How visible is the visible hand of top management in strategic renewals? Guided evolution and the intraorganizational ecology model of adaptation

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Abstract

This article presents a formal model of an organization that faces a process of strategic renewal. By simulating the model, the role of the top management is investigated in guiding internal entrepreneurship in an intraorganizational ecology of strategic initiatives. The simulation study advances received strategy-process literature in three ways. First, it clarifies the role that slack resources play within a web of interacting variables. Second, the study indicates the behavioral features of the top management that are desirable to appropriately calibrate slack flows. More specifically, two constructs are described: (i) *time to adapt core business expectations* and (ii) *time to react to change in expectations* which capture the top management's capability to produce accurate expectations and to buttress appropriate reaction to change in those expectations. Third, the article integrates the interaction among top managers' agency, evolutionary forces, and self-organization in the strategy process.

Key words: L2 Firm Objectives, Organization, Behavior

JEL classification: C63 Computational Techniques; Simulation Modeling

1. Introduction

The nature of organizational change and the mechanisms that underpin a process of organizational adaptation are at the core of the field of management and organization (Astley and Van De Ven, 1983; Ginsberg, 1988; Gersick, 1991; Van de Ven and Poole, 1995). The intraorganizational ecology theory of organizational change (here called IOE), pioneered by Robert Burgelman (1991, 1994) and shared by some organizational theorists (e.g., Miner, 1994), presents a unique synthesis to the adaptation versus selection debate on organizational change. The perspective views a firm as an ecology of strategic initiatives: the induced initiatives, which both fall within the scope of the firm's corporate strategy and are induced by it, and the autonomous initiatives, which fall outside the scope of the firm's corporate strategy.

This article aims to shed light on the mechanisms that produce unfolding paths of strategic renewal by applying a behavioral perspective (Powell *et al.*, 2011) to specifically look at the role played by top management.

While the IOE theory describes the structure of induced and autonomous strategic processes (Burgelman, 1991), much less is known about the interdependencies among the two types of processes within strategic renewals and about the role that top-management behavior plays in orchestrating such interdependencies. In this respect, the theory remains vague about the specific features of top-management intervention as operators of the intraorganizational ecology of strategic initiatives.

Why do some firms successfully complete their strategic renewals while others fail when trying to implement adaptation of their corporate strategies? The variety of possible outcomes and the heterogeneity of paths of adaptation behavior suggest that something further can be said concerning the inner mechanisms at work in a process of strategic renewal. More importantly, the role of top managers could be explored further.

For example, Burgelman refers to the key role played by unabsorbed slack resources in strategic renewal processes (Burgelman, 1983b, 1983c: 1356; 1991: 248) and by official resource allocation mechanisms oriented by a maximize-margin-per-wafer rule in preventing an escalation of commitment to core business (Burgelman, 1991: 245; 1994: 49–50). Less is said on how top management may influence allocation behavior of slacks to complement the working of official resource allocation systems.

In the light of this, in the IOE model there are a lot of hidden and useful insights to be extracted.

The simulation experiments described in this article contribute to the IOE model in three ways. First, the experiments clarify the role that slack resources play and suggest that, rather than the stock, what is important is the longitudinal distribution of flows of slack. Second, the study indicates the behavioral features of top management that are desirable to appropriately calibrate slack flows. Two constructs are described—time to adapt core business expectations and time to react to changes in expectations—that capture the top management's capability to produce accurate expectations and to buttress appropriate reaction to change in those expectations. Finally, this study elicits a causal structure, which is hidden in the verbal description of the IOE model, that facilitates the interpretation of the sources of path-dependency and causal determinism underpinning the variety of behaviors emerging in strategic renewals.

Therefore, as a related contribution, this work speaks to those scholars who study corporate strategic behavior by combining top managers' agency, evolutionary forces, and self-organization (Thietart, 2016). The model presented in this article, with the connected simulations, provides vivid examples of how causal determinism combines with *mindful deviation* (Garud and Karnøe, 2001) or *guided evolution* (Lovas and Ghoshal, 2000) to steer corporate strategic behavior.

Furthermore, the reported simulation experiments suggest that a source of the path-dependency that hinders managerial intervention is the stock-like nature of corporate resources. Therefore, as an additional contribution, the article encourages scholars to investigate the connections between the resource-based view (Wernerfelt, 1984; Barney, 1986; Peteraf, 1993) and strategy-process literature (Peteraf, 2005).

Digging into the verbal description of the IOE framework, a formal model is generated of an organization that undergoes a strategic renewal process. The model shows a number of stylized traits that capture a general representation of a large firm that echoes the verbal description of Burgelman's IOE model. A computer simulation is used to explore nonobvious longitudinal interaction among top-management intervention and organizational structural features (Lant and Mezias, 1992; Adner, 2002).

The article is articulated as follows. In the next section, IOE theory is discussed. Then, the methodology is presented. The fourth section describes the formal model. The fifth section reports simulation experiments, and the sixth section explains simulation results. The last section discusses insights from simulation experiments and draws some conclusions.

1.1 The classic "adaptation versus selection" debate

Although rooted in the tradition of strategic management research, the theoretical contributions of the IOE theory need to be understood in the context of the adaptation versus selection debate on organizational change, which has been, and still perhaps is, one of the central debates in the field of organizational studies (Aldrich, 1979; Astley and Van De Ven, 1983).

According to an ecological perspective (e.g., Hannan and Freeman, 1977, 1984, 1989), established firms exhibit strong structural inertia. In the presence of inertia, Darwinian evolutionary dynamics apply to the competition among firms. Organizational change takes place not in the form of voluntary adaptation by the established firm, but in the form of change in the population of firms. One population of firms with a specific type of structural form dies out in the course of environmental change, and it is replaced by another population of firms with a new structural form, which fits in better with a new environment. It is the environment that selects one population of firms over others.

This ecological perspective is in sharp contrast to the traditional strategic perspective adopted by business policy and by management scholars, who believe in the discretion of company management, particularly large, resource-rich management, in controlling the fate of its organization (e.g., Chandler, 1962; Thompson, 1967; Andrews, 1971; Child, 1972). Although these two perspectives—deterministic environmental selection on the one hand and voluntary organizational adaptation on the other—present contrasting views on organizational change, the subsequent theory development has demonstrated that the two are not necessarily inconsistent with each other. Rather, each of these perspectives highlights one type of force exercising an influence on organizational change: the adaptive force of a firm guided by the intent of management, on the one hand, and inertial force (which prevents a firm from responding to the selective pressures from the environment) on the other (Hrebiniak and Joyce, 1985).

More subtly, in a recent turn, the debate borrowed concepts from complexity theory to emphasize how choice and adaptation can be reinterpreted by looking at the role of contextual variables that both constrain and inform choice (De Rond and Thietart, 2007). In addressing the origins of the constraints on choice, this approach, rather than overpowering environmental determinism, underscores the role of the cumulative unintended effect of previously made decisions and of the interdependencies among resources (Albert *et al.*, 2015) in contexts where managers face "nonlinear, continuous phenomenon characterized by chaotic dynamics" (Mac Kay and Chia, 2013: 210).

