for the first time large-sample support for the relevance of complex adaptive systems theory for viewing change in organizational as well as natural systems. Incremental change and discontinuous change are not simply discrete, well-insulated processes. Incremental change enters as a causal factor in discontinuous change in its own right, even controlling for established factors such as strategy change (Chandler, 1962) and size change (Blau & Schoenherr, 1971).

We have further drawn on complex adaptive systems theory as a metaphorical framework (Richardson, 2011) by which to interpret this kind of nonlinear escalation. In particular, complex adaptive systems theory has helped us build propositions about the processes by which change might escalate and the conditions in which this is more likely. In terms of processes, we find that organizations are sensitive to something like the butterfly effect (Lorenz, 1993), with discrete perturbations leading eventually to discontinuous change. This holds whether or not the organization is already in disequilbrium. On the other hand, we suggest a boundary condition for susceptibility to sudden sand-pile avalanches following the progressive accumulation of incremental change (Bak and Paczuski, 1995). Accumulated incremental change is only likely to trigger discontinuous change in conditions of disequilibrium. Ordinarily, then, it is bursts of change that are more likely to lead directly to escalation. Doubling the annual rate of reconfiguration from three (close to the mean) to six increases the likelihood of subsequent restructuring from less than a third to substantially over a half. Although we cannot access directly the precise internal mechanisms of this perturbation process, we can interpret it in terms of earlier studies. The lag between intense bursts of incremental change and subsequent discontinuous change – most significantly, a three year gap - fits with both the opening of mindsets at Branson (Chiles et al., 2004) and the two-step process at Intel (Burgelman and Grove, 2007). In the light of these studies, we speculate that bursts of reconfiguration may loosen up mindsets and prepare managers for greater change. But still it seems to take time to gather and accept the evidence that even intensive bursts of reconfiguration are insufficient as forms of change. Only once the evidence is clear and overwhelming do managers appear to take decisive action in the form of restructuring.

Complex adaptive systems theory points also to various possible moderating effects on change escalation. In particular, heightened organizational disequilibrium may provide particularly sensitive conditions for undertaking large amounts of incremental change. Relevant disequilibrium conditions include downturns in growth (Huber et al., 1995) and (more weakly) new external CEOs (Miller, 1993). On the other hand, we do not find support for the role of interconnectedness, suggested by complex adaptive systems theory and indeed by organizational configuration and complementarity theories (Miller, 1982; Zenger, 2002). Strategically interconnected organizations appear just as able to absorb incremental change as more loosely-coupled organizations. In respect to reconfigurations at least, interconnections do not seem likely to amplify the repercussions of incremental change throughout the organization as a whole.

The robustness of strategically-interconnected systems and the ability of organizations ordinarily to absorb cumulative incremental change may indicate some limits to the transfer of complex adaptive systems theory into the context of human organizations. First, unlike natural systems, organizations are typically designed at least partly through conscious managerial intervention. An interpretation of the equivalent levels of robustness we find across degrees of strategic interconnectedness in our sample is that, in general, managers may be constructing for themselves organizations that they know they can normally manage. In building connectedness, they appear to avoid levels that increase their vulnerability to nonlinear change. It is heightened disequilibrium, not organization design, which renders organizations likely to tip over the edge of chaos. Second, these organizations' non-responsiveness in the face of steadily accumulating incremental change suggests a degree of organizational robustness. It seems that managers can ordinarily cope with moderate levels of incremental change over time; their organizations are pushed to discontinuous change only when accumulated incremental change is combined with disequilibrium or when exposed to intense bursts of incremental change. The insignificant effects of both interconnectedness and ordinary accumulation are consistent with a view of managers as, generally, effective designers and copers. As MacClean and MacIntosh (2011) have suggested, in transferring complex adaptive systems theory from natural to human organizations, we should attend to the intervening role of management.

Our findings have implications for other streams of organization theory, especially for momentum approaches to change (e.g. Amburgey and Miner, 1992) and views of incremental change as an organizational routine (Eisenhardt and Brown, 1999). First, by contrast to Kelly and Amburgey (1991), we find that one kind of change can unfreeze another. Momentum approaches to change should therefore be sensitive not only to repetition of the same routine but to escalation to another level. Second, the potential for escalation qualifies the value of incremental change as an organizational routine. Contrary to Ilinitch et al (1996), incremental change may not substitute for discontinuous change, but cause it. Here it is important to recognize that the routines produced by the repetition of incremental change (Eisenhardt and Brown, 1999) are not necessarily relevant to the discontinuous changes that can result. Weick and Quinn (1999) warn that different types of change can have very different managerial implications: in discontinuous change, change agents are 'prime-movers'; in incremental change, they are 'sense-makers'. An organization satisfied with its well-honed routines for incremental change may be ill-prepared for escalation to discontinuous change. Given the rising probabilities we identified earlier, managers may need to be particularly aware that suddenly intensifying the rate of incremental change in a particular year is likely to set off a quite different kind of change some years later.

