Reorganizational Proliferation: How Organizational Change and Inertia Work Together

Simon C. Parker
University of Western Ontario, Canada

Arjen van Witteloostuijn *
University of Antwerp, Belgium and Utrecht University, the Netherlands

Abstract

This paper integrates insights from both sides of the organizational change–inertia debate in a single theoretical model, using math and simulation. In this way, we seek to offer a tool to explore the interaction between the forces to change and those to stay put, as well as to investigate the performance implications of different change–inertia mixtures. In our approach, we integrate different theories as special cases nested in an overarching theoretical model. The model thereby identifies the scope conditions of different theories, focusing on two critical parameters: active managerial reorganization and passive organizational inertia. We show that depending upon the magnitude of this pair of forces different outcomes emerge, ranging from complete stasis to chaotic flexibility. So, our key argument is that forces pro change and pro inertia tend to operate simultaneously as two independent organizational features, rather than as an 'average' force located somewhere on a single continuum. As we will demonstrate, this has wide-ranging consequences for organizational outcomes.

*Corresponding author. Correspondence address: University of Antwerp, Faculty of Applied Economics, Antwerp Centre of Evolutionary Demography, Prinsstraat 13, 2000 Antwerp, Belgium (arjen.vanwitteloostuijn@ua.ac.be). Arjen van Witteloostuijn gratefully acknowledges the financial support through the Odysseus program of the Flemish Science Foundation (FWO).

1 Introduction

> We trained hard, but it seemed that every time we were beginning to form up into teams, we would be reorganized. I was to learn later in life that we tend to meet any new situation by reorganizing; and a wonderful method it can be for creating the illusion of progress while producing confusion, inefficiency, and demoralization.

This quote is not from an employee of General Motors in 2009 AD, but is attributed to a disgruntled soldier in Ancient Rome, one Petronius Arbiter, in 210 BC. The irresistible tendency for organizations to reorganize, it seems, is universal across time and space. And, although over two millennia have passed since Petronius Arbiter wondered about the illusion of reorganizations, it seems that organizations have progressed little in understanding the antecedents and consequences of organizational change. This article proposes a new model which, under a minimal set of assumptions, attempts to uncover some of the reasons why this may be so — or why what we term 'reorganizational proliferation' is likely to emerge in many organizations. Reorganizational proliferation refers to a dynamic state of permanent reorganizational activity. We believe that the model illustrates why the routine-like 'let's change' response to a perceived state of misfit is often misguided, and can shed light on what organizations can do to avoid reorganizational proliferation.

Of course, we are far from the first to try to unravel the mystery of ongoing organizational change. Using 'organizational change' and 'organizational inertia' as the search strings in www.scholar.google.com (accessed on November 7, 2009) generated about 2,750,000 and 108,000 hits, respectively. This simple statistic triggers two observations. First, the literature on organizational change is huge, as is the one on organizational inertia. This is witnessed by the 58 and 6 articles in *Administrative Science Quarterly*, 17 and 3 in the *Academy of Management Journal*, 22 and 0 in the *Academy of Management Review*, 19 and 3 in *Organization Science*, 6 and 1 in the *Strategic Management Journal*, and 4 and 2 in *Management Science* with organizational change and/or inertia, respectively, in the title. As Sorge and van Witteloostuijn (2004) observe, the size of the academic literature on organizational change mirrors the popularity of organizational change in the business world itself.

Second, the organizational change topic is much more popular than its organizational inertia counterpart. Overall, the management literature seems to favor the pro-change perspective, arguing that organizations need to flexibly adapt to changing circumstances to enhance their performance. Of course, some do argue why organizational inertia might, under particular circumstances, be a good thing, but this is the exception rather than the rule (Sorge and van Witteloostuijn, 2004). This bias in the management literature is clear from the emphasis on change rather than inertia in any major textbook (see, e.g., Johnson, Scholes and Whittington, 2007). Looking in more detail into the nature of the Google hits produces a third observation. The number one publication in terms of cites is the 1984 article by Mike Hannan and the late John Freeman in the *American Sociological Review* entitled "Structural inertia and organizational change", with 2,607 cites.

Indeed, we argue that the twin nature of the title of Hannan and Freeman's (1984) classic article hits the nail on the head in that in order to understand organizational change we need to include an analysis of organizational inertia, and *vice versa*. Their basic argument is that organizational inertia is the dominant force, and that organizational change is associated with a higher likelihood of organizational mortality. We agree with Hannan and Freeman that we need to study organizational change and organizational inertia in tandem. However, Hannan and Freeman's logic emphasizes one specific corner outcome. In this paper, we develop a theoretical model in which Hannan and Freeman's 'change is bad, inertia is good' argument is nested as a special case in a general theory of organizational change and inertia, as is the claim that 'change is good, inertia is bad' that dominates so much of the management literature.

In view of the above, we argue that it is the *interaction* between organizational change and inertia that offers the key to deepen our understanding of the implications of both forces that dominate so much organizational life. Specifically, we develop a model in which we, first, assume that a manager decides on a subjectively optimal level of organizational change in order to reach a target level of optimal fitness. Second, we adopt the realistic assumption that the manager has imperfect information about the long-term consequences of organizational change. Particularly, third, we argue that the interaction of the manager's change efforts with the organization's inertia forces may well produce unexpected organizational change patterns, due to unforeseen organizational change cascade effects. That is, as argued by Hannan, Pólos and Carroll (2003a), change now is likely to trigger a series of other changes later — a path dependency that is difficult to anticipate at the start. Jointly, this set of three key elements of the model produces a variety of organizational change pattern outcomes, from complete stasis to full chaos.