1.2 Intraorganizational ecology model as a synthesis

The IOE theory aims to present an integration of ecological and strategic perspectives by showing how large established firms simultaneously deal with internal adaptive forces and external selection pressures when adjusting to changes in their environment (Burgelman, 1991, 1994). In doing so, IOE theory capitalizes on the variation-selection-retention approach of the cultural evolutionary theory (Campbell, 1969; Weick, 1979) and on the Bower model of resource allocation behavior in large organizations (1970). While population ecologists take firms as units of analysis, and focus on populations of firms, IOE theorists take an intraorganizational point of view (Galunic and Weeks, 2002) and focus on the ecology of strategic initiatives within an organization. Based on this theoretical framework, the IOE theory explains organizational change as the dynamic interplay between two key strategic processes: induced and autonomous strategic processes. The former process hosts strategic initiatives that fall within the scope of a firm's current corporate strategy. While the process is essential to build the distinctive competencies of the firm, it simultaneously contributes to developing organizational inertia by suppressing the firm's capacity to experiment. On the other hand, the autonomous process consists of the strategic initiatives that fall outside the scope of corporate strategy and contributes to increase variations at a corporate level. These strategic initiatives escape from the selective pressures of the internal selection environment, lead to the development of new competencies, and prepare for organizational change by challenging the existing corporate strategy and opening the way to a strategic renewal process.

1.3 The role of top management

The peculiarity of the IOE theory is to depict firms' strategic renewal as a process that blends forces of a different nature: environmental determinism, top managers' voluntarism, and bottom-up pressures. In the IOE model, while bottom-up mechanisms of the strategic renewal process are fairly well understood, the circumstances and the content of top-management behavior remains more ambiguous. According to the model, the top management governs the strategic context determination process by which both autonomous initiatives are "evaluated and funded outside the regular context" (Burgelman, 1991: 247) and the official concept of corporate strategy is amended to retroactively include results of the autonomous process. However, such a process remains "elusive" and deals with "highly equivocal inputs" (Burgelman, 1991: 247). For example, when the top management intends to encourage autonomous process, it is plausible to assume that, at least in part, its role entails tolerating middle managers that carve out resources available in the interstices of organizations when the investment needed is "…too large to do the development *under the table*…" (Burgelman, 1991: 247) and, without "strong and forceful" support from top management, emerging new ventures would fail (Burgelman, 2002: 346). In addition, top management may permit or forbid acquisitions (Burgelman, 2002: 349), thereby regulating the rate of asset accumulation in a new business.

More recently, Burgelman and Grove (2007) proposed that top managers administrate the balance between induced and autonomous strategic processes; yet, there has been limited exploration of how the top management calibrates the balance between induced and autonomous processes, emphasizing or de-emphasizing one or the other, given the strong and complex interdependencies that link the two processes.

2. Methodology

The longitudinal and evolutionary nature of the interaction between induced and autonomous strategic processes makes deriving its implications sufficiently ambiguous. It is difficult to explicate how the processes unfold over time in different contexts to yield different aggregate results. The unfolding of these processes can, however, be observed in a computer simulation. I used a computer simulation to build an experimental environment to closely scrutinize the top management's behavior in allocating slack resources to the autonomous strategic process. The IOE model was originally developed by using an in-depth clinical study of Intel and its successful exit from the DRAM business and its entry into the memory business. The formal model presented in this article incorporates stylized traits of Burgelman's IOE narrative and, thus, describes a large firm that invests significant portions of resources in its induced strategic process and uses a portion of its stock of slack resources to nurture an autonomous process.

Following Sastry (1997), to build the model, a textual analysis was conducted of Burgelman's relevant papers (1983a,b,c, 1985, 1991, 1994, 2002; Burgelman and Mittman, 1994; Burgelman and Grove, 2007). The textual analysis was the basis for identifying constructs and relationships among constructs. In this phase, the IOE model was interpreted within the larger cultural territory that includes the strategy process and resource allocation process literature (Bower, 1970; Noda and Bower, 1996; Bower and Gilbert, 2005), and the behavioral theory of the firm (Cyert and March, 1963; March and Simon, 1958; Levitt and March, 1988).

In a second step, the theoretical model was formalized by creating a system of differential equations[1] (Rahmandad and Repenning, 2015). Finally, once the model was built, the relationships between the structure of the systems and the unfolding behaviors were explored with simulation experiments.

To simulate the model, parameters were calibrated to reproduce a situation whose plausibility could easily be put under scrutiny. The model portrays a large and rich firm with a robust endowment of both slack resources and assets accumulated in its core business. The firm initially operates in equilibrium, that is, assets in core business are stable and produce a stable flow of corporate earnings that cover depreciation of core assets, pay out dividends, and balance out losses that arise from experimentation in a new emerging business.[2]

The simulation study presented in this article is different from Burgelman and Mittman's previous modeling of IOE theory and simulation (1994) in two ways. First, to explain emerging organizational behavior, their focus is on individual decision-making and attitude toward risk at the level of middle management while we focus on top-management behavior. Second, Burgelman and Mittman's experiments are based on a discrete-time simulation, whereas this study emphasizes the dynamic and longitudinal dimension of adaptation. Thus, the model in this article mimics a continuous-time process that investigates how a complex network of interplaying pressures, forces, and inertial effects combine with top-management decision-making to shape a firm's resource accumulation behavior and adaptation.

3. The model

The model is articulated in three sectors that respectively represent dynamics of core asset accumulation and depletion in the induced process, dynamics of noncore asset accumulation and depletion in the autonomous process, and dynamics of slack resources accumulation and depletion. The model includes equations that govern the behavior of a

1 In the following, we describe the formal model; in addition, the software code utilized to simulate the model is available in the supplementary appendix.

2 Initial values of variables are obtained through the equilibrium analysis of the system of differential equations. The equilibrium analysis is available on request from the author.

number of state variables. Standard continuous-time notation represents differential equations to describe the behavior[3] of state variables. Below, I describe the equations of the model.

3.1 Modeling core assets dynamics in the induced process

In the IOE model, a firm's resource allocation pattern in the core business takes place within the induced strategic process and is regulated by a firm's official resource allocation mechanism. Resource allocation mechanisms vary among firms, but in the IOE model particular emphasis is assigned to financial criteria. Thus, in my formal model, resource allocation mechanisms are informed by financial criteria. In my model, the financial rule consists of allocating all available resources to strategic initiatives that yield higher returns on investments. Thus, in equation (1), a_f is the portion of funds allocated to core business with financial criteria. The variable a_f ranges between 1 and 0. The value of 1 indicates a total, 100%, commitment to a firm's core business, while the value of 0 indicates total commitment to a new business. In the equation, π_c and π_n are, respectively, return on asset (ROA) in core and new businesses.

$$a_f = \begin{cases} 1 & \text{if} \quad \pi_c > \pi_n \\ 0 & \text{if} \quad \pi_c < \pi_n \\ 0.5 & \text{if} \quad \pi_c = \pi_n \end{cases} \tag{1}$$

However, in Burgelman's account of the Intel case, despite the evident financial superiority of new businesses, "important amounts of resource continued to flow to (the core business)" (Burgelman, 1991: 245). Similarly, I assumed that the information attached to a_f produces a pressure to modify resource allocation that only gradually influences a firm's resource allocation pattern (A_t). Thus, adjustment of resource allocation pattern is calculated in equation (2) as the weighted average of (a_f) and (A_{t-1}) where the weighting factor τ_a sets the pace at which the resource allocation pattern is molded by incoming information:

$$A_t = A_{t-1} + \int_{t-1}^{t} \dot{A} \cdot dt \text{ with } \dot{A} = \frac{a_f - A_{t-1}}{\tau_a} \tag{2}$$

This formulation has been previously used to describe decision-making processes that are anchored to past historical data and that incrementally take into account incoming information (Sterman, 1987; Lant, 1992; Schneider, 1992; Sastry, 1997).