We underline several limitations of this study. While we do bring a large sample to the question of nonlinear change, we are not able to investigate directly the detailed processes by which it happens. For example, we extrapolate from qualitative studies (Chiles et al, 2004; Burgelman and Grove, 2007) to illuminate the lagged process between initial perturbation and eventual restructuring. Secondly, we have considered only nonlinear change in organizational structure, from reconfiguration to restructuring. It is possible that other dimensions of organizations that are less amenable to deliberate managerial control, for example organizational culture, may be subject to different processes of escalation. A third limitation is the unexamined nature of the performance implications of nonlinear change. Prior case studies have tended to emphasize benefits, with incremental change easing the transition to more radical change (Chiles et al., 2004; Burgelman & Grove, 2007; Plowman et al., 2007). However, the performance effects of restructurings specifically are generally more equivocal (Bowman et al, 1999). Our results suggest that reconfigurations can prompt restructurings even when controlling for strategy and size change. In this sense, incremental change could be triggering superfluous change. We urge more research into the performance consequences of discontinuous changes consequent upon bursts of incremental change.

In sum, this study advances our understanding of the extent of escalation towards discontinuous change, the processes of such escalation and the conditions when this escalation is more likely. We provide for the first time large-sample evidence for the importance of nonlinear change in organizations, in line with the propositions of earlier theorists drawing on complex adaptive systems theory (Van de Ven and Poole, 1995; Weick and Quinn, 1999). Moreover, we develop from complex adaptive systems theory alternative processes of change escalation, and confirm the general relevance of perturbation (or butterfly) effects and the more limited relevance of accumulation (or sand-pile) effects. We also draw on complex systems theory in order to identify relevant disequilibrium conditions in organizations. Our findings warn organizations to moderate the pace of incremental change, in the form of reconfigurations, if they wish to avoid discontinuous change, in the form of restructurings, particularly in conditions of heightened disequilibrium. If they cannot moderate this pace, then organizations should prepare for the distinctive challenges of discontinuous change. However, we also qualify the relevance of complex adaptive systems theory to organizations. Interconnectedness and the progressive accumulation of change do not apparently increase the likelihood of discontinuous change in the same way as in natural systems. In organizational systems, researchers adopting the complex adaptive systems lens should be sensitive to the potential role of managers in the design of organizations and the absorption of ordinary change.

Endnotes

[1] We also run a single model containing all variables to test all hypotheses with accumulation and perturbation effects simultaneously. But this model suffered from multicollinearity caused in large part by the high correlations between the measure of cumulated reconfigurations and the lags of reconfiguration. While we would have preferred to report one single model, the results we report are more robust and unaffected by multicollinearity.

[2] We conducted a sensitivity analysis to check the robustness of our results around the 0.30 cut-off point for restructuring. We tested the models by counting as restructuring changes superior or equal to 0.27 and superior or equal to 0.33, i.e. 10% below and 10% above the 0.30 cut-off point. In the former case, our count increased by 24% with 32 additional events. In the latter case, our count decreased by 17% with 23 fewer events. At both cut-offs, we found consistent results with those discussed earlier. Thus, our results for Hypotheses 1a and 1b are consistent across a range of 85 to 140 events.

[3] As regards the effect of disequilibrium and strategic interconnectedness associated with the perturbation process, we ran a model which contained all the lags of the main terms and a model including the latter and their corresponding interactions. But we ran into two sorts of issues: multicollinearity and an excessively high number of degrees of freedom relative to N. We choose to present the models 3 and 4 with lags that optimize the degrees of freedom relative to N, avoid multicollinearity and best minimize the log likelihood.

References

Amburgey, T. L., Dawn, K., & Barnett, W. P. (1993). Resetting the clock: The dynamics of organizational change and failure. *Administrative Science Quarterly*, 38(1), 51-73.

Amburgey, T. L., & Miner, A. S. (1992). Strategic momentum: The effects of repetitive positional and contextual momentum on merger activity. *Strategic Management Journal*, 13(5), 335-348.

Andriani, P., & McKelvey, B. (2009). From Gaussian to Paretian thinking: Causes and consequences of power laws in organization. *Organization Science*, 20(6), 1053-1071.

Aupperle, K.E., Acar, W., & Mukherjee, D. (2013). Revisiting the fit-performance thesis half a century later: a historical analysis of Chandler's own matched and mismatched firms. *Business History,* 56(3), 341-371.