Hence, we adopt a similar opposing forces logic like, e.g., Larsen and Lomi (2002) and Rudolph and Repenning (2002). In the present paper, we try to integrate insights from both sides of the change–inertia debate in a single theoretical model, using math and simulation. In this way, we seek to offer a tool to explore the interaction between the forces to change and those to stay put, as well as to investigate the performance implications of different change-inertia mixtures. In our approach, we integrate different theories as special cases nested in an overarching theoretical model. Our model thereby identifies the scope conditions of different theories, focusing on two critical parameters: active managerial reorganization and passive organizational inertia. We show that depending upon the magnitude of this pair of forces different outcomes emerge, ranging from complete statis to chaotic flexibility. So, our key argument is that forces pro change and pro inertia tend to operate simultaneously as two independent organizational features, rather than as an "average" force located somewhere on a single continuum. We go on to demonstrate that, if current organizational changes trigger future organizational changes, this has wide-ranging consequences for organizational outcomes, and may well produce reorganizational proliferation.

In Section 2, we review a sample of organizational change and inertia studies in order to position our work in the broader literature. In Section 3, we introduce the key assumptions and outcomes of our model. Section 4 discusses the mathematical properties of our model, before Section 5 reflects on implications for managers and organizations. Section 6 presents the results from some simulations. Section 7 concludes.

2 Literature review

2.1 Change or inertia?

A complete overview of the organizational change and inertia literature is undoable in the context of a journal paper. The electronic search in the above six top journals in the management domain alone produced 141 articles on this pair of issues. Yet among these, only a small minority refers to both organizational change and organizational inertia in the author-supplied abstract. A few examples are Fredrickson and Iaquinto (1989), Huff, Huff and Thomas (1992), Keck and Tushman (1993), Greve (1996, 1998), Burgelman and Grove (2007), and Péli (2009). Three stylized facts emerge from this small change-inertia literature that are central to what we try to achieve in the current paper.

Firstly, this literature reveals a clear pro-change bias. With the exception of work inspired by organizational ecology's theory of relative inertia, the dominant argument is that organizational change is good and organizational inertia is bad from the perspective of the organization's performance. Secondly, by far the majority of change-inertia research involves the antecedents and consequences of organizational change or inertia in relation to the nature of environmental change. By and large, the argument is that dynamic environments are associated with organizational change, and stable environments with organizational inertia, in the sense of increasing the likelihood of either change or inertia to be associated with a positive effect on organizational performance. Thirdly, the literature tends to conceptualize organizational change and inertia as referring to a single continuum. Organizations feature a degree of organizational change or inertia, which may vary over time.

In this paper, we develop a model that has three features, related to the above. First, our model does not assume that change or inertia is intrinsically good or bad. Rather, it can go either way, depending upon the way the pro-change and pro-inertia forces interact in producing specific organizational outcomes. Second, our model focuses on features internal to the organization only, revealing how a wide variety of organizational outcomes – from complete statis to patternless chaos – can emerge through dynamics completely internal to the organization. Third, our model conceptualizes organizational change and inertia as two forces that operate simultaneously in interaction, reflecting two independent dimensions rather than different positions on a single continuum.

2.2 Simulation method

Two other issues related to the change-inertia debate are organizational adaptation and organizational learning, which generates 546,000 and 1,890,000 hits via www.scholar.google.com (again, accessed on November 7, 2009). These literatures host an impressive simulation tradition. Two types of, often related, simulation work stand out for their resemblance with what we will do below. First, a series of simulation studies deal with issues of intra-organizational interdependencies and modularities, building upon complexity theory (e.g., Rivkin, 2000, 2001; Rivkin and Siggelkow, 2002, 2003). In this line of work, a key conclusion is that learning how to adapt or imitate complex architectures, characterized by closely knit modules (i.e., activities or units), is anything but easy, because changing one module triggers a wave of changes in the complex and difficult-to-observe chain of interdependent modules. This relates to the organizational change cascade effect that will turn out to be central to our own model. Second, another cluster of simulation models focuses on organizational adaptation and selection processes, relating to contingency and ecology theories (e.g., Levinthal, 1997; Levinthal and Waglien, 1999; Levinthal and Posen, 2007). Here, an important conclusion is that selection does not necessarily filter out those organizations with the lowest long-run fitness, due to the erratic effect of adaptation on short-run performance. This is akin to the chaotic outcomes that our model can generate.

Our approach particularly resembles simulations exploring the effect of two countervailing forces on organizational outcomes. Here, a reference to four examples must suffice. First, Huff, Huff and Thomas (1992) model the interaction of an organization's cumulative inertia with its cumulative stress, which is the built-up strain experienced by the organization. In the context of a four-phase model, they explore the conditions under which an organization decides to engage in strategic renewal. An important finding is that "initial levels of stress and inertia have long-term effects upon the organization's history of strategic change" (Huff et al., 1992: 71). Second, Larsen and Lomi (2002) study the feedback loop of organizational inertia and capabilities. The question is how the development of competitivenessenhancing organizational capabilities is affected by the organization's degree of inertia. They conclude that "there is an 'optimal' level of inertia, which is above the lowest attainable level" (Larsen and Lomi, 2002: 291). Third, Rudolph and Repenning (2002) simulate implications of the negative and positive effects of stress on the ability of organizations to deal with a series of non-novel interruptions. Their central argument is that organizational disaster may not only be caused by novel events, but also by an accumulation of non-novel events. Indeed, they observe that, echoing Turner (1978), "the accumulation of unnoticed events during an 'incubation' period can cascade into disaster as a result of a precipitating event" (Rudolph and Repenning, 2002: 3). Fourth, Ethiraj and Levinthal (2004) study the impact of organizational design change *vis-à-vis* inertia in the face of different rates of environmental change. They develop a simulation model to explore whether boundededly rational managers can engage in adapting complex organizational forms so as to restore the organization's fit with the environment, concluding that "the relative efficacy of adaptive efforts in hierarchical structures persists with moderate levels of environmental change, but as the rate of environmental change increases or the organization gets larger, the capacity to adapt effectively recedes" (Ethiray and Levinthal, 2004: 431).