Assets in core and noncore business may include manufacturing resources (Burgelman, 1994: 25), differentiated skills, complementary assets and routines (Burgelman, 1994: 30), and technological competencies (Burgelman, 1994: 47). They are built as a result of investment in the business and, at the same time, tend to decline because of depreciation. In equation (3), assets in the core business (C_t) are accumulated through a rate of change that is obtained by subtracting the rate of depreciation (c_d) from the rate of investment (c_i):

$$C_t = C_{t-1} + \int_{t-1}^{t} \dot{C} \cdot dt \text{ where } \dot{C} = c_i - c_d. \tag{3}$$

The rate of investment is determined by the level of funds available for investments and the resource allocation pattern A_t. Funds for investments are corporate earnings (e_{corp}) after a certain percentage (ψ) has been drained to accumulate slack resources:

$$c_i = A_t \cdot e_{corp} \cdot (1 - \psi). \tag{4}$$

3 The value of the generic state variable (X), at time (t), is the integral of previous changes as follows:

$$X_t = X_0 + \int_{0}^{t} \dot{X} \cdot dt \text{ where } \dot{X} = \frac{dX}{dt}.$$

Corporate earnings available for internal allocation are calculated as the sum of new and core business earnings minus the cost of overheads and dividends (both indicated by the parameter ς):

$$e_{corp} = (e_c + e_n) \cdot (1 - \varsigma). \tag{5}$$

The depreciation rate of the asset base in the core business captures the obsolescence of intellectual and tangible assets and is calculated in equation (6) by decreasing the asset base C_t by a fixed proportion η:

$$c_d = C_t \cdot \eta. \tag{6}$$

In core business, earnings depend on accumulated assets and average industry ROAs (π_c) and are calculated in equation (7) as follows:

$$e_c = C_t \cdot \pi_c - \rho_c \tag{7}$$

where ρ_c are fixed costs of operating in the business.[4]

3.2 Modeling noncore asset dynamics in the autonomous process

In the autonomous process, I modeled dynamics of asset building in a new emerging business. The process of accumulation of N_t, the assets accumulated in the new business, is described as follows:

$$N_t = N_{t-1} + \int_{t-1}^{t} \dot{N} \cdot dt \text{ where } \dot{N} = n_i - n_d \tag{8}$$

A key feature that characterizes asset accumulation in noncore business is that the latter takes place within the autonomous strategic process. Thus, it is assumed that the emerging business is outside the scope of the focal firm's current strategy and accumulated core competencies. Consequently, in equation (9), investments in noncore business (n_i) is the sum of two components:

$$n_i = (1 - A_t) \cdot e_{corp} \cdot (1 - \psi) + S_t \cdot \epsilon. \tag{9}$$

First, the official resource allocation system allocates a share of financial resources to new strategic initiatives, which corresponds to the $(1 - A_t)$. According to the IOE theory, I expect this component to be initially irrelevant since the autonomous strategic process is excluded from the official resource allocation mechanism, at least until it produces appreciable operational results. Second, I assumed that a portion (ϵ) of accumulated slack resources (S_t) flows to finance autonomous strategic initiatives in noncore business, since slack resources are used to nurture experimentation in strategic initiatives so that the latter "are permitted to grow without real concern for the relation between additional payments and additional revenues" (Cyert and March, 1963:42). The idea that stocks of unabsorbed slack resources are a major engine for organizational change and adaptation is well entrenched in literature (Thompson, 1967; Miles and Cameron, 1982; Bourgeois, 1981; Chakravarthy, 1982). The level of ϵ captures an organizational feature, that is, the opportunities for middle managers to fund initiatives "under the table" (Burgelman, 1991: 247). A larger ϵ identifies tolerant top managers that allow a larger proportion of accumulated slack to flow into the autonomous process.

The rate of depreciation in new business is:

$$n_d = N_t \cdot \eta. \tag{10}$$

In noncore business, earnings are obtained using equation (11). Thus,

4 Core business earnings also determine the decision of the focal firm to remain in the business. To make the simulation more realistic, a control was introduced that forces the firm out of the business when earnings are negative:

$$\begin{cases} if \ \ \mathrm{e_c} > 0 \ \text{ then } \ \mathrm{c_d} = C \cdot \eta \\ else \qquad\qquad\qquad \mathrm{c_d} = C \end{cases}$$

$$e_n = N_t \cdot \pi_n - \rho_n. \quad (11)$$

As shown in equation (11), a strategic process is simulated in which the earnings of initiatives in the autonomous process are completely independent of assets built in a firm's core business. In addition, to account for the role of business-level self-reinforcing mechanisms such as learning and economies of scale that follow from first mover advantages, I explicitly assumed that costs in new business decrease as assets are built. Equation (12) captures the process:

$$e_n = N_t \cdot \pi_n - \rho_n \cdot f_\lambda(N_t) \quad (12)$$

where

$$f_\lambda = \left(\frac{N_t}{N_{t_0}}\right)^{-\lambda}. \quad (13)$$

The function f_λ transforms asset building into a firm's ability to outperform average industry profitability. In the formulation of equation (12), a decrease in costs is the product of economies of scale and learning processes, and the latter depend on asset accumulation, which is captured by the ratio between accumulated asset (N_t) and initial asset (N_{t_0}) [equation (13)] (Arrow, 1962; Radzicki and Sterman, 1994). I assumed that the experience and scale effect are at the lowest level at the beginning of the simulation. If accumulated assets in new business decrease, experience and scale effects cannot decrease further.

3.3 Modeling slack resource dynamics

Finally, unabsorbed slack resource is cash reserves not absorbed by the investment policy and devoted to "payments to the members of the coalition in excess of what is required to maintain the organization" (Cyert and March, 1963: 42). In the model, slack is a stock of resources (S_t) both visible and employable by managers (Sharfman *et al.*, 1988). Slack resources are accumulated in different areas of an organization, allocated to different actors (Cyert and March, 1963), and therefore calculated in many ways. Bourgeois (1981) and Singh (1986) provide an exhaustive analysis of alternative definitions. Unabsorbed slack resources are defined as uncommitted liquid resources in organizations (Singh, 1986) that may be used for investments in emerging businesses. I hypothesized a positive correlation between corporate performances and slack accumulation (Cyert and March, 1963; Singh, 1986; Sharfman *et al.*, 1988) and slack accumulation is modeled as proportional to corporate earnings. The modeled process reflects both deliberate decisions to create internal funds and reserves, and fund accumulation that escapes official bargaining processes. Thus, in equation (14), the process of slack resource accumulation is modeled as follows:

$$S_t = S_{t-1} + \int_{t-1}^{t} \dot{S} \cdot dt \;\; where \;\; \dot{S} = s_i - s_d \quad (14)$$

The accumulation rate is a proportion of corporate earnings since it is assumed that, within an organization, a certain proportion of corporate earnings (ψ) is allocated to build up slack resources:

$$s_i = \psi \cdot e_{corp}. \quad (15)$$

The rate of decrease is the result of two mechanisms:

$$s_d = \begin{cases} S_t \cdot \epsilon & \text{if} \quad e_{corp} > 0 \\ S_t \cdot \epsilon - \mathrm{e_{corp}} & \text{if} \quad e_{corp} < 0 \end{cases}. \quad (16)$$

First, slack resources are deployed to experiment in new business. Second, slack resources provide a reservoir of internal resources to cover losses. Indeed, "the cushion provided by organizational slack allows firms to survive in the face of adversity. Under pressure of a failure (or impending failure), to meet some sets of demands on the coalition, the organization discovers some previously unrecognized opportunities for increasing the total resources available" (Cyert and March, 1963:43). Thus, it is assumed that if corporate earnings are positive, slack resources are only eroded by the outflow directed to autonomous processes; when losses occur, slacks cover losses.

4. Simulation experiments

The analysis is articulated in three steps. In the first step, an equilibrium run is produced as a reference mode that serves as a benchmark to evaluate the impact of a model's changes on emerging behavior. In a second step, the equilibrium is disturbed by simulating a scenario in which core business ROA decays and new business ROA surges so that after five simulated years (60 simulated months) ROA in core and new businesses are equal, and after 10 simulated years (120 simulated months) ROA in core and new businesses are, respectively, −20% and 20% (Figure 1).