Bak, P., & Paczuski, M. (1995). Complexity, contingency, and criticality. *Proceedings of the National Academy of Sciences of the United States of America,* 92(15), 6689-6696.

Barkema, H., & Schijven, M. (2008). Toward unlocking the full potential of acquisitions: The role of organizational restructuring. *Academy of Management Journal*, 51(4), 686-722.

Barker, V. L., & Duhaime, I. M. (1997). Strategic change in the turnaround process: Theory and evidence. *Strategic Management Journal*, 18(1), 13-38.

Blau, P. M., & Schoenherr, R. A. (1971). *The structure of organizations*. New York: Basic Books.

Boeker, W., & Goodstein, J. (1993). Performance and successor choice: The moderating effects of governance and ownership. *Academy of Management Journal*, 36(1), 172-186.

Bowman, E. H., Singh, H., Useem, M., & Bhadury, R. (1999). When Does Restructuring Improve Economic Performance? *California Management Review*, 41(2), 33-54.

Brown, S. L., & Eisenhardt, K. M. (1997). The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. *Administrative Science Quarterly*, 42(1), 1-34.

Brown, S.L. & Eisenhardt, K.M. (1998). *Competing on the Edge: Strategy as Structured Chaos.* Boston, MA: Harvard University Press.

Burgelman, R. A., & Grove, A. S. (2007). Let chaos reign, then rein in chaos-- repeatedly. *Strategic Management Journal*, 28(10), 695-979.

Carroll, T., & Burton, R. M. (2000). Organizations and complexity: Searching for the edge of chaos. *Computational and Mathematical Organization Theory*, 6, 319-330.

Chandler, A. D. (1962). *Strategy and Structure : Chapters in the History of The Industrial Enterprise*. Cambridge: M.I.T. Press.

Chiles, T. H., Meyer, A. E., & Hench, T. J. (2004). Organizational emergence: The origin of transformation of Branson, Missouri's musical theaters. *Organization Science*, 15(5), 499-519.

Cullen, J. B., Anderson, K. S., & Baker, D. D. (1986). Blau's theory of structural differentiation revisited: A theory of structural change or scale? *Academy of Management Journal*, 29(2), 203-229.

Davis, J. P., Eisenhardt, K. M., & Bingham, C. B. (2009). Optimal structure, market dynamism and the strategy of simple rules. *Administrative Science Quarterly*, 54(3), 413-452.

Dess, G. G., & Beard, D. W. (1984). Dimensions of organizational task environments. *Administrative Science Quarterly*, 29(1), 52-73.

Dicken, P. (2003). *Global Shift: (4th ed.)*. London: Sage.

Donaldson, L. (1987). Strategy and structural adjustment to regain fit and performance: in defence of contingency theory. *Journal of Management Studies*, 24(1), 1-24.

Dooley, K. J. (1997). A complex adaptive systems model of organization change. *Nonlinear Dynamics, Psychology and Life Sciences*, 1(1), 69-97.

Eisenhardt, K. M., & Brown, S. L. (1999). Patching: Restitching business portfolios in dynamics markets. *Harvard Business Review*, 77(3), 72-82.

Eoyang, G. H. (2011). Complexity and The Dynamics of Organizational Change. In P. Allen, S. Maguire, & B. McKelvey (Eds.), *The Sage Handbook of Complexity and Management*. London: Sage.

Galunic, C. D., & Eisenhardt, K. M. (2001). Architectural innovation and modular corporate forms. *Academy of Management Journal*, 44(6), 1229-1249.

Greenwood, R., & Hinings, C. R. (1996). Understanding radical organizational change: Bringing together the old and the new institutionalism. *Academy of Management Review*, 21(4), 1022.

Gulati R. (1995), Social Structure and Alliance Formation Patterns: a Longitudinal Analysis, *Administrative Science Quarterly*, 40 (4), 619-642

Hambrick, D. C., & Cannella, A. A. (2004). CEOs who have COOs: contingency analysis of an unexplored structural form. *Strategic Management Journal*, 25, 959-979.

Hannan, M. T., & Freeman, J. (1984). Structural inertia and organizational change. *American Sociological Review*, 49, 149-164.

Huber, G. P., Sutcliffe, K. M., Miller, C. C., & Glick, W. H. (1995). Understanding and predicting organizational change. In G. P. Huber, & W. H. Glick (Eds.), *Organizational change and redesign*. New York: Oxford University Press, Chapter 7.

Ilinitch, A., D'Aveni, R. A., & Lewin, A. Y. (1996). New organizational forms and strategies for managing in hypercompetitive environments. *Organization Science*, 7(3), 211-220.