Like these four studies, we also model the interaction between two opposing forces. In our case, the focus is on the subtle interaction between forces of organizational change, as decided upon by managers, on the one hand, and organizational inertia, as a feature of the organization, on the other hand. Key is the assumption that an organizational change now provides the seed for a series of later organizational changes, due to the organizational cascade effect (see also Hannan et al., 2003a). So, change today has a delayed effect on change tomorrow. This introduces path dependencies in the model that turn out to be associated with a rich variety of different outcomes, varying from complete statis to chaotic change patterns. In this way, our model produces outcomes that relate nicely to several different theories, ranging from organizational ecology to hypercompetition. Before we explore these issues, we first introduce the building blocks of the model.

3 The model

Our chain of logic is based on a simple conceptual framework, which argues that two forces characterize any organization. On the one hand, intrinsically, an organization is associated with a specific degree of resistance to change. On the other hand, the organization's managers invest a specific amount of effort in organizational change. Both stylized facts are well established in the management literature, a classic example being Argyris and Schön's (1978) and Argyris' (1993) contributions to the organizational change and learning literature. Central to this work is an analysis of what management can do to overcome the organization's 'natural' resistance to change. Putting these conceptual building blocks to work in interaction within a mathematical model reveals how managerial efforts to affect organizational change in the face of inertia can lead to a rich variety of subsequent organizational change patterns, including stable rates of organizational change, stasis, and even 'chaos'. These organizational change patterns, in turn, can impact organizational performance negatively, neutrally or positively, depending upon the associated process costs and content benefits (Barnett and Carroll, 1995). We now introduce our mathematical model, step by step.

Let x_t denote the extent of the focal firm's reorganization at time t. In each period, managers re-evaluate their organization and can choose to adjust x_t. At times of increasing reorganization efforts, x_{t+1} exceeds x_t. Then the rate of change of reorganization is $\Delta x_{t+1} := x_{t+1} - x_t > 0$. At times of decreasing reorganization efforts, $\Delta x_{t+1} < 0$. An organization with a stable degree of organizational change is characterized by $\Delta x_{t+1} = 0$, where x_{t+1} may be greater than zero. This implies a constant, or 'stable', amount of reorganization in every period.

The remainder of this section focuses on two issues. The first subsection looks at the performance implications of reorganization. Reorganizations generate costs and benefits which impact organizational performance. The second subsection looks at a different issue, namely the impact of past reorganizations on future reorganizations. The idea here is that reorganizations may have legacy effects which prompt further attempts by managers to reorganize later on, provided the earlier reorganizations are neither so small that they make no impact at all, nor so drastic that they exhaust the firm's capacity to do anything more in the future. Indeed, ongoing (intertemporal) reorganization can be a very pertinent issue in some —- if not the majority of — organizations, which sometimes seem to reorganize on an almost ongoing basis, not always waiting, for example, for the outcomes of previous reorganizations to fully take effect before embarking on new reorganization initiatives (Sorge and van Witteloostuijn, 2004). In effect, organizational change fashions tend to come in waves, with the duration of the cycles having shortened over time in the post-war period (Abrahamson and Fairchild, 1999) due to consultancy addiction, shareholder pressure, managerial hubris, and financial market pressure. Cases in point are quality circles, business process re-engineering, and shareholder value metrics.

3.1 Implications of reorganization for performance

At the outset, we must state what managers know and what they do not know. That is, we need to define the boundedness of their rationality, a standard assumption in the management literature (Simon, 1991). The initial degree of reorganization which managers inherit at some $t-k$ is given by x_{t-k-1}. Managers expect that reorganization efforts x_{t-k} made at time $t-k$ will incur the one-off cost $c(x_{t-k} - x_{t-k-1}) > 0$, where $c(\cdot)$ is an increasing function. We can think of $c(\cdot)$ as adjustment costs (Δx_{t-k}) associated with disruption of accustomed routines (March, 1991). Managers are willing to incur this cost in order to tackle problems of 'misfit' which hamper organizational performance. This misfit-driven change trigger is standard in the management literature, as emphasized by contingency theory (Parker and van Witteloostuijn, 2009).

To be specific, denote the degree of reorganization needed to put the organization into a state of fit by x^*. Measured in terms of organizational change, the inherited degree of misfit just before x_{t-k} is chosen is taken to be some increasing function of $|x^* - x_{t-k-1}|$. Managers try to choose x_{t-k} to maximize *subjective* performance, where the word subjective indicates that managers may not have perfect information. The expected sequence of benefits associated with x_{t-k} is denoted by $\{b_{t-k+\tau}(|x^* - x_{t-k}|)\}_{\tau=0}^{\infty}$, where $b(\cdot)$ is a decreasing function of its argument — misfit.

In summary, managers are assumed to know about these costs and benefits when they initiate x_{t-k}. The impact of reorganization x_{t-k} on subjective performance is the present value of the difference between expected benefits and costs, given by

$$P_S := \sum_{\tau=0}^{\infty} \beta^\tau b_{t-k+\tau}(|x^* - x_{t-k}|) - c(x_{t-k} - x_{t-k-1}), \tag{1}$$

where $0 < \beta < 1$ is the discount factor: $\beta = (1+\rho)^{-1}$, with $\rho > 0$ being the discount rate. Observe that the present value calculation starts at $t-k$, which is why no β appears in front of the cost term which is incurred at $t-k$. Note also that if discount rates decrease, β increases. This values future benefits more than current costs, making P_S more likely to be positive. This would presumably encourage managers to initiate x_{t-k}, rather than sticking with the status quo — under which performance is

$$P_{SQ} := \sum_{\tau=0}^{\infty} \beta^\tau b_{t-k+\tau}(|x^* - x_{t-k-1}|). \tag{2}$$

Note the absence of costs in (2) relative to (1): this follows because under the status quo no costly adjustments are made. Potentially offsetting this positive aspect, any inherited misfit in (2) may persist indefinitely, while it may be reduced in (1) by a judicious choice of x_{t-k} (see below).