In this second step, the ability of the modeled firm to successfully implement a strategic renewal is tested, by dismissing core business and building a healthy competitive position in the emerging business. It is assumed that the simulated firm fails strategic renewal, if it is not able to build up assets in new business and to reach a level of positive corporate earnings (even after a period of losses). Of course, the model considers a limit in the losses that the modeled firm can afford. Indeed, the firm fails if accumulated losses become larger than accumulated assets, the latter being equal to the sum of slack resources and assets in both core and noncore business. In the scenario of Figure 1, the firm fails to adapt. This simulation run is labeled *standard fail*. Table 1 reports calibration of the model's parameters in the *standard fail* simulation run.

The third step of the research explores which plausible interventions on the standard model improve adaptation performances. First, the model is simulated by assigning different values to the parameter ϵ in the range 0–1.[5] In these experiments, ϵ is a parameter whose exogenously assigned value remains constant throughout the simulation. Table 2 reports the calibration of the parameters in two selected experiments. A more sophisticated routine, which I labeled *top management calibration*, is then introduced to simulate the top management's behavior in regulating parameter ϵ.[6] When the routine is applied, ϵ is endogenously defined and adapts dynamically as the simulation unfolds.

4.1 Modeling top-management behavior

More specifically, in the third step of the experimentation protocol, I modeled the calibration of ϵ as an endogenous process. The idea underpinning the formulation is that, given a minimum fixed amount of slack that physiologically drains to new ventures ($\bar{\epsilon}$) (see Table 2 for the calibrations of $\bar{\epsilon}$ in the experiments), during the strategic context determination process, the top management may decide to assign a supplementary portion of slack resources when expected performances in the core business become pessimistic (when the parameter ϵ is endogenous we refer to it as $\tilde{\epsilon}$). Expected performances are operationalized as the perceived gap ($g_t{}^P$) between expected earnings in core business and actual earnings. The assumption here is that the top management is more likely to explore alternative courses of action when it is unhappy with the performances of the core business. Similarly, Burgelman suggests that "...emphasis on either expansion of mainstream business or diversification..." depends "...on perceptions, at different times, of the prospects of current mainstream business" (Burgelman, 1983a: 240).

More generally, the idea that decision-makers tend to repeat actions that produced good results and abandon actions that generated bad results is rooted in the early studies of micro-sociology (Homans, 1961), in the behavioral decision theory, according to which decision-makers discard a decision-making rule, and search for a new one, when motivated by unsatisfactory results (March and Simon, 1958; Cyert and March, 1963; Ginsberg and Baum, 1994), and in the prospect theory where attitude to experiment increases in loss domains (Tversky and Kahneman, 1979). Top managements' allocation behavior is described in equation (17) using the function $f_s(g_t{}^P)$.

$$\tilde{\varepsilon} = \bar{\varepsilon} + f_s(g_t^P) \quad (17)$$

The function $f_s(g_t^P)$ captures more or less informal policies through which the top management lets unabsorbed slack resources be used to support an autonomous strategic process (Burgelman, 1991: 250) by middle managers. Following Lant and Mezias (1992), who modeled the probability of organizational change as an increasing function of the size of the discrepancy between actual performance and aspiration level, $f_s(g_t^P)$ is an increasing function of the

5 Sensitivity analysis is conducted in two steps. First, 100 runs were simulated by assigning to ϵ values starting from zero and increasing by 0.1 up to 1. Second, 1000 runs were simulated by randomly assigning to ϵ values in the range 0–1.

6 In this section, we specifically refer to the parameters that have a theoretical interest. However, sensitivity tests were conducted on all the parameters of the model to check that these changes have only scaling effects on the model behavior.

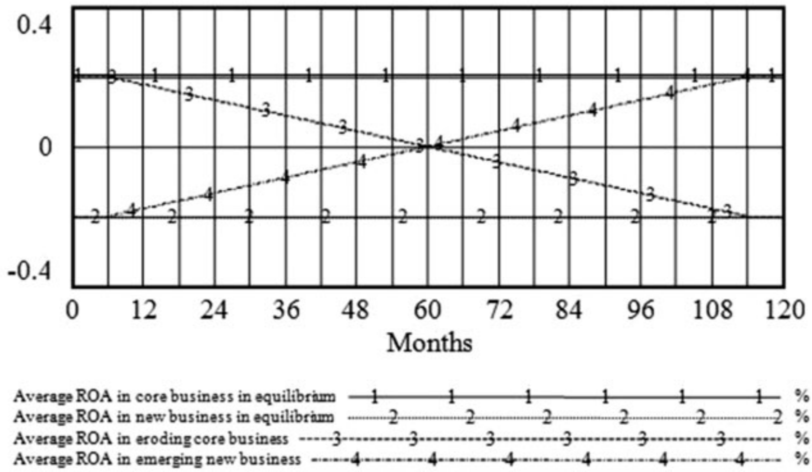

Figure 1. Environmental scenario.

Table 1. Description and calibration of the model parameters

Symbol	Name	Value	Unit of measure
π_c	Average industry ROA in core business	0.2 (at t_0)	%
π_n	Average industry ROA in new business	-0.2 (at t_0)	%
$\rho_c + \rho_n$	Fixed costs in core and new business	6	\$
η	Asset erosion rate in core and new business	0.02	%
λ	Strength of learning economies	1	Dimensionless
ς	Cost of overheads and dividends	0.6	%
ψ	Slack resource accumulation	0.1	%
ε	Proportion of slack to the autonomous process.	0.001	%
$\bar{\varepsilon}$	Slack resource drain (in the experiment with endogenous slack allocation policy)	0.001	%
τ_a	Time to adapt allocation pattern	3	Months
τ_r	Time to react to change in expectations	3	Months
τ_e	Time to adapt core business expectations	3	Months
C_{t_0}	Initial value of assets in core business	49.09	\$
N_{t_0}	Initial value of assets in new business	5.45	\$
S_{t_0}	Initial value of slack resource stock	109.09	\$

Table 2. Calibration of the model parameters in the reported experiments

Experiment		Parameter value
Standard fail	Low slack drain	$\epsilon = 0.001$
	High slack drain	$\epsilon = 0.5$
Top-management calibration	Analysis of expectation adaptation	$\bar{\epsilon} = 0.001; \tau_e = \{1, 3, 9, 24\}$
	Analysis of reaction to change in expectations	$\bar{\epsilon} = 0.001; \tau_r = \{1, 3, 9, 24\}$

perceived gap (g_t^P). Thus: $f'_s \geq 0; f''_s > 0; f_{s\min} = 0; f_{s\max} = 1$. The function modifies equation (9) as explained in equation (18):

$$n_i = (1 - A_t) \cdot e_{corp} \cdot (1 - \psi) + S_t \cdot \tilde{\epsilon}. \tag{18}$$

The pressure exerted by the gap is modeled as a process of smoothed average of information on the actual gap (g^A). The formulation mimics the inertia needed for the pressure to accumulate; the parameter $\tau_r$plays a key role in representing top-management decision-making since it represents the *time to react to change in expectations*, or the delay in perceiving the need to intervene [equation (19)].

$$g_t^P = g_{t-1}^P + \int_{t-1}^{t} \dot{g}^P \cdot dt \text{ where } \dot{g}^P = \frac{g^A - g_t^P}{\tau_r} \tag{19}$$

The actual gap between expected earnings in core business (e_t^E) and earnings (e_c) is then calculated as follows:

$$g^A = \frac{e_t^E - e_c}{|e_c^E|} \tag{20}$$

The process of expectation formation in core business (e_t^E) is again modeled as a smoothed average of information concerning past earnings in the core business. The parameter τ_e, that is, the *time to adapt core business expectations*, is another crucial element of top-management decision-making and describes the pace at which expectations adapt to incoming information on past earnings in the core business:

$$e_t^E = e_{t-1}^E + \int_{t-1}^{t} \dot{e}_t^E \cdot dt \text{ where } \dot{e}^E = \frac{e_c - e_t^E}{\tau_e} \tag{21}$$

To explore the behavior of the function $f_s(g_t^P)$, a sensitivity analysis was conducted on the parameters τ_r and τ_e.