Karaevli, A. (2007). Performance consequences of new CEO 'outsiderness": Moderating effects of pre and post-succession context. *Strategic Management Journal*, 28(7), 681-706.

Karim, S. (2006). Modularity in organizational structure: The reconfiguration of internally developed and acquired business units. *Strategic Management Journal*, 27(9), 799-824.

Karim, S. (2009). Business unit reorganization and innovation in new product markets. *Management Science,* 55(7), 1237-1254.

Karim, S. (2012). Exploring structural embeddedness of product market activities and resources within business units. *Strategic Organization,* 10(4), 333-365.

Karim, S., & Williams, C. (2012). Structural knowledge: How executive experience with structural composition affects intrafirm mobility and unit reconfiguration. *Strategic Management Journal,* 33(6), 681-709.

Kauffman, S. A. (1993). *The Origins of Order: Self-Organization and Selection in Evolution*. New York: Oxford University Press.

Kay, N. M. (2000). *Pattern in Corporate Evolution*. Oxford: Oxford University Press.

Keats, B. W., & Hitt, M. A. (1988). A causal model of linkages among environmental dimensions, macro organizatioinal characteristics, and performance. *Academy of Management Journal*, 31(3), 570-598.

Kelly, D., & Amburgey, T.L. (1991). Organizational inertia and momentum: A dynamic model of strategic change. *Academy of Management Journal,* 34(3), 591-612.

Kor, Y., Y., & Mahoney, J. T. (2005). How dynamics, management, and governance of resource deployments influence firm-level performance. *Strategic Management Journal*, 26(5), 489-496.

Lamont B.T., Robert W.J., Hoffman J.J. (1994). Performance during "M-form" reorganization and recovery time: the effects of prior strategy and implementation speed. *Academy of Management Journal* 37(1): 153-166.

Levinthal, D.A., & March, J.G. (1993). The myopia of learning. *Strategic Management Journal,* 14(2), 95-112.

Lorenz, E. (1993). The Butterfly Effect. In R. Abraham, & Y. Ueda (Eds.), *The Chaos Avant-Garde*. Singapore: World Scientific.

McKinley, W., & Scherer, A. G. (2000). Some unanticipated consequences of organizational restructuring. *Academy of Management Review*, 25(4), 735-752.

McLean, D., & McIntosh, R. (2011). Organizing at the Edge of Chaos: Insights from Action Research. In P. Allen, S. Maguire, & B. MacKelvey (Eds.), *The Sage Handbook of Complexity and Management*. London: Sage.

Miller, D. (1982). Evolution and revolution: A quantum view of structural change in organizations. *Journal of Management Studies*, 19(2), 131-151.

Miller, D. (1993). Some organizational consequences of CEO succession. *Academy of Management Journal*, 36(3), 644-659.

Miller, J. H., & Page, S. E. (2007). *Complex Adaptive Systems: An Introduction to Computational Models of Social Life*. Princeton, NJ: Princeton University Press.

Nadler, D. A., & Tushman, M. L. (1995). Types of Organizational Change: from Incremental Improvement to Discontinuous Transformation. In D. A. Nadler, R. Shaw, & A. E. Walton (Eds.), *Discontinuous Change: Leading Organizational Transformation*. San Francisco: Jossey-Bass.

Nepstad, D. C., Stickler, C. M., Soares-Filho, B., & Merry, F. (2008). Interactions among Amazon land use, forests and climate: prospects for a near-term forest tipping point. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363, 1737-1746.

Palepu, K. (1985). Diversification strategy, profit performance, and the entropy measure of diversification *Strategic Management Journal*, 6, 239-255.

Plowman, D. A., Baker, L. T., Beck, T., Kulkarni, M., Thomas-Solansky, S., & Villareal-Travis, D. (2007). Radical change accidentally: The emergence and amplification of small change. *Academy of Management Journal*, 50(3), 515-543.

Prigogine, I. (1978). Time, structure and fluctuations. *Science*, 201(4358), 777-785.

Richardson, K.A. (2011). Complexity and Management: A Pluralistic View. In P. Allen, S. Maguire & B. MacKelvey (Eds.), *The Sage Handbook of Complexity and Management,* London : Sage.

Romanelli, E., & Tushman, M. L. (1994). Organizational transformation as punctuated equilibrium: An empirical test. *Academy of Management Journal*, 37(5), 1141-1166.

Rugman, A. M., & Verbeke, A. (2004). A perspective on regional and global strategies of multinational entreprises. *Journal of International Business Studies*, 35(1), 3-18.

Rumelt, R. (1974). *Strategy, Structure and Economic Performance*. Cambridge: MA: Harvard Business School Press.