A key contention of our model is that, because of bounded rationality, managers do not know, or do not take into account, the *dynamic evolution* of reorganization efforts, discussed in the next subsection. For the sake of simplicity, we suppose that they do not consider these future dynamics at all. However, assuming that managers imperfectly foresee these dynamics generates results similar to what we report here. Ample evidence shows that many CEOs are no longer in post by the time their reorganization has materialized completely, and that they may simply be unable or unwilling to forecast future reorganizations k periods ahead. For instance, Dahya, McConnell and Travlos (2002) report an increased incidence of CEO turnover in the UK after the introduction of the Cadbury Code for corporate governance, and Kaplan and Minton (2006) observe increasing CEO turnover and decreasing CEO tenure in the US over the 1990s and 2000s. Alternatively, if managers suffer from bounded rationality (e.g., Amit and Schoemaker, 1993; Foss, 2003; Ethiraj and Levinthal, 2004) they do not know (or do not even believe in the existence of) the novel intertemporal structure of reorganization outcomes explored in this paper. Indeed, under one outcome of the intertemporal structure we analyze below, it can be shown that managers may not even be *able* to use pattern recognition heuristics to decipher this structure *ex post* by applying empirical methods to historical data, let alone that they would foresee all this *ex ante*.

But if managers do not know, or do not take into account, the implications of their reorganization for future reorganization possibilities, their organization's *actual* ('objective') performance, denoted by P_O, will generally differ from P_S. Specifically, if x_{t-k} affects $x_{t+\tau}$ for $\tau = 1, 2, \ldots$, as will be argued in the next subsection, then the costs and benefits at $t+1$ onwards will differ from those described above. Objective costs may be higher than subjective costs because as well as incurring $c(x_{t-k} - x_{t-k-1})$, the organization may also incur a sequence of future adjustment costs $\{c(x_{t+\tau} - x_{t+\tau-1})\}_{\tau=1}^{\infty}$ chosen by subsequent management teams. At the same time, benefits may be lower than the subjective benefits generated by choosing x_{t-k} to reduce organizational misfit $|x^* - x_{t-k}|$ arising at $t-k$ and expected to persist into the future. To see why, notice that if x_{t-k} affects $x_{t+\tau}$ for $\tau = 1, 2, \ldots$, then *actual* misfit will no longer be $|x^* - x_{t-k}|$ at $t + \tau$ but will instead be $|x^* - x_{t+\tau}|$ for $\tau = 1, 2, \ldots$. So choices of x_{t-k} which could be optimal for the interval $(t-k, t)$ might no longer generally be optimal at $t+1$ and beyond.

This may reflect the commonly observed phenomenon that even well-intentioned reorganizations ultimately end up being more costly than anticipated, while simultaneously failing to deliver the promised benefits. Evidence on the failure rates of organizational change programs and M & As support this observation (e.g., Reichers, Wanous and Austin, 1997; Dikova, Rao Sahib and van Witteloostuijn, 2009), as does managerial hubris theory (e.g., Roll, 1996; Hayward and Hambrick, 1997). Formally,

$$\begin{aligned} P_O \;:=\; & \sum_{\tau=0}^{k} \beta^\tau b_{t-k+\tau}(|x^* - x_{t-k}|) - c(x_{t-k} - x_{t-k-1}) \\ & + \sum_{\tau=k+1}^{\infty} \beta^\tau \left[b_{t-k+\tau}(|x^* - x_{t-k+\tau}|) - c\left(x_{t-k+\tau+1} - x_{t-k+\tau}\right)\right] \end{aligned} \tag{3}$$

To recap, reorganizations may generate lower objective than subjective performance because (for reasons which are explained next) reorganizations carry the seeds for future reorganizations which are not and cannot be anticipated. Furthermore, the more volatile the temporal profile of reorganization, the greater the adjustment costs are likely to be, and the less likely it is that a given reorganization will succeed in generating the expected or forecasted benefits in terms of increased or restored fit. As a result, the organization's actual performance may well become worse. It therefore behoves us to analyze the intertemporal profile of reorganization in depth — an issue we turn to now.

3.2 Implications of reorganization for future reorganization

We consider two factors which may impart an intertemporal, or dynamic, character to the amounts of reorganization that organizations experience over time. The first factor is simply internal forces of inertia, as suggested by the large literature on organizational inertia, which might counteract active efforts by managers, as suggested by the even larger organizational change literature. This can be thought of as driving $x(t)$ towards zero at a rate of $\delta \in (0, 1)$, say, per period. For instance, if management made no offsetting reorganization efforts of its own (the second factor to be considered below), we would simply have $\Delta x_{t-k+1} = -\delta x_{t-k}$, which (given some initial value $x_0 \geq 0$) eventually yields the 'static' outcome of $\lim_{t\to\infty} x_t = 0$. This outcome is termed static because the organization would reach a point where reorganization ceases absolutely and forever. This is the ultimate state of organizational inertia, implying absolute rigidity.

In the real world, though, few organizations appear to be completely inert. For instance, the prominent structural inertia theory of Hannan and Freeman (1984) assumes relative and not absolute inertia, arguing that organizations do change, but at a speed that falls short of shifts in the environment. The primary reason for organizational change in our model is a second dynamic feature: managers actively initiate reorganization efforts. By the nature of their job, (top) managers are biased to be active rather than passive (Wiersema and Bantel, 1992). Action is, so to speak, the very core of a manager's job description (Sorge and van Witteloostuijn, 2004). We contend that these initiatives are not formed in a vacuum completely independently of previous reorganization efforts, but have an endogenous or 'spawning' character, which operates with a lag. Reorganizations frequently generate rich sources of information within the organization, which takes managers time to compile, process, understand and learn from. This information might be picked up in periodic strategic reviews, which take place every k periods, for example.