5. Simulation results

Simulation experiments convey a first insight: there is no constant value in the range 0–1 that, once assigned to the parameter ϵ, allows the focal firm to adapt. Thus, the parameter ϵ needs to be regulated along the way, and this regulation appears to be a fairly complex issue.

Figure 2 compares earnings in new businesses both in the standard fail and in the case in which the function $f_s(g_t^P)$ is activated. For the standard fail, I present two simulations, respectively, with $\epsilon = 0.001$ and $\epsilon = 0.5$. As shown, with both values, the new business is unable to take off (curves 1 and 2). On the other hand, by applying the $f_s(g_t^P)$ function, the firm survives (curve 3). High values of ϵ (curve 2) correspond to an early investment of slack resources

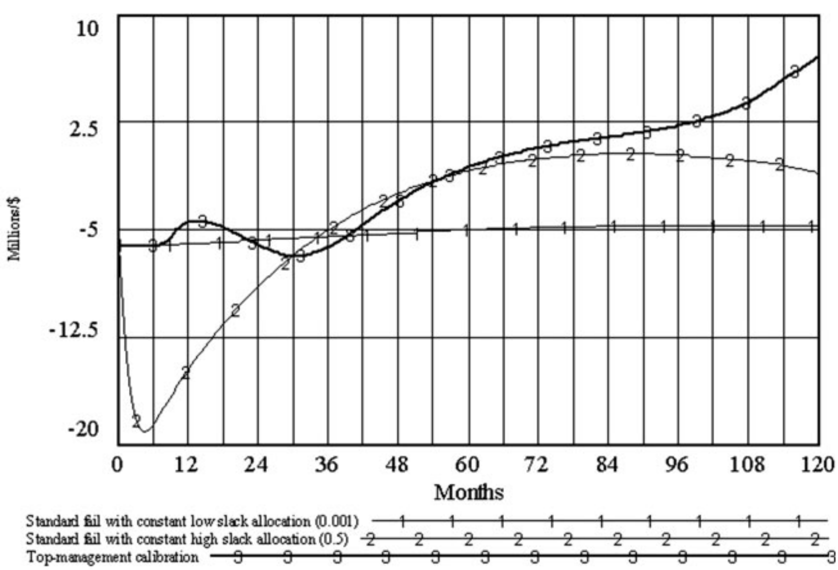

Figure 2. Simulated path of earnings in new business.

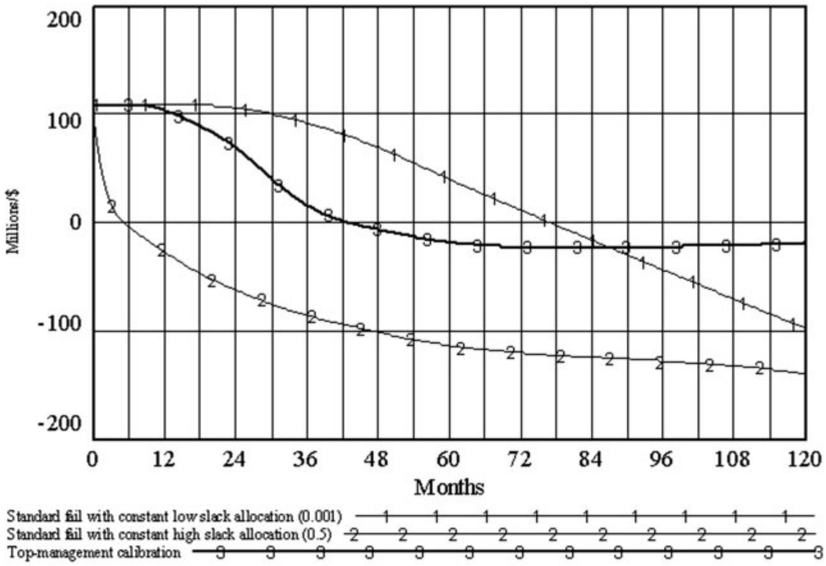

Figure 3. Simulated path of slack resource allocation.

when new business profitability is still negative. Large investments produce large losses that weaken core business when this is still the main source of slack resource accumulation. On the other hand, low values of ϵ are connected to too timid investments in new business that do not allow the latter to grow and to trigger learning (curve 1). Thus, when the core business starts to decline, assets accumulated in the new business are small and the business is too weak to survive.

As for curve 3, when $f_s(g_t^P)$ is activated, earnings in new business oscillate before the simulated month 48. The analysis of the oscillations conveys insights on the complex adaptation dynamics. In the first 12 simulated months, curve 3 shows an increase in earning in new business. This increase follows from the ability to calibrate investments in new business to exploit learning curve advantages without producing large losses. Beginning in month 12, earnings reported in curve 3 decrease, whereas earnings reported in curves 1 and 2 improve. Figure 3, which compares the paths of slack resources, provides an explanation. When $f_s(g_t^P)$ is activated, during the first simulated year, losses are limited. Therefore, at the end of the year, slack resources are still available to support investments in the new business. The investments produce the reported losses. When $\epsilon = 0.001$, losses do not occur, simply because investments in the new business are too low. On the other hand, when $\epsilon = 0.5$, losses do not occur because the company has exhausted slack resources (curve 2 in Figure 3), investments in new business are interrupted, and losses are thus reduced.

This is a key turning point. To sustain earnings in a business in which average industry ROA is still negative, a further investment would be required. At the same time, however, the core business is deteriorating. Core business erosion wears down corporate resources and, hence, slack resources. Thus, once investments have displayed their effect in the first simulated year, earnings in new business fall. Slack continues to flow in the new business because slack allocation is guided by the deteriorating performance of core business. However, the slack flow is fading because core earnings are weakening and, consequently, slack stock is eroding away. On the other hand, ROA in new business is increasing and, thus, earnings start to rise again from simulated month 30. The fate of the firm is forged between simulated months 54 and 60, when earnings in the new business are higher than those in the core business and the firm officially abandons its core business. Now, official resource allocation mechanism is able to redirect available corporate resources to the new business, and the latter can survive without the support of slack resources. In the standard fail simulation, with low values of ϵ, slack resources are initially preserved (curve 1 in Figure 3) but investments are cut. When core business starts to decline, assets accumulated in the new business are small and the firm is too weak to survive. Thus, slack resources gradually erode away. When high values of ϵ are considered, an early dissipation of slack resources occurs when new business profitability is still negative (curve 2 in Figure 3). On the other hand, when function $f_s(g_t^P)$ is applied, slack stock erodes faster than curve 1 because resource allocation to the autonomous process accelerates as core business performance erodes, but slack erosion is slower than in the case of curve 2 because slack allocation has unfolded gradually.