Stopford, J. M., & Wells, L. T. (1972). *Managing the multinational enterprise: Organization of the firm and ownership of the subsidiaries*. London: Longman.

Tushman, M.L., Newman, W.H., & Romanelli, E. (1986). Convergence and upheaval: Managing the unsteady pace of organizational evolution. *California Management Review,* 29(1), 583-594.

Tushman, M.L., & O'Reilly, C.A. (1996). Ambidextrous organizations: Managing evolutionary and revolutionary change. *California Management Review,* 38(4), 8-30.

Van de Ven, A., & Poole, M. S. (1995). Explaining development and change in organizations. *Academy of Management Review*, 20(3), 510-540.

Weick, K. E. (1976). Educational organizations as loosely coupled systems. *Administrative Science Quarterly*, 21(1), 1-19.

Weick, K. E., & Quinn, R. E. (1999). Organizational change and development. *Annual Review of Psychology*, 50, 361-386.

Whittington, R., Pettigrew, A., Peck, S., Fenton, E., & Conyon, M. (1999). Change and complementarities in the new competitive landscape: A European panel study, 1992-1996. *Organization Science*, 10(5), 583-600.

Wiersema, M. F. (1992). Strategic consequences of executive succession within diversified firms. *Journal of Management Studies*, 29(1), 73-94.

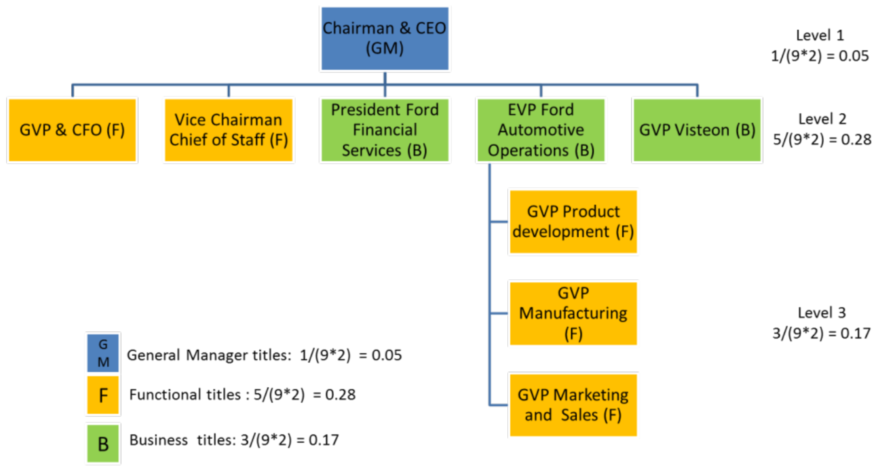
Wooldridge, J. M. (2002). *Econometric analysis of cross section and panel data*. Boston: MIT Press.

Wooldridge, J. M. (2005). Simple solutions to the initial conditions problem in dynamic, nonlinear panel-data models with unobserved heterogeneity. *Journal of Applied Econometrics*, 30, 39-54.

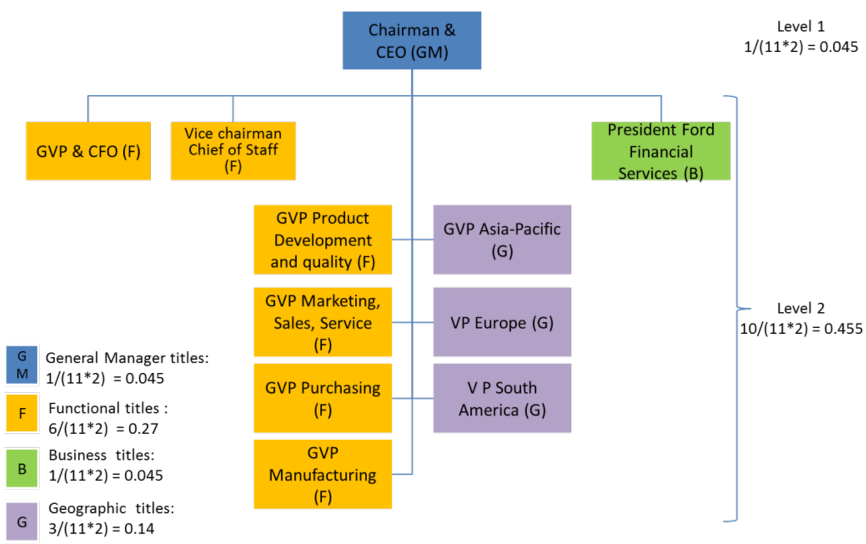
Zenger, T. R. (2002). Crafting internal hybrids: Complementarities, common change initiatives, and the team-based organization. *International Journal of the Economics of Business*, 9(1), 79-95.