Consider, for instance, a reorganization effort designed to split a firm up into several geographical (e.g., national) divisions, in order to get closer to the local needs of customers and so promote better 'fit' between the firm's marketing efforts and local market conditions (Harzing, 2000). When, k periods later, the reorganization is reviewed, it becomes clear to managers that other related reorganizations might also now be potentially valuable, such as extended localization from countries to regions of countries, or splitting up of HR functions along national or regional lines as well. Another example is Chung and Beamish (2010), who contend that continual ownership change in international joint ventures negatively affects ventures' short and long-run performance. Such continual change might suggest that there is a self-sustaining, or path-dependent, property of reorganizations which arises out of ongoing, dynamic organizational learning that is often of a trial-and-error nature. Some changes further down the line may be intentional, as management learns how to further improve upon the initial change or how to adapt the original change to shifting circumstances. This is the key message in the large literature on the learning organization (e.g., Senge, 1990). Some other further changes may be unintentional. Recently, Hannan et al. (2003a, b) explored a similar path-dependent process which they termed 'organizational change cascades'. Their argument is that an original change initiative tends to have unexpected consequences throughout the organization, which in turn triggers a series of new and unanticipated changes.

In short, each reorganization effort is assumed to spawn further reorganizations an integer number $k > 1$ periods later. Initially, k is taken to be fixed and given; later on, we will explore the implications of different values of k. Effectively, one can think of the value of k as being determined 'institutionally' — i.e., within an organization given its processual and structural features. For example, one might expect k to be modest in firms which continually re-evaluate themselves, or in (possibly smaller) firms where change management is easier to impose and measure. In contrast, k is likely to be higher in complacent firms, or in (possibly larger) firms with more complicated organizational structures which take a long time to evaluate and understand. Indeed, the organizational change and inertia literatures have identified many organizational features that promote either change or inertia, varying from simple characteristics such as age and size to more subtle features like culture and complexity (see, e.g., Argyris, 1993; Hannan et al., 2003b).

Denote the effect of managerial reorganization efforts made k periods ago on current reorganization efforts by $M(x_{t-k})$, where $M(\cdot)$ is some positive-valued function. Then actual subsequent organizational change is the net effect of two countervailing forces: positive managerial effort and negative organizational inertia. Letting $p > 0$ denote the positive impact of $M(x_{t-k})$ on $\Delta x_{t+1} = x_{t+1} - x_t$, it follows that

$$x_{t+1} - x_t = pM(x_{t-k}) - \delta x_t\,, \qquad t = 0, 1, \ldots \tag{4}$$

Our final task is to propose a plausible functional form for $M(x_{t-k})$. Consider, again, the path-dependent spawning process discussed above. It seems obvious that there will be some limits to this process. An organization that did not do any reorganization in the past — for which $x_{t-k} = 0$ — has no basis from which any follow-on reorganizations can be spawned: hence $M(0) = 0$. Only as levels of reorganization rise above 0 can there be enough effect k periods later to engender learning and therefore further reorganization opportunities. Hence $M(x_{t-k})$ becomes an increasing function of x_{t-k}. However, another limit presents itself once reorganization efforts become so great that the costs involved reach prohibitive levels. Massive past reorganizations can (figuratively and quite possibly also literally) exhaust an organization's resources and capabilities to spawn subsequent initiatives, resulting in a decrease in $M(x_{t-k})$. In the limit, we can expect $\lim_{x\to\infty} M(x_{t-k}) = 0$. In summary, therefore, we assume $M(x_{t-k})$ to be strictly positive for intermediate values of x_{t-k} and to attain a peak where x_{t-k} is far enough from both very low and very high extremes. A convenient representation of $M(x_{t-k})$ for our purposes which perfectly captures this structure is $M(x_{t-k}) = x_{t-k}e^{-ax_{t-k}}$, where $a > 0$ is a finite positive constant. This specification is illustrated in Figure 1. This specification is similar to the one in Rudolph and Repenning's (2002) simulation model of organizational collapse. Note that alternative specifications yield similar qualitative results.[1]

[1] E.g., $M(x_{t-k}) = px_{t-k}/(1 + x^a_{t-k})$: see Padhi and Srivistava (2008).

[Insert Figure 1 about here]

Putting this into (4) yields the following model of dynamic organizational change:

$$x_{t+1} - x_t = p x_{t-k} e^{-a x_{t-k}} - \delta x_t \,, \qquad t = 0, 1, \ldots \tag{5}$$

Eq. (5) is called a 'delay difference equation', and is a type of 'Mackey-Glass' equation which has found many applications in physics, population dynamics, physiology, medicine, neural control and economics (see Heiden and Bayer, 2002, for references).

The remainder of this paper attempts the following tasks. The next section describes and illustrates the rich mathematical properties of (5). The one after discusses the implications of these findings for managers and organizations. It turns out that novel lessons can be learned from this exercise which help to put into perspective previous insights from contingency theory, change management and organizational ecology.

4 Mathematical properties of the model

The two critical parameters of the model are δ and p. As noted in (4) and (5), these parameters weight two forces which pull in opposite directions: active managerial reorganization (which pulls in a positive direction) and passive organizational inertia (which pulls in a negative direction). The absolute and relative sizes of these parameters determine the time profile of reorganization outcomes, which (it turns out) can take a rich variety of forms. The present section characterizes these different forms, while the one after draws implications from these outcomes for managers and organizations.

[Insert Figures 2 and 3 about here]

Figure 2 divides the (δ, p) space into three zones which describe the dynamic structure of (5). The first zone, A, arises when $\delta > p$. Here inertia is the dominant force, which overcomes managerial efforts to reorganize. The solution of (5) in this case, called the 'zero equilibrium' or *attractor*, is $\lim_{t\to\infty} x_t = 0$. Using parameter values summarized in note 3 below, this is illustrated in time-series representation in Figure 3, which plots x_t against time, t. In principle, this outcome could be consistent either with successful organizational configuration (a state of 'fit': $x^* = 0 = \lim_{t\to\infty} x_t$) or, at the other extreme, with performance-damaging ossification (a state of 'misfit': $x^* \neq 0 = \lim_{t\to\infty} x_t$).