What the simulation study suggests is that there is a time window (in the simulation it is located between month 50 and month 60) in which core earnings are no longer able to build up slack resources, perspectives in new business are still uncertain and official resource allocation mechanism is still cautious in allocating resources to new business. At this point, having the largest possible slack stock accumulated will provide enough reserve to support the new business in the transition through the window. The larger the window, the more dangerous the transition and the more slack is needed. In the model, two factors contribute to shorten the window. First, the learning curve: the faster the learning, the sooner the firm will become profitable in the new business. Second, the time required by the new business to transit from the introduction phase of the life cycle to the growth phase. Given these exogenous factors, however, what should the top management do to manage the transition? Simulation experiments suggest that the top management should be able, perhaps counterintuitively, to contain slack flow when core business is healthy and gradually release accumulated slack when core business weakens.

To further explore this point, a sensitivity analysis has been performed on two parameters: *time to adapt core business expectations*, τ_e, and *time to react to change in expectations*, τ_r. Both the parameters point to the same issue: top management's behavior in processing information on core business performances and in responding to this information. As for the parameter τ_e, Figure 4 suggests that corporate earnings improve when the parameter diminishes; that is, top management's expectations on core business performances rapidly adapt to past performances. With shorter delays, expected earnings quickly adapt to historical earnings and the gap is kept small, thereby reducing the pressure to act on slack flow. Figure 5 suggests that, if τ_e is small enough, the top management's intervention on slack flow peaks when core business earnings become negative (curve 1). More precisely, small τ_e describes a situation in which top managers do not overreact to the worsening of core business performances. As a consequence, the investment in the new business, rather than being dissipated along the adaptation path, is concentrated when needed, that is, in the crucial window of time between months 48 and 50. Such a measured manipulation preserves slack resource and adaptation chances.

Parameter τ_r affects simulated strategic renewal in a similar way. As shown in Figure 6, corporate earnings grow as the value of τ_r increases. In Figure 7, by increasing *time to react to change in expectations*, a smoothing effect is produced that prevents the simulated firm from overreacting to reported change in performances. Again, moving toward a smoother process contributes to focus slack allocation when earnings in core business are closer to zero.

Figure 8 helps to capture the role of the two parameters in connection to the deep causal feedback structure that underpins the relationships among new business, core business, and slack resources. As shown in Figure 8, investment in new business needs slack resources (link 1). While perspectives in new business are unclear though, investing in the new business when ROA is negative implies large losses (link 2). Consequently, at the beginning of the simulation, both investments in new business (link 3) and the related losses (link 4) deplete slack resources. Of course, the more we invest, the more assets we build and the more we trigger economies of scale and learning that reduce losses (links 5/a and 5/b). This asset accumulation process, however, is burdened with some inertia and only produces its beneficial effects in the longer term. On the other hand, slack stock is accumulated by core earnings (link 6). Allocating large portions of slack flows too early means slack stock being eroded by losses and the resources generated by the core earnings dissipated in counterbalancing these losses. In this respect, earnings in the core business influence the flow of slack to the new business in two ways. First, they make resources available through link 6. Second, they inform top managers through link 7: when earnings in the core business decrease, slack flow to new business (if still available) increases.

This feedback perspective captures the paradox that hinders the take-off of the new business. In the diagram in Figure 8, three feedback structures mold the unfolding simulated behavior. The structures have different dynamic properties. One structure is positive feedback, which reinforces received stimuli, the other two are negative feedback, which counterbalance the stimuli (Plowman *et al.*, 2007; Albert *et al.*, 2015).

In the reported simulations, the fate of the autonomous process depends on the ability to activate the positive feedback that triggers a self-reinforcing process. In Figure 8, as slack resources flow builds up assets in the new business (link 5/a), losses in the new business decrease (link 5/b), stock of slack resources stops eroding (link 4), slack flow gets larger (link 1), and, therefore, further slack flow can be allocated to accumulate assets in the new business (link 5/a again).

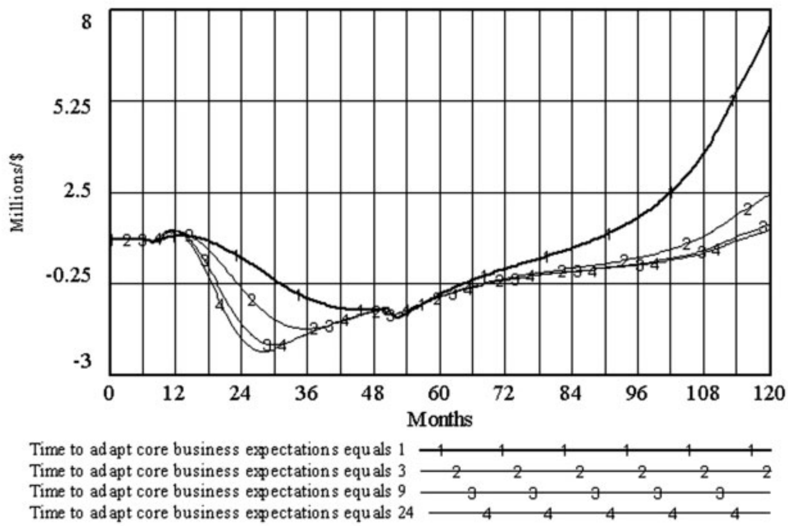

Figure 4. Simulated path of corporate earnings with different calibration of τ_e.

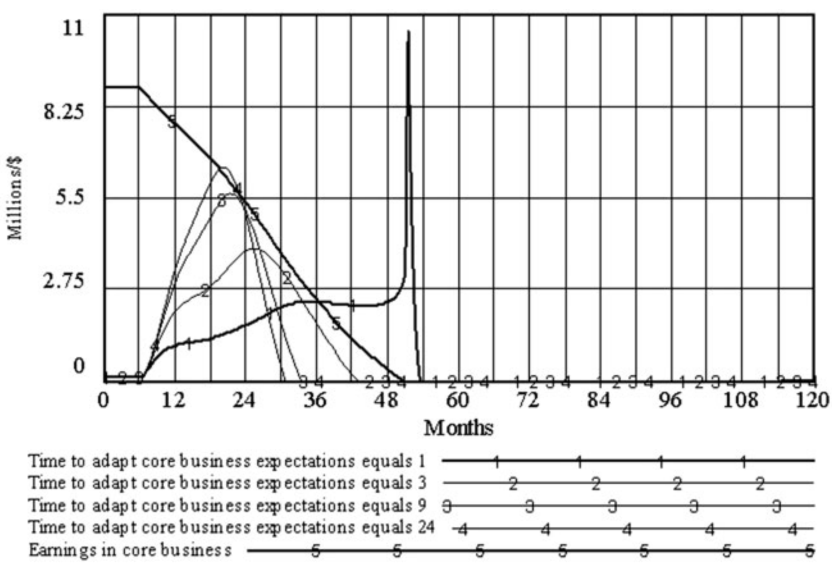

Figure 5. Simulated slack allocation to autonomous process with different calibration of τ_e.

On the other hand, however, the positive feedback is counterbalanced by two types of negative feedback. The first of these connects slack flow in the new business and the stock of slack resources. When slack flow increases, the stock of slack resources erodes (link 3) and, as a consequence, further allocation is curbed (link 1). In addition, a second type of negative feedback intervenes as the slack that flows into the new business generates losses (link 2). The losses erode slack stock (link 4), thereby curbing slack flow (link 1).

The feedback perspective suggests that, in the reported simulations, much of the success of strategic renewal depends on how carefully the three structures are managed. Thus, in this feedback perspective, parameters τ_e and τ_r are important because they define the top management's behavior in orchestrating the combination of the three types of feedback.