Figure 1 – Ford's 1999 Restructuring

Ford's structure in 1998



Ford's structure in 1999



Restructuring in 1999 (change ratio > 0.30)

	Level 1	Level 2	Level 3	General Manager titles	Function titles	Business titles	Geography titles	Σ
1998	0.05	0.28	0.17	0.05	0.28	0.17	0	1
1999	0.045	0.455	0	0.045	0.27	0.045	0.14	1
Δ (abs value)	|0.005|	|0.175|	|0.17|	|0.005|	|0.01|	|0.125|	|0.14|	**0.63 (change ratio)**

Figure 2 – Restructurings and reconfigurations at Ford between 1985 and 2004

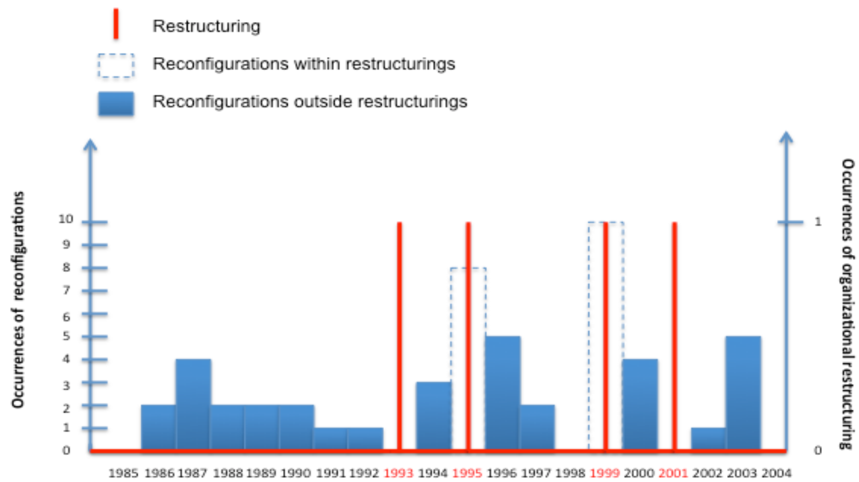


Figure 3 – Interpretation of the perturbation effect (Model 4 with average partial effects and selected values of reconfiguration intensity)

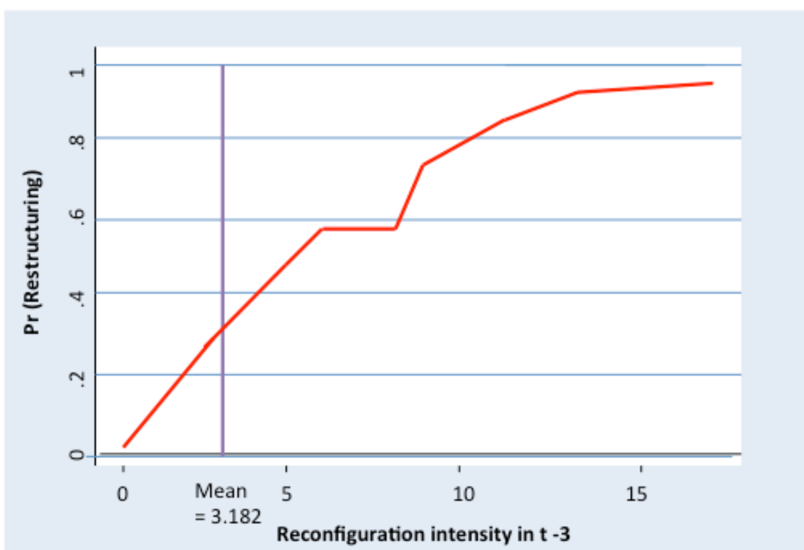


Table 1 – Descriptive statistics for Fortune 50 firms over 1989-2004 time window

	Min	Max	Mean
Restructuring	0	1	0.156
Reconfigurations	0	17	3.182
# of employees	6,590	775,100	108,685
Total sales	$3.6bn	$263.9bn	$33.2bn
Total assets	$2.6bn	$750.3bn	$43.8bn
Age	13	132	81
Total diversification	0	2.28	0.93
Related diversification	0	1.72	0.341
Multinationality (foreign sales over total sales)	0%	80%	33.7%