[Insert Figure 4 about here]

Zones B and C of Figure 2 arise when $\delta < p$. Both zones B and C feature reorganizational proliferation, albeit in different patterns, with constant, periodic or chaotic series of reorganizations. Active managerial efforts are now the dominant force.

First of all, the zero equilibrium outcome is unstable for these parameter values. In zone B, a different 'positive equilibrium' replaces it as the stable solution, or attractor, namely $\lim_{t\to\infty} x_t = \frac{1}{a}\log\left(\frac{p}{\delta}\right)$. This implies that firms eventually reach a stage where they settle into a constant degree of reorganization each period. It may take a while to reach this point, but a firm with parameters in zone B is bound to reach it eventually. The time-series representation of this type of organizational dynamic is illustrated in Figure 4.

[Insert Figures 5, 6 & 7 about here]

However, when both δ and $p > \delta$ are both sufficiently high,[2] the positive equilibrium described above is no longer stable. This case is illustrated as zone C of Figure 2. In zone C, both periodic and non-periodic cycles are possible, depending on the particular values of the parameters (see below). Time-series representations of these outcomes are illustrated in Figures 5 and 6, respectively.[3] Firms revealing periodic cycles can be thought of as undergoing recurrent reorganizations with an intensity that fluctuates in a regular manner. Sometimes there are high levels of activity, and sometimes there are low levels of activity, but high periods are followed in a predictable fashion by low periods and *vice versa*. The length of each cycle is k. In

[2] The technical meaning of 'sufficiently high' is

$$p > p^* =: \delta \exp\left\{\frac{1 + [(1-\delta)^2 + 1 - 2(1-\delta)\cos\theta]^{1/2}}{\delta}\right\},$$

where θ is the solution in $(0, \pi/(k+1))$ of

$$\frac{\sin k\theta}{\sin(k+1)\theta} = \frac{1}{1-\delta}$$

(see Wang and Wei, 2008).

[3] Denoting the parameter vector by $\mathbf{v} = (\delta, p, \alpha, k)$, Figures 3 through 7 are generated using the following values: $\mathbf{v}_1 = (0.75, 0.5, 1, 5)$; $\mathbf{v}_2 = (0.5, 4, 1.5, 5)$; $\mathbf{v}_3 = (0.5, 6, 1, 5)$; $\mathbf{v}_4 = (0.75, 18, 1, 5)$; and $\mathbf{v}_5 = (0.75, 18, 1, 15)$, respectively. These parameters are chosen to illustrate the different outcomes quite starkly; no special significance ought to be attached to these specific numbers.

contrast, non-periodic cycles which obtain for different parameter values are chaotic: the degree of reorganization fluctuates unpredictably period to period. No regular patterns can be discerned from past experience to inform future predictions.

Figure 7 explores what happens when the delay, k, between managerial reorganization efforts and their future impacts lengthen from 5 periods (as in Figure 6) to 15 periods. It is readily observed that chaotic patterns of reorganization become more pronounced; even the notion of an 'average' cycle length vanishes. Note that the patterns depicted in Figures 6 and 7 illustrate purely deterministic chaos: there is no 'noise' or random component to the system being analyzed. Also, note that we do not need any assumption about the nature of environmental changes. All dynamic outcomes are generated by organization-internal processes only, and would occur even if the environment is completely stable.

5 Implications for managers and organizations

Consider a period of initial organizational stasis: $x_{t-k-1} = 0$. Moreover, suppose that an organization is in a state of considerable misfit. This prompts managers to choose some $x_{t-k} > 0$. If this has only modest effects on future reorganization efforts (i.e., if p is not too large), then convergence to a stable equilibrium is likely (Zones A or B). But if p is even only slightly larger than p^* defined in footnote 2 (Zone C), we can get into completely different outcomes of volatility. This sensitivity to very small changes in parameter values is the famous 'butterfly effect': minute differences in initial conditions can have major long-run effects. The simulation analysis performed below will show that the resulting performance implications can be dramatic. From a managerial perspective, this implies the desirability of diagnosing the organization's sensitivity to the spawning effect of organizational change. For instance, Hannan et al. (2003a, b) argue that organizational change cascades are more likely to emerge in complex organizations. Another example is the classic 'tight coupling' argument (e.g., Orton and Weick, 1990; Perrow, 1994), implying that if different organizational activities and departments are tightly coupled, change in one activity or department will trigger follow-up changes in the other activities and departments.

Notice as well that it is **not** the choice of x_{t-k} which drives future volatility, but the parameters δ and p of the dynamic reorganization process (5). That is, it is not the scale of a reorganization which impacts long-run organizational performance, but rather the subsequent spawning of future reorganizations. This point carries important implications for managerial action. For example, if intertemporal organizational spawning harms future performance (see the simulation section), then organizations should discourage change. Owners might need to tie the hands of current and future managers to prevent the emergence of organizations leading to chaotic volatility — which can entail such high adjustment costs that the organization badly underperforms. Alternatively, given the spawning sensitivity diagnosis, action can be undertaken to reduce the spawning effect by, e.g., simplifying the organizations structure, relaxing the workforce's resistance against change or developing a more loosely coupled architecture.

Initial misfit might matter in another way, too. Consider two organizations, A and B, which are very similar, except for A initially having $P_S^A < 0 < \min\{P_O^A, P_{SQ}^A\}$, while B initially has $P_O^B < 0 < P_{SQ}^B < P_S^B$. That is, managers in A wrongly subjectively expect a reorganization at $t-k$ to impair subsequent performance, whereas managers in B wrongly subjectively expect it to improve performance. As a result, A does no reorganization while B does. Under some parameterizations considered below, it is possible that A remains in stasis, survives and prospers, whereas B sparks off a chaotic and destructive pattern of volatility. This illustrates the practical importance of the butterfly effect in the context of reorganizations. It also offers another rationale for the anti-change argument explored in organizational ecology. For instance, Péli (1997) argues that if the benefits of organizational change are highly uncertain, given the complex and dynamic environment in which the organization operates, the survival-enhancing strategy is to stay put to avoid the cost of change. Clearly, if the organization is drawn into a butterfly effect of erratic change cascades, this argument is further reinforced without the need to impose any assumption on the nature of environmental change.