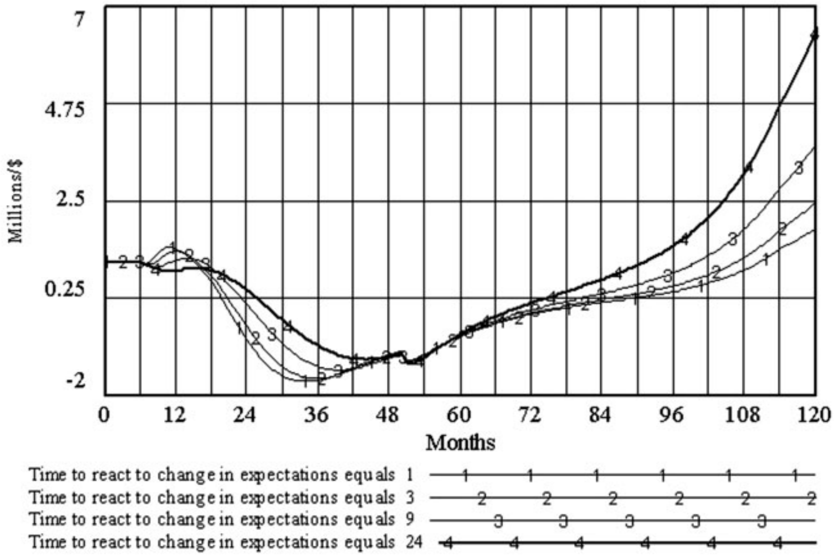

Figure 6. Simulated path of corporate earnings with different calibration of τ_r.

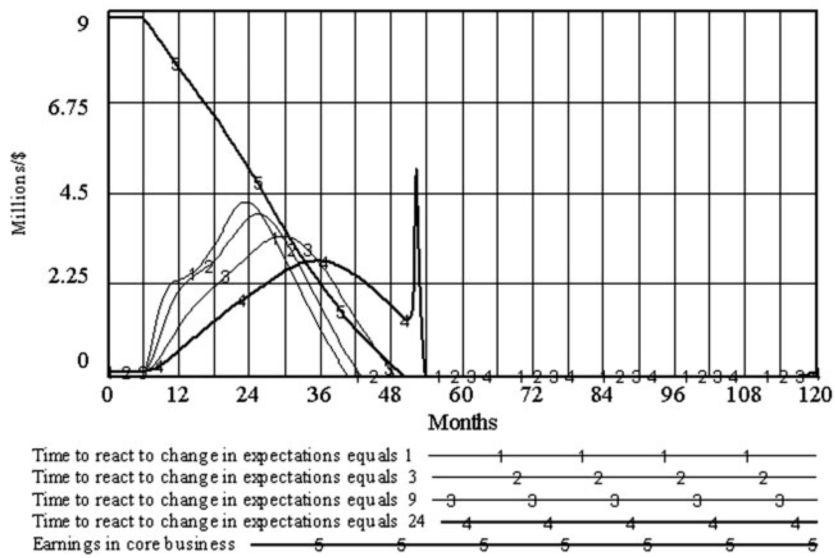

Figure 7. Simulated slack allocation to autonomous process with different calibration of τ_r.

More precisely, the parameters connect the path of slack allocation to the new business to the dynamics of the core business performance (link 7). As shown in the graph, increases in τ_e and τ_r will, respectively, amplify or smooth the intervention on slack flow. Thus, the relationship between core earnings and slack flow is mediated by τ_e and τ_r.

As for τ_e, an increase in the parameter expands the slack flow in the new business. The larger the τ_e is, the more slowly deteriorating performances in the core business contribute to changing top management's expectations. This implies that top management is not ready to adapt to a deteriorating core business by adjusting its expectations concerning the business downward. Put differently, the smaller τ_e is, the faster top management adapts to low performances in the core business, and the more they consider these performances physiological rather than a dramatic event. The parameter τ_e captures the phenomenon that Levitt and March called *superstitious learning* (1988), which occurs

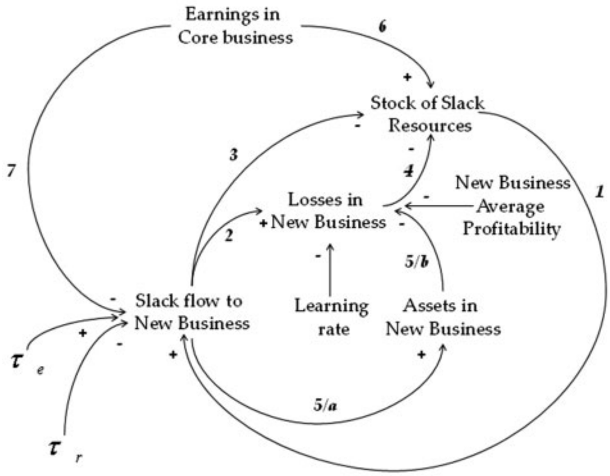

Figure 8. Feedback structure underpinning investment in new business.

when rapid adaptation of aspirations forces targets to very rapidly follow current performance levels. In the case reported in the simulation study, when τ_e is small, aspirations rapidly adapt to performances and, as a consequence, the deterioration of the core business does not encourage top management to unleash slack resources. The larger τ_e is the more prone top management is to allocate slack resources to the new business, in the face of the emerging weakness of core business.

The effect of τ_r on the flow of slack resources is the opposite. Here, as τ_r increases, the flow of slack resources to new business decreases. A large value for τ_r means that an increase in the gap between expected and actual performances takes longer to trigger a reallocation of slack flow to the new business.

Therefore, in the feedback perspective presented, τ_e and τ_r are brakes or accelerators that speed up or rein in the feedback loop described.

6. Discussion and conclusions

Drawing on Burgelman's rich inductive research, this article presents a model that tries to complement the IOE model of adaptation. While the IOE model emphasizes the role of slack resources stocks and of bottom-up decision-making mechanisms, this article highlights the coordinating role of the top management. The model's aim is to offer a parsimonious explanation for how this coordinating role materializes.

The findings of the simulation study suggest that the top management's intervention is fundamental in calibrating the flow of slack resources to the autonomous strategic initiatives flourishing in the new businesses. This calibration needs to incorporate a delicate balance between sharpness in extrapolating trends from past results and caution in reacting to perceived threats to core business. This combination may result in an extremely powerful adaptation mechanism when the environment produces ambiguous signals. In this vein, this work contributes to investigate how the top management needs to coordinate induced and autonomous strategic processes when taking bet-the-company decisions such as the leaving a business. The focus on the concepts of *time to adapt core business expectations* and *time to react to change in expectations* may light up the direction for the empirical investigation of cases of failed strategic renewal.

In this perspective, as a more general contribution, the article provides specific points to support the idea that corporate managers matter, as presented by Adner and Helfat (2003: 1023). More precisely, I focused on what the attractive traits of managerial intervention that reveal *dynamic managerial capabilities* (2003: 1023) are. While the IOE model originally emphasized the role of middle managers in carving out slack resources to invest in new business, I suggest that this activity faces a limit when resource requirements increase so rapidly that it becomes impossible to fund the new venture under the table (Burgelman, 1991: 247; Eisenman and Bower, 2005). In addition, front-line and middle managers are likely to have a local view focused on the necessity to attract resources for their ventures; this view does not necessarily consider long-term and corporate-wide negative consequences of accelerating resource flow to a new venture. The described experiments portray a scenario in which dynamic managerial capabilities are connected to the ability to rapidly update expectations and carefully measure interventions. These capabilities support top management with a historical perspective that impresses a desired longitudinal pattern over resource accumulation. The historical perspective associated to a feedback perspective helps to recognize points in time in which it is possible to intervene and points in time in which organizational behavior emerges as the necessary result of underlying pressures. Endowed with such dynamic capabilities, in the presented simulation study, top managers are capable of maintaining some discretion in governing adaptation by mindfully deviating and molding emerging paths of resource allocation so that strategic renewal emerges as a *guided evolution* (Lovas and Ghoshal, 2000) or a *path creation* (Garud and Karnøe, 2001: 6–9). The firm portrayed in the experiments survives even in a very unfavorable environment where the core business undergoes a sharp decay and experimentation in a new business still produces ambiguous signals. Burgelman and Grove (2007) suggest that when a firm faces these circumstances, the top management plays a key role in taking bet-the-company decision to leave core business and invest in a new business. The simulation study suggests that to take this bet-the-company decision requires the top management to be able to exit from core business and simultaneously mold the longitudinally unfolding path of slack resource allocation.