Table 2- Bivariate correlation matrix

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13
1.Restructuring	0.156	0.363	0	1	1.00												
2.Cumulated reconfig[(a)].	0.032	1.016	-.936	6.530	*-0.10*	1.00											
3. Reconfig.intensity t-1[(a)]	-.016	0.980	-.993	4.020	0.01	**0.49**	1.00										
4. Reconfig.intensity t-2[(a)]	-.012	0.971	-.993	4.020	-0.02	**0.44**	**0.23**	1.00									
5. Reconfig.intensity t -3[(a)]	0.016	1.000	-.993	4.020	0.03	**0.33**	**0.25**	**0.21**	1.00								
6. Reconfig intensity t-4[(a)]	0.007	0.994	-.993	4.020	-0.03	**0.23**	**0.17**	**0.22**	**0.21**	1.00							
7.Cumulated Tobin's Q decline since pv. restrg [(a)]	0.026	1.017	-.982	4.560	*-0.09*	**0.75**	**0.25**	**0.22**	**0.15**	0.06	1.00						
8. Consecutive sales declines t - 4 to t -7[(a)]	-.009	1.022	-1.16	2.865	-.002	**-.16**	*-0.11*	**-0.17**	*-0.13*	*-0.10*	**-0.14**	1.00					
9. New outsider CEO t-1	0.033	0.178	0	1	-0.03	0.01	0.00	0.04	0.00	-0.04	0.01	-.02	1.00				
10. Strat. interconnect.t-1[(a)]	0.081	1.056	-.830	3.839	0.01	0.02	**0.13**	*0.11*	*0.12*	*0.12*	**-0.18**	*-.11*	0.02	1.00			
11. Strat. interconnect t-3[(a)]	0.047	1.026	-.830	3.812	-0.01	0.00	*0.10*	*0.08*	*0.09*	*0.09*	**-0.16**	*-.08*	0.01	**0.90**	1.00		
12. Restructuring 1989	0.187	0.390	0	1	0.03	*0.10*	0.01	0.02	0.03	0.03	*0.13*	0.02	*0.09*	**-.16**	**-.16**	1.00	
13. Restructuring t-1	0.162	0.368	0	1	**-0.14**	**-.36**	**-0.43**	0.01	-0.03	0.03	**-0.37**	-.02	*0.12*	0.03	0.00	0.03	1.00
14. Envt dynamism t-1	0.034	0.030	0.001	0.346	-0.07	**0.14**	*0.11*	*0.09*	0.06	**0.13**	0.05	0.04	-.01	0.03	-.00	-.01	0.04
15. Diversif. change t-1	0.077	0.142	0.000	1.710	*0.09*	0.08	*0.12*	*0.08*	0.07	0.01	-0.01	0.05	*0.10*	0.06	-.03	-.01	0.03
16. Multinat. change t -1	0.022	0.028	0.000	0.255	0.01	-.02	-0.01	-0.01	-0.00	-0.03	-0.08	*0.10*	0.06	-.01	-.02	0.01	0.01
17.Size change t -1[(a)]	0.001	1.107	-.504	19.563	*0.11*	0.02	0.03	-0.03	-0.02	-0.01	-0.01	-.07	*0.08*	0.05	0.02	-.06	0.02
18. ROA variation t -1 [(a)]	-.019	1.082	-16.7	8.925	-0.04	-.00	*-0.09*	0.00	0.01	-0.04	0.04	0.04	-.01	0.01	0.01	0.00	0.02
19. Sales variation t -1	0.052	0.163	-.823	1.103	-0.01	0.03	0.01	0.06	0.00	-0.03	0.06	0.04	-.04	-.01	0.00	*-.09*	-0.02
20 Tobin's q variation t -1	0.043	0.217	-.584	1.526	-0.04	-.06	-0.01	-0.06	-0.04	0.00	**-0.17**	0.05	0.06	0.04	0.05	-.04	-0.04
21. Size t -1 (log) [(a)]	-.031	1.026	-2.86	2.868	0.03	**0.20**	*0.12*	**0.13**	**0.13**	*0.11*	0.08	**-.30**	0.04	**0.20**	**0.18**	-.02	0.03

Table 3 (continued)

	14	15	16	17	18	19	20	21
14. Envt dynamism t-1	1.00							
15. Diversif. change t-1	**0.13**	1.00						
16. Multinationality change t -1	0.03	**0.16**	1.00					
17.Size change t -1[(a)]	-0.06	**0.17**	**0.13**	1.00				
18. ROA variation t -1 [(a)]	0.00	0.03	0.01	-0.00	1.00			
19. Sales variation t -1	-0.00	*-0.08*	-0.02	-0.00	0.05	1.00		
20 Tobin's q variation t -1	0.01	*0.10*	0.05	0.04	-0.05	0.04	1.00	

Table 3–Impact of incremental change (reconfigurations) on discontinuous change (restructuring) - Binary dynamic panel data (random effect correlated probit)