A different possibility is that ossifying firms might actually do best by reorganizing and even enduring chaotic cycles than by continuing to do nothing. In this case, both P_S and P_O could be positive as a result of $x_{t-k} > 0$ while $P_{SQ} < 0$. In short, some firms might be so badly internally configured that even chaotic cycles are an improvement. In the context of rapid evolution of the external environment, this process can be linked to the pro-change argument advocated by those who refer to the need to change in light of hypercompetition (e.g., D'Aveni, 1994; Ilinitch, Lewin and D'Aveni, 1998; Volberda, 1996; Wiggins and Ruefli, 2005). But in other cases, as noted above, chaotic organizational change can be fatal. For example, ongoing erratic reorganizations can alienate workers who then leave in disillusionment, undermining the organization's performance in the process. When worker morale is very important, organizations should be very cautious before initiating organizational change (Cascio and Wynn, 2004), especially if they operate in a chaotic parameter regime and initial misfit is not too bad. This could be an argument for Leibenstein's (1966) 'X-inefficiency': it is sometimes best to tolerate some suboptimality rather than reach for a cure which is worse than the disease. The simulations considered next illustrate these possibilities using some specific functional forms and numerical calibrations.

6 Simulation

At the outset, note that, starting at $t-k$, the dynamic process (5) only starts linking current with lagged reorganizations by time $t+1$. Hence $x_{t-k+\tau} = x_{t-k}$ for all $\tau = 1, 2, \ldots, k$. Assume the following functional forms: a quadratic cost function and a linear benefit function conditioned negatively on misfit. That is,

$$
\begin{aligned}
c(x_{t-k} - x_{t-k-1}) &= \frac{\phi}{2}(x_{t-k} - x_{t-k-1})^2 && (6) \\
b_{t-k+\tau}(|x^* - x_{t-k}|) &= \Pi - \lambda|x^* - x_{t-k}| \quad \text{for} \quad \tau = 0, 1, 2, \ldots && (7) \\
b_{t-k+\tau}(|x^* - x_{t-k+\tau}|) &= \Pi - \lambda|x^* - x_{t-k+\tau}| \quad \text{for} \quad \tau = k+1, k+2, \ldots && (8)
\end{aligned}
$$

where ϕ, Π and λ are all positive scalars. The greater is ϕ, the greater are the costs of reorganization. One can interpret Π as performance when the organization is in a state of perfect fit; performance is reduced by misfit, the severity of which is regulated by λ.

Using the functional forms (6) through (8), setting $x_{t-k-1} = 0$ for simplicity and without loss of generality, and using (1) through (3), one can immediately obtain the following expressions for P_S, P_{SQ} and P_O:

$$\begin{aligned}
P_S &= \frac{\Pi - \lambda|x^* - x_{t-k}|}{1-\beta} - \frac{\phi}{2}x_{t-k}^2 && (9)\\
P_{SQ} &= \frac{\Pi - \lambda x^*}{1-\beta} && (10)\\
P_O &= P_S + \frac{\beta^{k+1}\lambda|x^* - x_{t-k}|}{1-\beta} - \sum_{\tau=1}^{\infty}\beta^{k+\tau}[\lambda|x^* - x_{t+\tau}| \\
&\quad + \frac{\phi}{2}(x_{t+\tau} - x_{t+\tau-1})^2] && (11)
\end{aligned}$$

Note that Eq. (9) can be maximized with respect to x_{t-k} to obtain a 'subjectively optimal' reorganization choice at $t-k$. In this way, the managerial choice of reorganizational effort is endogenized. Setting values of x^* in the simulation such that $x^* > x_{t-k}$, the optimal choice is $x_{t-k} = \lambda/\phi(1-\beta)$. In fact, our simulation results do not depend on this choice. A subjectively sub-optimal choice is also possible, as will be illustrated in one of the simulations below. It will merely prove convenient to use the subjectively optimal values of x_{t-k} for now.

[Insert Table 1 about here]

Table 1 presents the results of six simulation exercises. Recalling that $\beta = (1+\rho)^{-1}$, where $\rho > 0$ is the discount rate, each simulation varies the parameters $\mathbf{w} = (\rho, \Pi, \lambda, \phi, x^*)$ and records the performance outcomes for each of the status quo, subjective and objective cases. By (9) and (10) [and by (1) and (2)], the subjective and status quo performance outcomes depend only on $\mathbf{w}$; by (11) [and by (3)], the objective performance outcomes depend on both $\mathbf{v}$ and $\mathbf{w}$. In the latter case, performance outcomes for any $\mathbf{w}$ are given for all of $\mathbf{v}_1$ through $\mathbf{v}_4$, where these $\mathbf{v}$ vectors were defined in footnote 3 above.

The first simulation, presented in column I, uses parameter values which yield a moderate amount of initial misfit: $x^* - x_{t-k} = 5.0 - 4.2 = 0.8$. Managers' subjective expectation of performance given a choice of $x_{t-k} = 4.20$ is 9.66, which seems to beat doing nothing ($P_{SQ} = 5.25$). But actual objective performance, P_O, turns out to be less favorable than both subjective performance and doing nothing. If the initial reorganization creates chaotic future organizational change (as happens with parameter set $\mathbf{v}_4$), objective performance turns negative, falling as low as $P_O(\mathbf{v}_4) = -9.83$. The organization would clearly have done best by doing nothing. This is in line with the inertia argument in organizational ecology (Hannan and Freeman, 1984; Péli, 1997).