From this angle, the results presented are addressed to those interested in the analysis of the quality of managerial gut decisions, or intuition. As Dane and Pratt (2007) suggest, effective intuitive decision-making is connected to complex cognitive schema and holistic associations. The feedback approach that is presented in this article suggests that how information on core business performances informs decisions on slack allocation depends on how articulated the managerial cognitive map is of cause–effect relationships among relevant processes and resources.

More importantly, the feedback approach helps to reframe the debate on determinism versus strategic choice. As De Rond and Thietart infer, strategic choice is insufficient to account for strategy, and causal backgrounds are necessary to interpret and exploit chance events (2007: 546). Causal backgrounds are contextual variables that both constrain and inform choice (2007: 536). The idea conveyed in this article is that honing managerial skills in feedback thinking improves the quality and the scope of strategic choice. The managers that are capable of eliciting complex feedback structures are better prepared to deal with the choice between the acceptance of the *necessity* of the path they are evolving along, and the *choice* of exploring novel trajectories.

More generally, this article contributes to advancing the use of feedback thinking in strategic management and organizational studies (Forrester, 1961; Sterman, 2000; Morecroft, 2007). Feedback thinking often surfaces when strategic renewal (Burgelman, 2002; Albert *et al.*, 2015; McKinley *et al.*, 2015), inertia, and adaptation are under analysis (Dobusch and Schubler, 2013). Yet, with a few notable exceptions (Romme *et al.*, 2010; Plowman *et al.*, 2007), one problem that characterizes managerial applications of feedback theory concerns the recurring focus on the concept of positive feedback (Dobusch and Schubler, 2013). This perspective masks the greater advantage provided by feedback theory: the interpretation of positive and negative feedback as the elementary building blocks of aggregated structures in which positive and negative feedback work in combination.

Furthermore, in the presented study, the concept of slack resource has been unpacked by modeling both stock and flows of slack resources. Computer simulation was used to separately examine the role of slack flow and of the availability of absolute levels of slack stock (Bourgeois, 1981; Sharfman *et al.*, 1988).

On the one hand, simulation experiments corroborate previous findings concerning the role of slack resources in corporate adaptation. As suggested by Burgelman (1991: 248), the experiments confirm that availability of stocks of slack resources is a necessary condition for successful strategic renewal. More specifically, in reported experiments, slack resources play a key role at the beginning of the simulated strategic renewal process when they absorb losses arising from experimentation in new businesses. On the other hand, experimentations further explore the role of slack resources by investigating desirable longitudinal patterns of slack flow to the autonomous strategic process. The enquiry reveals that a policy that correlates the longitudinal path of slack flow to the rate of deterioration of core business performances contributes to obtaining successful strategic renewals. This policy generates a pattern of slack allocation to the new business that prevents both delays and pathological acceleration in the rate of investment.

My findings resonate with the analysis of Beck *et al.* (2008) on organizational adaptation, which stresses the crucial role of slack resources along the path of adaptation.

In the light of this, Dierickx and Cool (1989: 1507), addressing properties of resource accumulation processes, talk about *time compression diseconomies* to describe situations in which compression of the time needed to accumulate a resource stock leads to undesired consequences. In the simulations, time compression diseconomies occur when pushing asset accumulation too early in a new business results in corporate resource dissipation rather than in a healthy take-off of a new venture. In the early history of the strategy renewal process, moving too many slack resources to a new resource-dissipating business might result in heavy losses that weaken corporate resources and the core business. On the other hand, *time delay diseconomies* occur as a consequence of a policy that delays slack resource allocation and asset accumulation in new business. The longer the slack resource allocation is delayed, the smaller the stock of slack available to support new business will be. Such delays might become hazardous when the new business is characterized by first mover advantage and when new business cannot share assets with the old core business.

As another contribution, therefore, this work addresses those interested in bridging resource-based view (Wernerfelt, 1984; Barney, 1986; Peteraf, 1993; Helfat and Peteraf, 2003) and strategy-process literature (Peteraf, 2005). Simulation experiments show how the dynamics of a firm's resource endowments explain the heterogeneity of observed patterns of strategic renewal. The properties of resource accumulation processes may assist as intermediate constructs between resource allocation decisions and unfolding paths of strategic renewal. For example, the reported experiments offer a clear example of how the concept of *time compression diseconomies* is particularly useful to address emerging dynamics of strategic renewal. The simulation study also provided an environment that helps to vividly illuminate the property of *interconnectedness* (Dierickx and Cool, 1989: 1508) as a powerful conceptual device that forces researchers to critically reconsider the relationship between induced and autonomous processes. Asset stocks in core and new businesses are interconnected because, to be accumulated, they both claim corporate resources, and thus, they compete for scarce resources.

However, on the other hand, given that the accumulation of stock of slack resources depends on corporate performances (Cyert and March, 1963; Singh, 1986), accumulation of asset stock in core business supports accumulation of stocks of assets in new business by making available slack resources. Thus, despite the attitude to think of the asset accumulation processes in new and core businesses in fierce competition with each other, experiments reveal that, at least in specific windows of time, they seem to cooperate rather than to compete.

Like any model, the one presented also has limits that reflect its maintained assumptions. Perhaps the most obvious of such limits derives from the assumption of top-management agency as being generated by a single decision-maker. The analysis of interaction dynamics within top-management teams and the role played by intraorganizational political processes may be the object of future work.

In this direction, for example, Rotemberg and Saloner (2000) modeled the interaction among three strategic layers and highlighted the role that governance mechanisms and reward systems have in balancing the relationship between visionary top management and middle managers. From this perspective, the model could be expanded by addressing the role of board composition and structure, as well as reward systems.

Another limit is that the modeling, and the related analysis, focus on top management's ability to manage financial resources. Yet, top management has a pivotal role in determining an organization's strategic context by highlighting opportunities for "... either expansion of mainstream business or diversification" (Burgelman, 1983a: 240). As reported by Tripsas and Gavetti (2000: 1157), in the face of radical environmental discontinuities, organizational adaptation is connected to "...the way managers model the new problem space and develop strategic prescriptions premised on this view of the world." From this perspective, future works may investigate how a more nuanced description of top management's strategic analysis affects the way in which firms face inertia and adapt to jolts in the external environment.

The presented simulation study highlighted the crucial role of time in the processes of expectation formation and resource allocation; future work can use empirical and case-based studies to investigate in greater detail how heterogeneity of patterns of strategic renewal is generated by different governance structures and by top-management teams with different features. Also, despite the calibration of the model's parameters and the fact that specification of functional forms has been designed to reflect plausible and general organizational features, further work may explore the implications of different parameter calibration or of different functional specifications. In addition, empirical analysis may test whether and how the parameters and the causal relationship that are reported in the simulation are connected to the performances of strategic renewals. In general, the contribution of this article is to ferret out some of the desirable features of top-management behavior. I suggest that if this line of enquiry is properly cultivated and extended, it may lead to the portrayal of what capabilities top managers are required to have to manage complex strategic dynamics.

Supplementary data

Supplementary appendix data available in online

Acknowledgements

I thank John Morecroft and Tomoyoshi Noda for their comments on a previous version of this paper. I also wish to acknowledge the insightful suggestions received from two anonymous reviewers.

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