Variables	M1	M2	M3	M4
	Accumulation process		Perturbation process	
Main Effects				
Cumulated reconfigurations since previous restructuring [(a)]	-0.143 (0.233)	-0.313 (0.271)		
Reconfiguration intensity in t -1 [(a)]			-0.109 (0.095)	-0.082 (0.102)
Reconfiguration intensity in t -2 [(a)]			0.086 (0.085)	0.126 (0.088) +
Reconfiguration intensity in t -3 [(a)]			0.183 (0.083) *	0.239 (0.088) **
Reconfiguration intensity in t -4 [(a)]			0.086 (0.084)	0.129 (0.088) +
Cumulated Tobin's q declines since previous restructuring [(a)]	0.379 (0.204) *	0.367 (0.217) *		
Consecutive sales declines in t -4 to -7 [(a)]			0.009 (0.098)	0.014 (0.103)
New outsider CEO in t -1	-0.516 (0.564)	-1.127 (0.897) +	-0.577 (0.532)	-1.076 (0.900) +
Level of strategic interconnectedness in t-1 [(a)]	0.357 (0.171) *	0.443 (0.182) *		
Level of strategic interconnectedness in t -3 [(a)]			-0.051 (0.159)	-0.083 (0.171)
Interactions				
Cum. reconf. since previous restrg x Cum. Tobin's q declines since previous restrg [(a)]		0.540 (0.161) ***		
Reconfiguration intensity in t-3 x Consecutive sales declines in t -4 to -7 [(a)]				0.299 (0.088) ***
Cum. reconfigurations since previous restrg [(a)] x New outsider CEO in t-1		1.973 (0.944) +		
Reconfiguration intensity in t-1 [(a)] x New outsider CEO in t -1				0.637 (0.424) +
Cum. reconf. since previous restrg x Level of strategic interconnectedness in t-1 [(a)]		-0.106 (0.147)		
Reconfiguration intensity in t-3 x Level of strategic interconnectedness in t-3 [(a)]				-0.013 (0.077)
Control variables				
Restructuring 1989	-0.000 (0.272)	-0.033 (0.288)	-0.331 (0.226) +	-0.336 (0.265) +
Restructuring in t -1	-1.164 (0.299) ***	-1.487 (0.320) ***	-1.184 (0.286) ***	-1.260 (0.300) ***
Environment dynamism in t -1	-9.156 (4.848) *	-6.948 (4.986) +	-8.551 (4.028) *	-10.212 (4.292) *
Diversification change in t -1	0.315 (0.606)	-0.122 (0.740)	1.101 (0.497) *	1.115 (0.514) *
Multinationality change in t -1	-1.481 (2.933)	-0.923 (3.016)	-2.760 (2.659)	-1.430 (2.732)
Size change in t -1 [(a)]	0.154 (0.081) *	0.145 (0.079) *	0.147 (0.076) *	0.140 (0.081) *
ROA variation in t -1 [(a)]	-0.087 (0.072)	-0.144 (0.082) *	-0.081 (0.054) +	-0.079 (0.055) +
Sales variation in t-1	0.511 (0.501)	0.817 (0.511) +	0.116 (0.465)	0.038 (0.481)
Tobin's q variation in t-1	-0.091 (0.456)	-0.175 (0.479)	-0.534 (0.391) +	-0.438 (0.388)
Size in y -1 (log transf.) [(a)]	-0.097 (0.313)	-0.011 (0.327)	0.031 (0.252)	-0.034 (0.258)
Constant	-1.580 (0.546) **	-1.488 (0.578) **	-1.476 (0.506) ***	-1.856 (0.560) ***
Time Dummies	YES	YES	YES	YES
ρ	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
N [(b)]	555	555	644	644
Log Likelihood	-167.93	-157.98	-233.97	-223.84
Chi^2 statistic for model significance (d.f.) [(c)]	70.17 ** (40)	74.89 ** (46)	63.66 * (46)	74.30 * (52)
Chi^2 statistic for significance of interactions (d.f.) [(d)]		19.90 ** (6)		20.26 ** (6)
McFadden pseudo R^2	0.421	0.455	0.194	0.230

+ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$, one-tailed tests. Standard errors in parentheses.
(a) Standardized variable. (b) The difference in sample sizes is caused by a reduced number of observations when one cumulates the number of reconfigurations between two occurrences of restructuring. In some cases, the first observed restructuring takes place much later than the start of our time window. For instance, Conagra's first and only restructuring took place in 2002. Since we cannot cumulate the number of reconfigurations until then, we are losing all the preceding observations. (c) Test of the model against the model that includes only the constant and the time dummy variables. (d) Test of the model against the partial model that excludes the three interaction variables. NB: The degrees of freedom also include the longitudinally-averaged exogenous variables.