The second simulation, presented in column II, treats a different case where initial misfit is more serious: $x^* - x_{t-k} = 5.0 - 2.875 = 2.125$. Here, the status quo is unattractive, yielding negative performance, while subjective performance given a choice of $x_{t-k} = 2.2875$ is expected to be positive ($P_S = 1.27$). As before, $P_O < P_S$, but there is now a twist: in this case, it can be better to reorganize — even if that induces chaos — than to do nothing [since $P_O(\mathbf{v}_4) = 0.74 > P_{SQ} = -0.38$]. Another, possibly surprising, insight from simulation II is that chaotic (or cyclical) dynamics can be associated with superior objective performance *vis-à-vis* convergent organizational dynamics. This is evident from the fact that $P_O(\mathbf{v}_4)$ (and $P_O(\mathbf{v}_3)$) exceeds both $P_O(\mathbf{v}_1)$ and $P_O(\mathbf{v}_2)$. This outcome relates to the hypercompetition argument (Ilinitch et al., 1998).

The first two simulations assumed that managers chose x_{t-k} as the subjectively optimal value. This assumption is relaxed in simulation III, which uses the same parameter set as I apart from setting x_{t-k} as 4.5. The results are very similar to those in column I, showing that the subjective optimality assumption is innocuous. More far-reaching simulations are explored in columns IV, V and VI, which illustrate the effects of increasing Π, x^* and λ respectively, relative to specification I. Evidently, higher values of Π are associated with positive performance, whereas higher values of x^* and λ are associated with negative performance. Thus an increased change effort aiming at restoring fit (x^*) and a larger degree of initial misfit (λ) give a higher likelihood of negative objective performance in simulation VI. This is in line, again, with organizational ecology's relative inertia logic.

Subtler effects are observed for the two remaining parameters, the discount rate ρ and the cost parameter ϕ. Performance does not vary monotonically with these parameters; their simulated effects are charted in an unpublished appendix, available from the authors on request. As this appendix shows, the chaotic vector $\mathbf{v}_4$ is associated with especially marked deteriorating objective performance as ϕ rises, reflecting the higher costs associated with greater swings of organizational changes under this regime.

7 Appraisal

Our model explores the interaction between active managerial change efforts and passive organizational resistance to change — or, put differently, the interplay of organizational change and inertia. In our model, managers make subjective decisions as to what they believe will be the "optimal' extent of organizational change. The ex post objective organizational change pattern is likely to turn out to be quite different from what was expected by the managers ex ante, though, due to subtle interactions of change effort with organizational resistance. Our key message is that only by taking both forces on board can we really understand the subtle consequences of organizational change, ranging from complete statis to chaos. We illustrated how different theories are nested in our model, and we discussed the lessons our model might imply for managers and organizations. In so doing, our model describes different types of organizations, characterized by different internally-driven change patterns. Indeed, even within a given industry, organizations tend to differ with respect to their degrees of inertia (see, e.g., the examples discussed in van Witteloostuijn, 1998). Also, our model offers an alternative explanation for the wave-like rise and fall of the intensity of change efforts (Abrahamson and Fairchild, 1999).

As in any simulation study, our model implies an abstraction from reality that points to future work. Here, by way of illustration, we would like to focus on three possible extensions. First, related work in the tradition of complexity theory emphasizes the role of intra-organizational interdependencies across activities or units (e.g., Milgrom and Roberts, 1995; Rivkin, 2000). Our model could be extended by explicitly including such complex organizational structures. This would endogenize the cascade effect. Second, ecological work focuses on the role of environmental selection processes (e.g., Lomi and Larsen, 1996; Lomi, Larsen and Freeman, 2005). In so doing, we could analyze the internal organizational dynamics explored in this paper in interaction with the nature of organization change in the context of ecological selection processes. Along these lines, we could model changing organizations that interact in the marketplace, revealing what type of organizational change patterns are more likely to survive in which type of environments. Only then, we can really explore the "change is good, inertia is bad' argument from strategic management vis-à-vis the "change is bad, inertia is good' logic from organizational ecology. Third, we do not include objective functions of managers. Following work in agency theory and delegation games, we could explore how the motives of managers affect the organizational change patterns in interaction with competition in the marketplace (Jansen, van Lier and van Witteloostuijn, 2007).

Our model illustrates that reorganizational proliferation will emerge under a minimal set of assumptions. Key are pro-change and pro-inertia forces that operate simultaneously, as well as the presence of organizational change cascades. With this pair of assumptions in place, an organization may feature constant, periodic or chaotic patterns of organizational change, irrespective of the nature of the environment. In the 2,200 year old words of the Ancient Roman soldier Petronius Arbiter, the "illusion of progress" associated with initial reorganizations may well hide a world of out-of-control sequences of organizational changes — "producing confusion, inefficiency, and demoralization."

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Table 1: Simulation results

	I	II	III	IV	V	VI
ρ	0.05	0.15	0.05	0.05	0.05	0.05
Π	0.75	0.70	0.75	1.00	0.75	0.75
λ	0.10	0.15	0.10	0.10	0.10	0.15
ϕ	0.50	0.40	0.50	0.50	0.50	0.50
x^*	5.00	5.00	5.00	5.00	7.50	7.50
x_{t-k}	4.20	2.875	4.50	4.20	4.20	6.30
P_{SQ}	5.25	-0.38	5.25	10.50	0.00	-7.88
P_S	9.66	1.27	9.64	14.91	4.41	2.05
$P_0(\mathbf{v}_1)$	1.32	-0.45	0.53	6.57	-3.93	-16.87
$P_0(\mathbf{v}_2)$	3.88	0.21	3.23	9.13	-1.37	-12.23
$P_0(\mathbf{v}_3)$	4.84	0.97	4.07	10.09	-0.41	-10.88
$P_0(\mathbf{v}_4)$	-9.83	0.74	-15.39	-4.58	-13.31	-26.64